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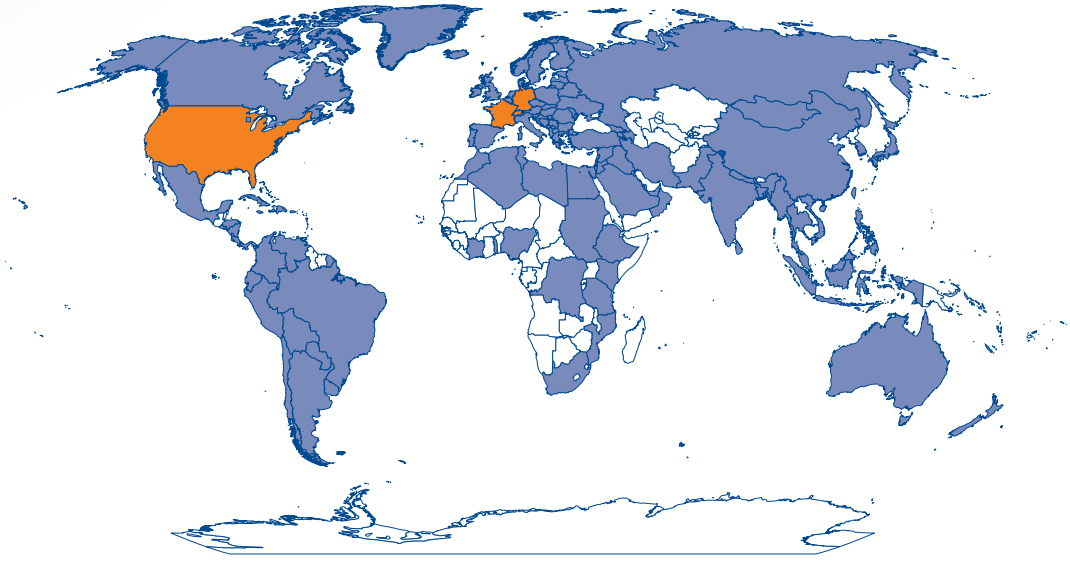

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MACHEREY-NAGEL · Company profile

Since 1911 MACHEREY-NAGEL has represented high quality, innovation and reliability in chemical and biomolecular analysis. Friendly expert advice for our highly valued customers as well as outstanding product quality have been the cornerstones of our corporate success for more than 100 years. CEO C. Wagner, the great-granddaughter of the company's founder, has been managing the enterprise since 2000.

Our product ranges:

Filtration

Rapid Tests

Water Analysis

Chromatography

Bioanalysis

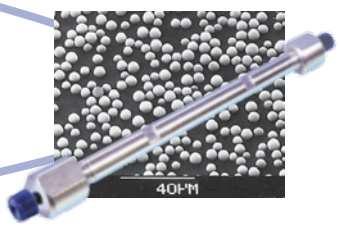
Dedicated from the very first: Milestones of Chromatography at MACHEREY-NAGEL

Chromatography

1952:
MN launches the first products for paper chromatography. In the same year, Martin and Synge receive the Nobel Prize in Chemistry for the development of partition chromatography.

1961:
MACHEREY-NAGEL becomes one of the pioneers in TLC.

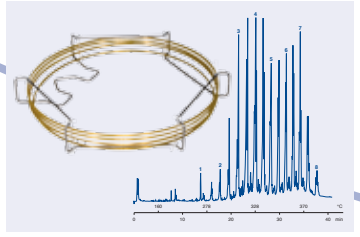
1970:
Expansion of the product range by column chromatography



1974:
NUCLEOSIL® · one of the first spherical HPLC silicas leads to our core competence in silica technology

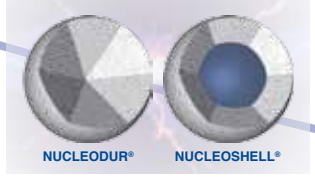
1982:
first fused silica capillary columns for GC

1987:
CHROMABOND®
columns for SPE



1994:
OPTIMA®
capillary columns for optimum GC separations

2002:
NUCLEODUR®
high purity spherical silica for HPLC



2011:
NUCLEOSHELL® core shell silica for highest efficiency in HPLC

MACHEREY-NAGEL on the internet

Visit our Chromatography pages

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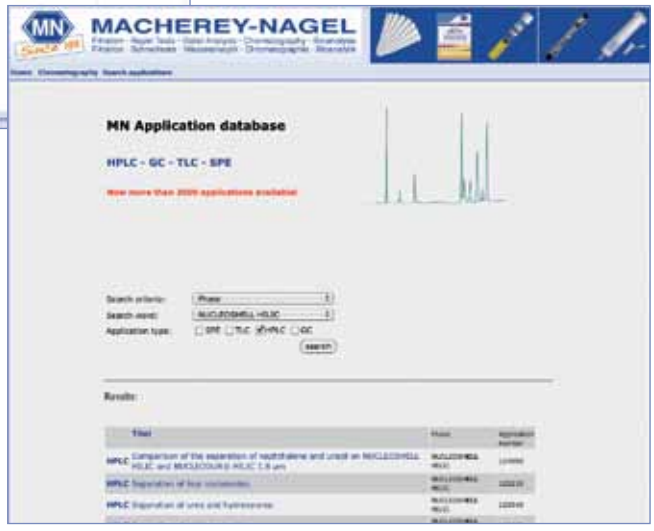

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Chromatography

Catalog contents

New products for sample preparation

Sample preparation

CHROMABOND® HR-Xpert

your way to cleaner samples by SPE

The professional concept of innovative RP and mixed-mode ion exchange phases for SPE

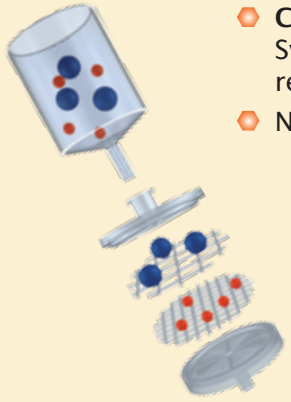
- **CHROMABOND® HR-X** · hydrophobic PS/DVB copolymer
- **CHROMABOND® HR-XC** and **HR-XCW**
  strong and weak mixed-mode cation exchangers
- **CHROMABOND® HR-XA** and **HR-XAW**
  strong and weak mixed-mode anion exchangers
- **Now available in 2 particle sizes:**
  standard particle size 85 µm
  particle size 45 µm for smaller sample volumes, lower adsorbent weight and smaller elution volumes

… Order your free samples today!
info@mn-net.com

Page 10

New CHROMAFIL® filters

for optimum filtration results



- **CHROMAFIL® Combi filters**
  Syringe filters with a coarse glass fiber prefilter recommended for solution with a high particle load
- New dimensions and pore sizes for Nylon, cellulose acetate and PTFE filters

Page 68

Vials and closures

completely revised product range

- Large selection of
  - **Crimp neck vials, crimp closures, crimping tools**
  - **Screw neck vials and screw closures**
  - **Special vials and closures**
- High quality products at an equitable price performance ration

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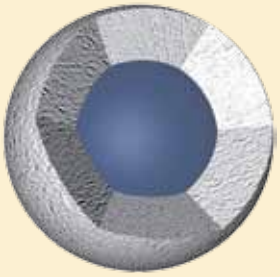
New products for HPLC

NUCLEOSHELL® core-shell silica

for rapid, efficient HPLC



- Solid core of silicon dioxide, homogeneous shell of porous silica
- Highest efficiency compared to totally porous materials
- Pore size 90 Å; particle size 2.7 µm (core 1.7 µm); specific surface 130 m^2/g
- Lower back pressure enables use on conventional LC systems
- Pressure stability 600 bar

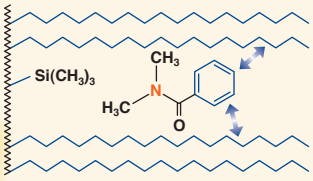
Page 144

NUCLEOSHELL® RP 18

nonpolar high density phase

- **Key features:**
  - Suitable for **LC/MS** and HPLC at pH extremes (pH 1–11)
  - Superior base deactivation, ideal for method development
- **Recommended application:**
  Overall sophisticated analytical separations, e.g., analgesics, anti-inflammatory drugs, antidepressants; herbicides; phytopharmaceuticals; immunosuppressants

  USP L1



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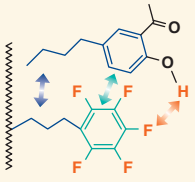
NUCLEOSHELL® PFP

hydrophobic pentafluorophenyl phase

- **Key features:**
  - Hydrophobic phase with alternative selectivity in comparison to classical C_{18} modifications
  - Separation principle based on 4 retention mechanisms (polar interactions (H bonds), dipole-dipole interactions, π–π interactions, hydrophobic interactions)
- **Recommended application:**
  Aromatic and unsaturated compounds, phenols, halogenated compounds, isomers, polar compounds like pharmaceuticals, antibiotics; high retention of basic compounds

  USP L43



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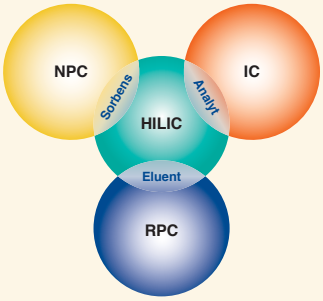
NUCLEOSHELL® HILIC

zwitterionic phase



- **Key features:**
  - Ideal for reproducible and stable chromatography of highly polar analytes
  - Very short column equilibration times
- **Recommended application:**
  Hydrophilic compounds such as organic polar acids and bases, polar natural compounds, nucleosides, oligonucleotides, amino acids, peptides, water soluble vitamins

Page 152

New products for HPLC

NUCLEODUR® PolarTec

RP phase with embedded polar group

- **Key features:**
  - Excellent base deactivation
  - Suitable for **LC/MS** and stable in 100% aqueous mobile phases
  - Pronounced steric selectivity
- **Recommended application:**
  Exceptional selectivity for phenols and nitrogen containing compounds, polar compounds like basic pharmaceuticals, organic acids, pesticides, amino acids, water soluble vitamins, etc.
  USP L1 and **L60**

Page 124

NUCLEODUR® PFP

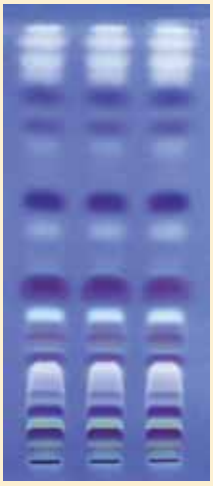
hydrophobic pentafluorophenyl phase

- **Key features:**
  - Hydrophobic phase with alternative selectivity in comparison to classical C_{18} modifications
  - Separation principle based on 4 retention mechanisms (polar interactions (H bonds), dipole-dipole interactions, π-π interactions, hydrophobic interactions)
  - Suitable for **LC/MS** due to low bleeding characteristics
- **Recommended application:**
  Aromatic and unsaturated compounds, phenols, halogenated compounds, isomers, polar compounds like pharmaceuticals, antibiotics; high retention of basic compounds
  USP L43

Page 136

ALUGRAM® Xtra

optimized TLC silica layers on aluminium



- **Outstanding wettability for precise colorization results,** even with 100% aqueous derivatization and visualization reagents
- **Excellent separation efficiency** and reproducibility from lot to lot
- **Easy and reliable cutting** due to an optimized binder system, no flaking of silica; now available as
  - **ALUGRAM® Xtra SIL G** with unmodified standard silica
  - **ALUGRAM® Xtra Nano-SIL** with unmodified HPTLC silica
  - **ALUGRAM® Xtra SILGUR** standard silica with concentrating zone
  - **ALUGRAM® Xtra Nano-SILGUR** HPTLC with concentrating zone

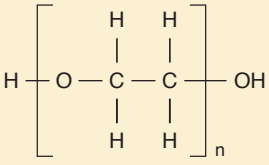
Pages 214-218

OPTIMA WAXplus®
OPTIMA® FFAPplus

optimized polar phases for GC

WAXplus

- Polar phase with improved cross-linking for reduced column bleeding and better temperature stability



- Good solvent stability, extended column lifetime, better performance in the MS in comparison to conventional Wax phases
- Recommended application: broad ranges of analyses, e.g., for solvents and alcohols, suitable for aqueous samples
- **USP G16**

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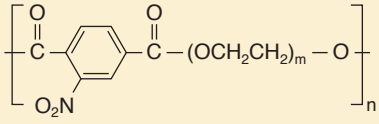
FFAPplus

- Polar polyethylene glycol phase with nitroterephthalic acid modification and innovative cross-linking



- Good solvent stability, extended column lifetime, better performance in the MS in comparison to conventional Wax phases, suitable for aqueous samples
- Recommended application: FAMEs, allows determination of free carboxylic acids without derivatization
- **USP G35** / close equivalent to G25

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Solid Phase Extraction (SPE)

Sample clarification

Vials, closures, and accessories

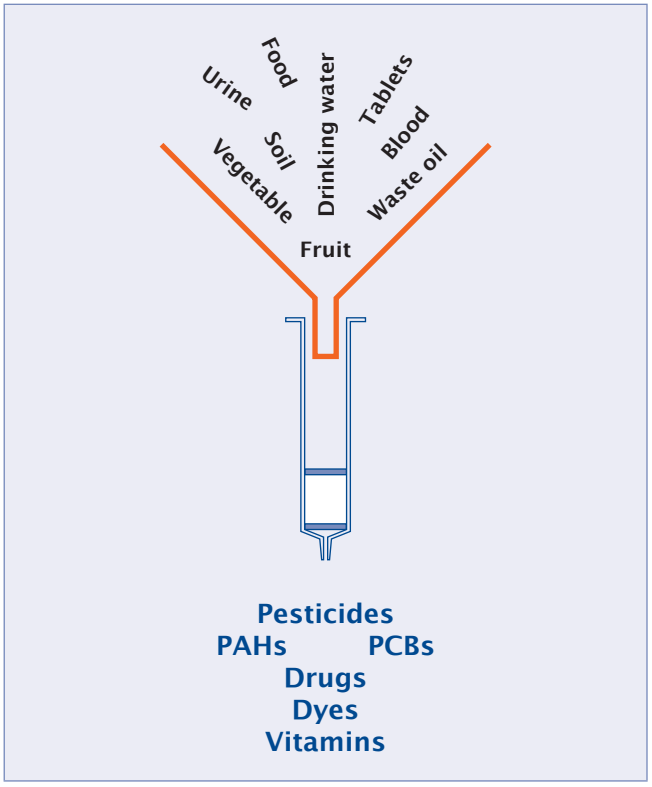
Basic principles of SPE

Solid phase extraction (SPE) is a powerful method for sample preparation and is used by most chromatographers today.

About 25 years ago MACHEREY-NAGEL designed and introduced CHROMABOND® SPE cartridges containing silica-based adsorbents. Since then we developed the widest range of phases and products for SPE based on silica and polymeric materials.

SPE has capabilities in a broad range of applications:

- Environmental analyses
- Pharmaceutical and biochemical analyses
- Organic chemistry
- Food analysis



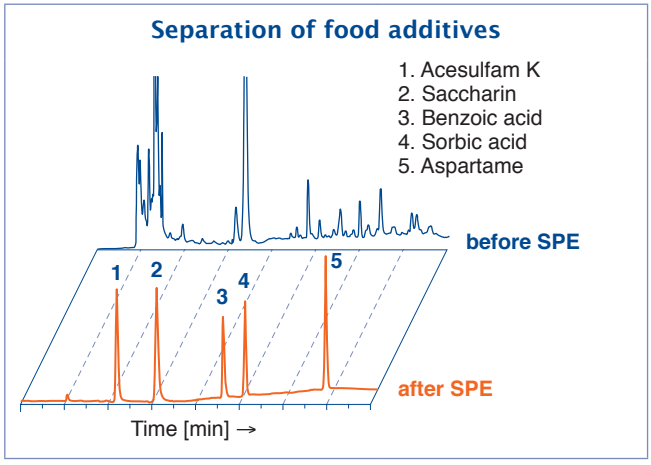
SPE is a form of digital (step-wise) chromatography designed to extract, partition, and / or adsorb one or more components from a liquid phase (sample) onto a stationary phase (adsorbent or resin). An adsorbed substance can be removed from the adsorbent by step-wise increase of elution strength of the eluent (step gradient technique). SPE extends a chromatographic system's lifetime, improves qualitative and quantitative analysis, and the demand placed on an analytical instrument is considerably lessened.

In general, SPE is used for three important purposes in state-of-the-art analyses:

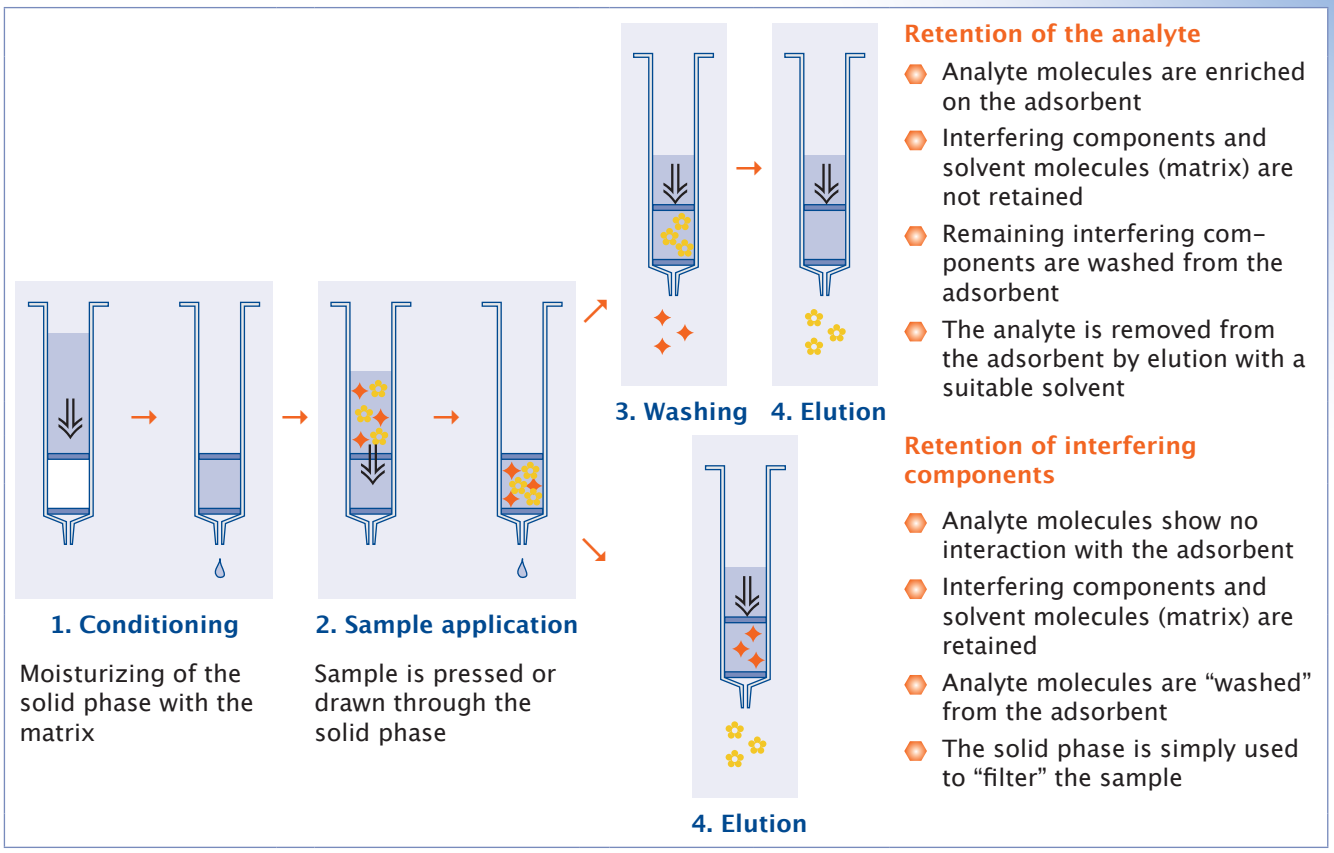
- Concentration of the analyte (up to factor 10.000 - increase of chromatographic sensibility and improved limits of detection)
- Removal of interfering compounds (protection of subsequent analyses like HPLC, GC, TLC, UV or IR spectroscopy, ...)
- Changing an analyte's environment to a simpler matrix more suitable for subsequent analyses

Advantages of SPE compared to classical liquid-liquid extraction:

- Lower consumption of solvents
- Faster - enormous time savings
- Lower costs per sample
- Potential for automation
- High consistency in individual sample handling
- More specific selectivity because of the broad range of adsorbents and different retention mechanisms
- Optimization of extraction by variation or adjusting of the solid phase and chromatographic conditions



Basic principles of SPE



Retention of the analyte

- Analyte molecules are enriched on the adsorbent
- Interfering components and solvent molecules (matrix) are not retained
- Remaining interfering components are washed from the adsorbent
- The analyte is removed from the adsorbent by elution with a suitable solvent

Retention of interfering components

- Analyte molecules show no interaction with the adsorbent
- Interfering components and solvent molecules (matrix) are retained
- Analyte molecules are "washed" from the adsorbent
- The solid phase is simply used to "filter" the sample

1. Conditioning

Moisturizing of the solid phase with the matrix

2. Sample application

Sample is pressed or drawn through the solid phase

Since analytes can be either adsorbed on the SPE packing material or directly flow through while the interfering substances are retained, two general separation procedures are possible – both cases are shown in the figure above.

Main steps of the SPE procedure

1. Conditioning of the adsorbent

Conditioning of the adsorbent is necessary in order to ensure reproducible interaction with the analyte. Conditioning, also called solvation, results in a wetting of the adsorbent and thus produces an environment, which is suitable for adsorption of the analyte. Nonpolar adsorbents are usually conditioned with 2–3 column volumes of a solvent, which is miscible with water (methanol, THF, 2-propanol etc.), followed by the solvent in which the analyte is dissolved (pure matrix, e.g., water, buffer). Polar adsorbents are conditioned with nonpolar solvents.

After the conditioning step the adsorbent bed **must not run dry**, because otherwise solvation is destroyed (deconditioning).

2. Sample application (adsorption)

Sample application can be performed with positive or negative pressure with a flow rate of ~3 mL/min. Sample volumes vary from a few mL up to liters.

3. Washing of the adsorbent

Washing of the adsorbent is usually achieved with a special wash solution; however, in some cases it may not be necessary. If the polarity difference between wash solution and eluent is very large, or if both are not miscible, drying of the adsorbent bed after washing is recommended to improve elution and recovery.

4. Elution

Elution with a suitable eluent should not be too fast. The elution speed depends on the column or cartridge dimension and the quantity of adsorbent (about 1 mL/min).

Basic principles of SPE

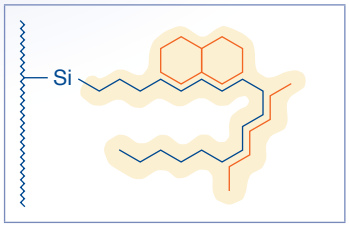
Molecular interactions in SPE

SPE adsorbents are most commonly categorized by the nature of their primary interaction mechanism with the analyte of interest. The three most common extraction mechanisms used in SPE are reversed phase (RP), normal phase (NP) and ion exchange.

Typical extraction mechanisms

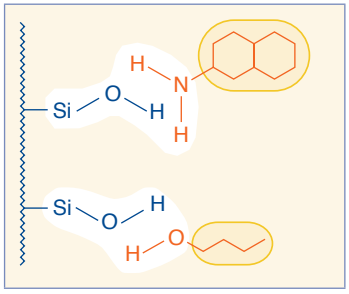
Reversed Phase	Extraction of hydrophobic or polar organic analytes from aqueous matrix
Normal Phase	Extraction of polar analytes from non-polar organic solvents
Ion Exchange	Extraction of charged analytes from aqueous or non-polar organic samples

Types of retention mechanisms:



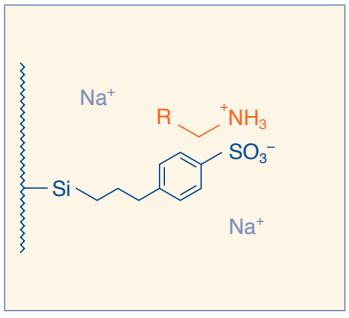
Nonpolar interactions

Silica-based:	C_{18} ec, C_{18}, C_{18} Hydra, C_8
Polymer-based:	HR-X, HR-P, Easy, PS-RP
Interactions:	hydrophobic
Sample:	mostly aqueous
Elution:	solvents with lower polarity (compared to water) CH_3OH, CH_2Cl_2, $CHCl_3$, hexane



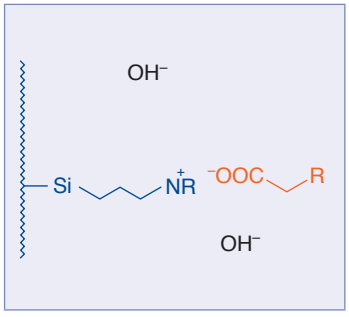
Polar interactions

Silica-based:	SiOH, CN, NH_2, OH (diol), C_6H_5
Other:	Alox, Florisil®
Interactions:	hydrogen bonds, dipole-dipole and π-π interactions
Sample:	mostly organic
Elution:	polar solvents (compared to sample solvent), e.g., (nonprotic) ethers, ketones (MTBE, THF, acetone) CH_2Cl_2, $CHCl_3$



Cation exchangers

Silica-based:	SA (SCX), PCA (WCX), PSA,
Polymer-based:	HR-XC, HR-XCW, PS-H^+
Interaction:	between charged analytes and functional group of cation exchanger
Sample:	aqueous (pH 3-5)
Elution:	acidic: pH 2 (e.g., HCl, or 20 % AcOH in CH_3OH - CH_3CN) basic: pH 8-9 (e.g., 5 % NH_3 in CH_3OH - CH_3CN) solvents or buffers with higher ionic strength and counter ions with high selectivity (e.g., Ca^{2+})



Anion exchangers

Silica-based:	SB (SAX), NH_2, DMA
Polymer-based:	HR-XA, HR-XAW, PS-OH^-
Interaction:	between charged analytes and functional group of anion exchanger
Sample:	aqueous (pH 8-9)
Elution:	basic: pH 10 (e.g., 20 % NH_3 in CH_3OH - CH_3CN) acidic: pH 4-5 (e.g., HCl, or 5 % AcOH in CH_3OH - CH_3CN) solvents or buffers with higher ionic strength and counter ions with high selectivity (e.g., citrate)

It should be noted, that in SPE the interactions described above are not found in pure form, but in combination. For example, modified silicas, unless they have been subjected to endcapping (silanization of residual silanol groups with short-chain silanes), still possess free silanol groups, which can enter into secondary interactions.

Sample pretreatment

For direct extraction with adsorbents the sample matrix (sample environment) has to fulfill three conditions:

- The matrix has to be liquid, if possible with low viscosity.
- Solids should be removed from the liquid matrix.
- The matrix (sample environment) should be suitable for retention of the analyte.

For solid samples there are different methods to convert the sample into a suitable matrix:

- Dissolution of the solid sample in a suitable solvent
- Lyophilization of the sample and dissolution in a suitable solvent
- Extraction of the solid sample with a suitable solvent
- Homogenization of the sample in a suitable solvent

In order to find the suitable solvent, one has to consider all desired sample components. Also, the suitable solvent should enhance retention of the analyte. For example, samples with large contents of solids are often homogenized in nonpolar solvents like hexane, while for samples with high water content dissolution in acids, bases, buffers or very polar solvents such as methanol is recommended.

Additionally, SPE allows to alter the properties of the sample matrix. If, for example, natural products are extracted with methanol or acetone, the polarity of the extracts can be increased by dilution with water, in order to enhance nonpolar solid phase extraction on the C_{18} material.

Our CHROMABOND® QC policy

- **Highest production standard**
  our facilities are EN ISO 9001:2008 certified
- All of our bonded phases and SPE products are vigorously tested for perfect **reproducibility** from lot-to-lot and within every single batch

  Careful attention to particle size distribution and pore diameters assures consistent column flow

  Chemical reproducibility is guaranteed by strict quality control throughout manufacturing
- All products are individually tested to meet our **strict quality specifications**, ensuring our outstanding product reproducibility, reliability and performance
- Each product is supplied with a **certificate of analysis** stating the results of internal examinations and quality control


Certificate

Phase: CHROMABOND® HR-X
LOT: 1211/1

Technical Data

Parameter | Result

Confirmation

Visit our Online Application Database: www.mn-net.com/apps
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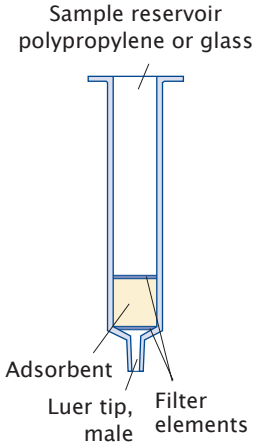
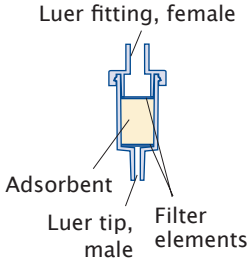
Solid Phase Extraction

Basic principles of SPE

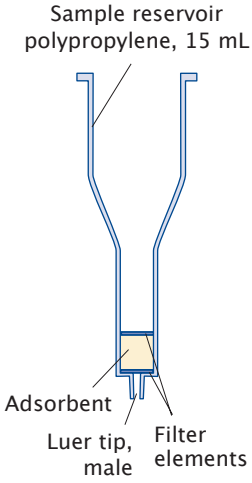
CHROMABOND®



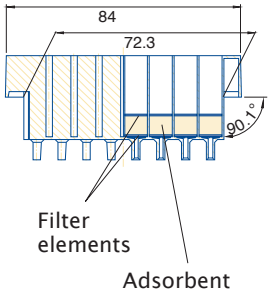
CHROMAFIX®



CHROMABOND® LV



CHROMABOND® MULTI 96



Design of columns, cartridges and 96-well plates

All CHROMABOND® columns, cartridges and 96-well plates are manufactured from polypropylene (PP) with lowest content of extractables (plasticizers, stabilizers, ...) offering blank value free results when using most common solvents. The high quality CHROMABOND® adsorbents are kept in place by chemically very inert polyethylene filter elements (PE, standard pore size 20 µm).

CHROMABOND® polypropylene columns

- PP columns with PE filter elements
- Different sizes from 1, 3, 6 up to 150 mL
- Adsorbent weights from 20 mg to 50 g
- Male Luer tip as exit
- Compatible with most robots (e.g., Gilson ASPEC™, Caliper AutoTrace®)

CHROMABOND® glass columns

- Glass columns with chemically very inert glass fiber filter elements (nominal pore size 1 µm)
- Two different sizes: 3 and 6 mL
- Available with all CHROMABOND® phases
- Excludes any influence from the column material (e.g., plasticizers)

CHROMAFIX® cartridges

- PP cartridges with PE filter elements
- Three different sizes with different adsorbent weights: **S**mall (0.4 mL), **M**edium (0.8 mL), **L**arge (1.8 mL)
- Female Luer tip at the inlet, male Luer tip as exit
- Offers alternative way of handling using positive pressure by syringes or peristaltic pumps
- Especially suited for convenient solid phase extraction of small sample volumes

CHROMABOND® LV columns

- Large volume PP columns with PE filter elements
- Three different adsorbent weights (100, 200 and 500 mg)
- Funnel-shaped reservoir with 15 mL volume
- Especially for clinical samples – the whole sample (e.g., urine, serum, blood) can be applied to the column in one step
- Can be directly used in the Zymate® lab robots of Zymark

CHROMABOND® MULTI 96 · SPE in 96-well format

- 96-well PP plates with PE filter elements
- Cavity volume 1.5 mL
- Adsorbent weights 10, 25, 50 and 100 mg
- Supplied with any CHROMABOND® SPE adsorbents
- For simultaneous preparation of 96 samples
- Easy method transfer from CHROMABOND® columns or CHROMAFIX® cartridges to CHROMABOND® MULTI 96
- Readily adaptable to all common automated / robotic handling systems (for details see page 54)

Online-SPE (see page 53)

- Online columns and cartridges
- SPE columns with caps and needles for the Gerstel MultiPurposeSampler (MPS)
- Columns for Gilson ASPEC™ systems (ASP)

SPE method development kits

For the development kits as well as for all individual CHROMABOND®, CHROMABOND® LV and CHROMAFIX® types columns are sealed in units of five columns each to prevent adsorption of contaminants from the environment, e.g., laboratory air.

Ordering information

Designation	Contents of the kit	REF
Investigating the best separation mechanism for a clean-up procedure		
CHROMABOND® HR-X*pert* development kit I	columns with 3 mL, 60 mg each (particle size 45 µm): 10 columns with HR-X; 5 columns each with HR-XC, HR-XA, HR-XCW, HR-XAW	**730723**
CHROMABOND® HR-X*pert* development kit II	columns with 3 mL, 200 mg each (particle size 85 µm): 10 columns with HR-X; 5 columns each with HR-XC, HR-XA, HR-XCW, HR-XAW	**730726**
CHROMABOND® polymer development kit	5 columns each with 3 mL, 200 mg: HR-X, HR-XC (MCX), HR-XA (MAX), HR-P, Easy, PS-H^+, PS-OH^-	**730288**
CHROMABOND® standard development kit	5 columns each with 3 mL, 500 mg: C_{18}, C_{18} ec, C_8, C_6H_5, NH_2, DMA, OH, CN, SiOH, SA (SCX), SB (SAX)	**730496**
Selecting the optimum RP phase for a clean-up procedure		
CHROMABOND® RP development kit I	10 columns each with 3 mL, 500 mg: C_{18}, C_{18} ec, C_8, C_4 and 10 columns each with 3 mL, 200 mg HR-P, HR-X	**730197**
CHROMABOND® RP development kit II	10 columns each with 1 mL, 100 mg: C_{18}, C_{18} ec, C_8, C_4, HR-P, HR-X	**730207**
CHROMAFIX® RP development kit I	10 cartridges each CHROMAFIX® S: C_{18}, C_{18} ec, C_8, C_4, HR-P, HR-X	**731883**
CHROMABOND® RP development kit III	10 columns each with 3 mL, 500 mg: C_{18}, C_{18} ec, C_{18} Hydra, C_8 and 10 columns each with 3 mL, 200 mg HR-P, HR-X	**730490**
CHROMABOND® RP development kit IV	10 columns each with 1 mL, 100 mg: C_{18}, C_{18} ec, C_{18} Hydra, C_8, HR-P, HR-X	**730491**
CHROMAFIX® RP development kit II	10 cartridges each CHROMAFIX® S: C_{18}, C_{18} ec, C_{18} Hydra, C_8, HR-P, HR-X	**731886**
CHROMABOND® RP development kit V	10 columns each with 3 mL, 500 mg: C_6H_5, NO_2, C_6H_{11} ec, C_4, C_2	**730492**
CHROMABOND® RP development kit VI	10 columns each with 1 mL, 100 mg: C_6H_5, NO_2, C_6H_{11} ec, C_4, C_2	**730493**
CHROMAFIX® RP development kit III	10 cartridges each CHROMAFIX® S: C_6H_5, NO_2, C_6H_{11} ec, C_4, C_2	**731887**
Selecting the optimum polar phase for a clean-up procedure		
CHROMABOND® polar development kit I	10 columns each with 3 mL, 500 mg: SiOH, Florisil®, NH_2, CN, OH	**730199**
CHROMABOND® polar development kit II	10 columns each with 1 mL, 100 mg: SiOH, Florisil®, NH_2, CN, OH	**730208**
CHROMAFIX® polar development kit	10 cartridges each CHROMAFIX® S: SiOH, Florisil®, NH_2, CN, OH	**731884**
Selecting the optimum ion exchanger for a clean-up procedure		
CHROMABOND® ion exchange development kit I	10 columns each with 3 mL, 500 mg: SA (SCX), SB (SAX), HR-XC (MCX), HR-XA (MAX), PS-OH^-, PS-H^+, DMA	**730206**
CHROMABOND® ion exchange development kit II	10 columns each with 1 mL, 100 mg: SA (SCX), SB (SAX), HR-XC (MCX), HR-XA (MAX), PS-OH^-, PS-H^+, DMA	**730209**
CHROMAFIX® ion exchange development kit I	10 cartridges each CHROMAFIX® S: SA (SCX), SB (SAX), HR-XC (MCX), HR-XA (MAX), PS-OH^-, PS-H^+, DMA	**731885**
CHROMABOND® cation exchange development kit I	10 columns each with 3 mL, 500 mg: SA (SCX), PSA, PCA, HR-XC (MCX), HR-XCW (WCX), PS-H^+	**730494**
CHROMAFIX® cation exchange development kit	10 cartridges each CHROMAFIX® S: SA (SCX), PSA, PCA, HR-XC (MCX), HR-XCW (WCX), PS-H^+	**731888**
Phase selection for clean-up procedures for environmental samples		
CHROMABOND® kit I for environmental sample preparation	10 columns each with 3 mL, 200 mg HR-P, 6 mL, 1000 mg C_{18} ec, 6 mL, 2000 mg C_{18} PAH, 6 mL, 500/1000 mg CN/SiOH, 3 mL, 500/500 mg SA/SiOH	**730205**
CHROMABOND® kit II for environmental sample preparation	5 columns each with 3 mL, 500/500 mg SiOH-H_2SO_4/SA, 3 mL, 500 mg SiOH, 6 mL, 1000 mg Florisil, 3 mL, 500/500 mg SA/SiOH, 6 mL, 700/2000/700 mg NAN	**730349**

Summary of MN phases for SPE

Code	Matrix	Modification / Application	Similar phases*	Page
Reversed phases				
HR-X	PS/DVB		ENVI-Chrom P · Strata™-X · Oasis® HLB · Nexus	14
Easy	PS/DVB	polar, bifunctional	Strata™-X · Oasis® HLB · Porapak™ RDX · Nexus, Bond Elut® PPL, Focus™ ·Styre Screen® DVB Bakerbond™ H_2O-philic DVB · Isolute® ENV+	20
HR-P	PS/DVB		Strata™ SDB-L ·Bond Elut® ENV, Bond Elut® LMS · DCS-PS/DVB, ENV PS-DVB · Bakerbond™ H_2O-phobic DVB · Isolute® 101 · LiChrolut® EN	21
PS-RP	PS/DVB	removal of organic components	like HR-P	22
C_{18} ec	silica	octadecyl, endcapped	Strata™ C18-E · Sep-Pak® tC18 · Bond Elut® C18 · DSC-18(Lt), ENVI-18, LC-18 · CLEAN-UP® C18, Bakerbond® Octadecyl · Isolute® C18(EC), LiChrolut® RP-18 E	23
C_{18} ec f	silica	as above, fast flow		23
C_{18}	silica	octadecyl, not endcapped	Strata™ C18-U · AccuBond® C18 · Bakerbond™ PolarPlus · Isolute® C18 · LiChrolut® RP-18	24
C_{18} f	silica	as above, fast flow		24
C_{18} PAH	silica	special octadecyl phase, for enrichment of PAHs from water	Bakerbond™ Octadecyl Lightload	42
C_{18} Hydra	silica	octadecyl, not endcapped, for polar analytes		25
C_8	silica	octyl	Strata™ C8 · Sep-Pak® C8 · Bond Elut® C8 · DSC-8, ENVI-8, LC-8 · CLEAN-UP® C8 · AccuBond® C8 · Bakerbond™ Octyl · Isolute® C8(EC)	26
C_4	silica	butyl		27
C_2	silica	dimethyl	Bond Elut® C2	27
C_6H_{11} ec	silica	cyclohexyl, endcapped	Bond Elut® CH	28
C_6H_5	silica	phenyl	Strata™ PH · Bond Elut® PH · DSC-Ph · CLEAN-UP® Phenyl · AccuBond® Phenyl · Bakerbond™ Phenyl · Isolute PH(EC)	29
Normal phases				
SiOH	silica	unmodified	Strata™ Si-1 · Bond Elut® silica · DSC-Si, LC-Si · CLEAN-UP® silica · Accubond® silica, Bakerbond™ silica gel · Isolute® silica · LiChrolut® Si	32
NH_2	silica	aminopropyl	Strata™ NH_2 · Sep-Pak® NH_2 · Bond Elut NH_2 · DSC-NH_2, LC-NH_2 · CLEAN-UP® aminopropyl · Accubond® NH_2 · Bakerbond™ amino · Isolute® NH_2 · LiChrolut® NH_2	31
OH (Diol)	silica	diol	DSC-Diol, LC-Diol · Accubond® Diol (OH)	30
CN	silica	cyano	Strata™ CN · Sep-Pak® CN · Bond Elut® CN-U· DSC-CN, LC-CN · CLEAN-UP® CN · Accubond® CN · Bakerbond™ cyano· Isolute® CN · LiChrolut® CN	30
Alox A	aluminium oxide acidic		LC-Alumina-A · Accubond® aluminium oxide A	33
Alox N	aluminium oxide neutral		LC-Alumina-N · Accubond® aluminium oxide N	33
Alox B	aluminium oxide basic		LC-Alumina-B · Accubond® aluminium oxide B	33
Florisil®	magnesium silicate		Strata™ FL-PR · Sep-Pak® Florisil® · Bond Elut® Florisil® · ENVI-Florisil®, LC-Florisil® · CLEAN-UP® Florisil® · Accubond® Florisil® · Bakerbond™ Florisil® · Isolute® FL · LiChrolut® Florisil®	34
PA	polyamide 6		DPA-6S	34
Ion exchangers				
SB	silica	quaternary ammonium anion exchanger (SAX)	Strata™ SAX, Sep-Pak® SAX, Bond Elut® SAX · DSC-SAX, LC-SAX · CLEAN-UP® Quaternary Amine · Accubond® SAX · Bakerbond™ Quaternary Amine · Isolute® SAX · LiChrolut® SAX	37

* Phases which provide a similar selectivity based on chemical or physical properties (list not complete)

Summary of MN phases for SPE

Code	Matrix	Modification / Application	Similar phases*	Page
SA	silica	benzenesulfonic acid cation exchanger (SCX)	Strata™ SCX · Bond Elut® SCX · DSC-SCX, LC-SCX · CLEAN-UP® Benzenesulfonic Acid · Accubond® SCX · Bakerbond™ Aromatic Sulfonic Acid · Isolute® SCX · LiChrolut® SCX	36
PCA	silica	propylcarboxylic acid cation exchanger (WCX)	Strata™ WCX · Bond Elut® CBA · DSC-WCX, LC-WCX · CLEAN-UP® Carboxylic Acid · Bakerbond™ Carboxylic Acid · Isolute® CBA	35
PSA	silica	propylsulfonic acid cation exchanger		35
HR-XC	PS/DVB	strong mixed mode cation exchanger for basic analytes (MCX)	Oasis® MCX · Strata™-X-C · HyperSep™ Retain™-CX· Styre Screen® DBX	16
HR-XA	PS/DVB	strong mixed mode anion exchanger for acidic analytes (MAX)	Oasis® MAX · Strata™-X-A · HyperSep™ Retain™-AX · Styre Screen® QAX	17
HR-XCW	PS/DVB	weak mixed mode cation exchanger for basic analytes (WCX)	Oasis® WCX · Strata™ X-CW	18
HR-XAW	PS/DVB	weak mixed mode anion exchanger for acidic analytes (WAX)	Oasis® WAX · Strata™ X-AW	19
PS-OH^-	PS/DVB	strong anion exchanger in OH^- form		22
PS-H^+	PS/DVB	strong cation exchanger in H^+ form		22
PS-Mix	PS/DVB	mixture of PS-OH^- and PS-H^+		22
PS-Ag^+	PS/DVB	strong cation exchanger in Ag^+ form		22
PS-Ba^{2+}	PS/DVB	strong cation exchanger in Ba^{2+} form		22
Phases for special applications				
Dry	Na_2SO_4	for drying organic samples		47
Drug	silica	bifunctional C_8/SA, for enrichment of drugs from urine	Strata™ Screen-C · Bond Elut® Certify I · DSC-MCAX · Clean Screen® DAU · Accubond® Evidex · Bakerbond™ Narc-2 · Isolute® HCX · LiChrolut® TSC · HyperSep™ Verify CX	38
Drug II	silica	bifunctional C_8/SB, for extraction of THC and derivatives and of acidic analytes from biological fluids	Strata™ Screen-A · Bond Elut Certify II · Clean Screen® THC · Bakerbond® Narc-1 · Isolute® HAX · HyperSep™ Verify AX	39
Crosslinks	cellulose	for enrichment of collagen crosslinks		40
Tetracycline	silica	special octadecyl phase, for enrichment of tetracyclines		40
HR-P-AOX	PS/DVB	for extraction of AOX from water (DIN 38409 - H22)		41
CN/SiOH	silica	combination phase for enrichment of PAHs from soil		44
NH_2/C_{18}	silica	combination phase for enrichment of PAHs from water		42
Na_2SO_4/Florisil®		combination phase for extraction of hydrocarbons from water (DIN H-53 / ISO DIS 9377-4)		43
SA/SiOH	silica	combination phase for enrichment of PCB from waste oil	Bakerbond™ PCB-N	45
SiOH-H_2SO_4/SA	silica	combination phase, used together with SiOH for enrichment of PCB from oil		46
NAN	silica / $AgNO_3$ + Na_2SO_4	combination phase for enrichment of PCB from sludge		44
ABC18	silica	octadecyl, with ion exchange functions, for acrylamide analysis	Isolute® M-M	47
Diamino	silica	primary and secondary amine functions (PSA), for determination of pesticides in food samples (QuEChERS method)	Supelclean™ PSA, Bond Elut® PSA	48
Phase separation		CHROMABOND® PTL/PTS		58
Liquid-liquid extraction		CHROMABOND® XTR	EXtrelut® · Chem Elut™ · Hydromatrix™	56

* Phases which provide a similar selectivity based on chemical or physical properties (list not complete)

CHROMABOND® HR-X*pert*

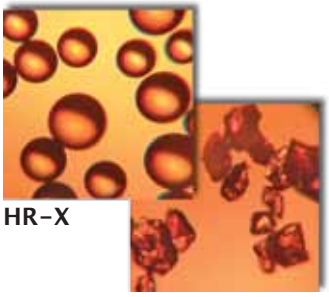
The professional concept of innovative SPE phases

The CHROMABOND® HR-X*pert* family comprises 5 polymer-based RP and mixed-mode ion exchange phases:

- **CHROMABOND® HR-X** hydrophobic PS/DVB copolymer
- **CHROMABOND® HR-XC** strong mixed-mode cation exchanger
- **CHROMABOND® HR-XA** strong mixed-mode anion exchanger
- **CHROMABOND® HR-XCW** weak mixed-mode cation exchanger
- **CHROMABOND® HR-XAW** weak mixed-mode anion exchanger

These innovative SPE phases offer

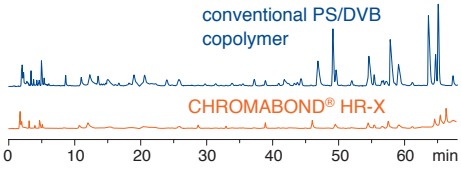
- **State-of-the-art spherical polymer**
  - Two particle sizes (45 µm and 85 µm) adequate for different sample volumes and matrices
  - Broad spectrum of application with special suitability for enrichment of pharmaceuticals from biological matrices
  - Ideal flow properties due to low content of particulate matter
- **Optimized pore structure** and **high specific surface**
  - High loadability and outstanding elution properties
  - Low solvent consumption
  - Rapid, economical analyses
- **High-purity adsorber material**
  - Allows highest reproducibility with extremely low blind values
  - Reliable analyses at ultra trace level
  - No method adaptation for new batches necessary



HR-X

conventional PS/DVB copolymer

Adsorbent blind values:



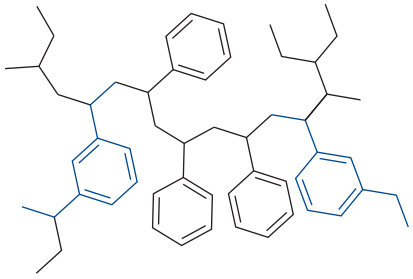
The HR-X*pert* concept guarantees:

- RP and mixed-mode SPE phases with distinct ion exchange and reversed phase properties: excellent enrichment of neutral, acidic and basic compounds
- Modern, spherical support polymer with optimized pore structure and high surface: good reproducibility, reliable and cost-efficient analysis
- Possibility for more aggressive washing procedures for matrix removal: cleaner samples and protection of your HPLC and GC instruments
- Quantification of analytes also from heavily contaminated samples: lower limits of detection also for critical matrices

CHROMABOND® HR-X*pert* is the perfect combination for all tasks in sample preparation

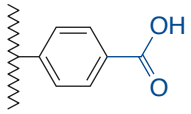
Chemical structures of the phases:

CHROMABOND® HR-X



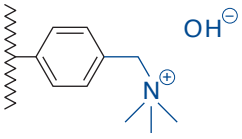
Hydrophobic
polystyrene-divinylbenzene copolymer
spherical base material for efficient enrichment and ideal flow behavior

CHROMABOND® HR-XCW



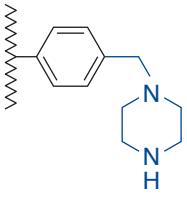
weak acidic
cation exchanger

CHROMABOND® HR-XA



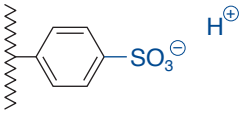
strong basic
anion exchanger

CHROMABOND® HR-XAW



weak basic
anion exchanger

CHROMABOND® HR-XC



strong acidic
cation exchanger

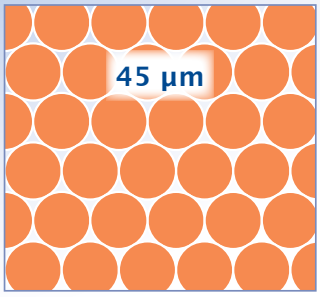
Similar phases:

CHROMABOND® HR-X:	Oasis® HLB, Strata™-X, Nexus, ENVI-Chrom P
CHROMABOND® HR-XC:	Oasis® MCX, Strata™-X-C, HyperSep™ Retain™-CX, StyreScreen® DBX
CHROMABOND® HR-XA:	Oasis® MAX, Strata™-X-A, HyperSep™ Retain™-AX, StyreScreen® QAX
CHROMABOND® HR-XCW:	Oasis® WCX, Strata™-X-CW
CHROMABOND® HR-XAW:	Oasis® WAX, Strata™-X-AW

CHROMABOND® HR-X*pert*

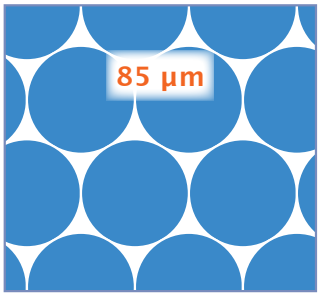
2 particle sizes – 1 goal: HR-X*pert* for optimized sample preparation

For different application requirements the particle sizes complement each other perfectly.



Ideal for:

+ smaller sample volumes
+ smaller adsorbent weights
+ lower elution volumes



Recommended for:

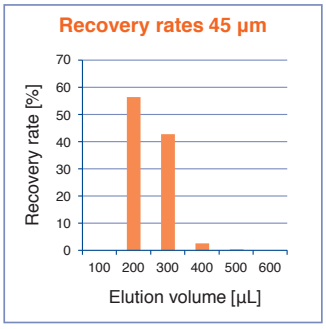
+ large volume or viscous samples, heavy matrix load
+ operation without vacuum possible (e.g., for volatile analytes)
+ higher adsorbent weight without increase in back pressure

Features of 45 µm particles

- About half the radius results in 8fold particle number per volume for approx. equal adsorbent weight
- Same specific surface for both particle sizes:
  → considerably larger freely accessible external surface for 45 µm particles
- Denser adsorbent packing:
  → enhanced interaction of the analyte with the adsorbent, better extraction results

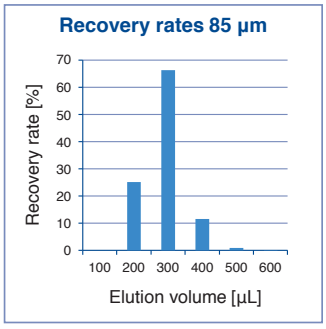
Ideal elution characteristics

Method: 1 mL column with 30 mg CHROMABOND® HR-X, 1 mL standard solution (1 mg/mL hexobarbital), drying, elution in portions of 100 µL with methanol (see application 305490 at ***www.mn-net.com/apps***)



Advantages of 45 µm particles:

+ faster elution
+ lower elution volumes required



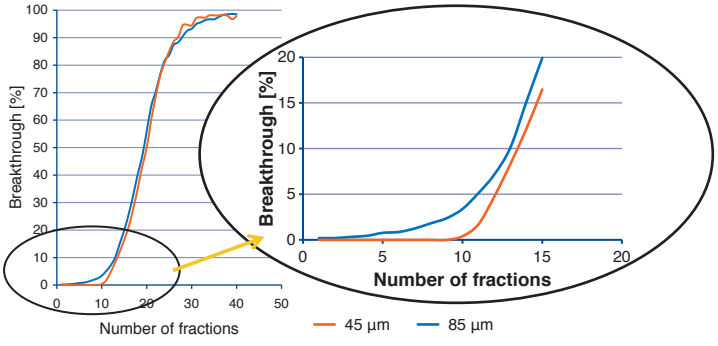
Breakthrough behavior in enrichment

Method: 1 mL column with 15 mg CHROMABOND® HR-X, apply portions of 1 mL standard solution (250 µg/mL hexobarbital in water), collect eluates (see application 305480 at ***www.mn-net.com***)

45 µm (red)
The analyte is completely retained up to fraction 10.

85 µm (blue)
Small amounts even break through with fraction 4.

45 µm particles provide better enrichment and breakthrough behavior for small adsorbent weights. When using larger adsorbent weights this effect is less pronounced, since then analytes have sufficient contact with the 85 µm adsorbent particles as well.

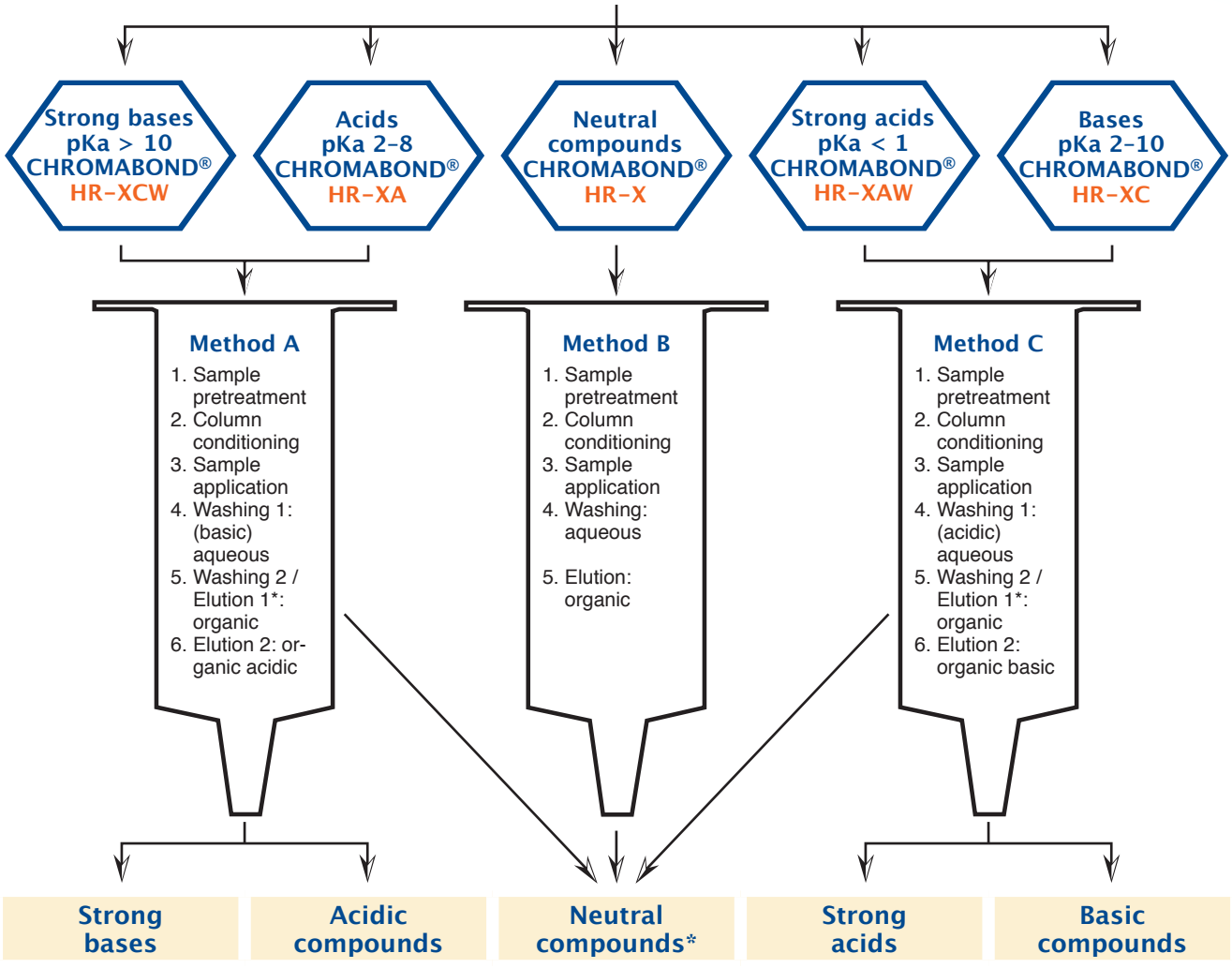


45 µm particles are ideal for small sample and elution volumes, while for large amounts of sample and adsorbent 85 µm particles show advantages due to better flow properties.

The CHROMABOND® HR-X*pert* concept for neutral, acidic and basic analytes

3 paths – 1 goal: cleaner samples

Depending on the character of the analytes HR-X*pert* offers suitable adsorbents and optimal methods for sample preparation, cleaning and concentration.



*** Under organic washing and elution conditions the following compounds will be also eluted:**

HR-X:	polar compounds such as organic acids and bases
HR-XC, HR-XCW:	acidic components and impurities
HR-XA, HR-XAW:	basic components and impurities

Polymer-based reversed phases for SPE

HR-X spherical, hydrophobic polystyrene-divinylbenzene adsorbent resin

- Hydrophobic polystyrene-divinylbenzene copolymer
  pH stability 1–14
  High-purity material with highest reproducibility and lowest blank values due to an optimized manufacturing process
  Spherical particles, size 45 µm and 85 µm (standard)
  pore size 55–60 Å; very high surface 1000 m^2/g
  capacity 390 mg/g (caffeine in water)
  Excellent recovery rates especially for the enrichment of pharmaceuticals and active ingredients due to the spherical structure of the particles, very homogeneous surface, and optimized pore structure
- Recommended application:
  Pharmaceuticals / active ingredients from tablets, creams and water / waste water
  Drugs and pharmaceuticals from urine, blood, serum and plasma
  Trace analysis of pesticides, herbicides, phenols, PAHs and PCBs from water

Drugs from water

Column type:
CHROMABOND® HR-X, 3 mL, 200 mg
REF 730931
Sample: 1 µg/mL each in water
Column conditioning: 5 mL methanol, 5 mL dist. water
Sample application: slowly aspirate 500 mL water (pH 3) through the column
Column washing: 5 mL water
Elution: after drying 3 x 2 mL acetonitrile

Further analysis: HPLC on NUCLEODUR® C_{18} Gravity, 5 µm; see MN Appl. No. 121690

Recovery rate [%]

Compound	HR-X	Strata™ X
Ketoprofen	98	92
Ibuprofen	91	93
Pentobarbital	99	95
Meclofenamic acid	92	93
Protriptyline	63	45
Nortriptyline	53	39

MN Appl. No. 304240

Pesticides from water

Column type:
CHROMABOND® HR-X, 3 mL, 200 mg
REF 730931
Sample pretreatment: samples are spiked with 500 ng of each pesticide in 1000 mL water, adjusted to pH 2 with HCl or pH 7
Column conditioning: 10 mL methanol, 10 mL dist. water
Sample application:
slowly pass 1000 mL spiked water sample through the column with the aid of a tubing adapter (REF 730243)
Elution: after drying 5 mL methanol – THF (1:1, v/v)

Further analysis: HPLC

Recovery rates [%]

Compound	HR-X pH 2
Metamitron	86
Quinmerac	90
Chloridazon	93
Picloram	83
Metribuzin	84
Cyanazine	83
Metabenzthiazuron	94
Chlortoluron	91
Isoproturon	89
Diuron	91
Dimethenamid-P	89
Linuron	94
Epoxyconazole	85
Penconazole	90
Alachlor	93
Propiconazole-1	89
Flufenacet	91
Diflufenicam	58
Triallate	42

Compound	HR-X pH 7
Desisopropylatrazine	90
2,4-Dichlorobenzamide	95
Desethylatrazine	89
Hexazinone	95
Bromacil	103
Simazine	91
Desethylterbuthylazine	89
Atrazine	88
Metalaxyl	97
Metazachlor	93
Propazine	88
Terbuthylazine	86
Metolachlor	97

MN Appl. No. 304250/304260

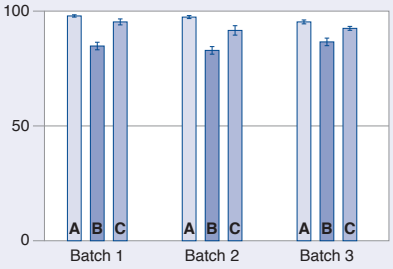
Options for online-SPE and automated SPE see page 53

Polymer-based reversed phases for SPE

Highest reproducibility

✓ within each batch ✓ from batch to batch

Compounds:
- A phenobarbital
- B pentobarbital
- C hexobarbital



Barbiturates from serum

Column type:
CHROMABOND® HR-X, 3 mL, 200 mg
REF 730931

Sample: 100 ng/mL each in serum
Column conditioning: 5 mL methanol, 5 mL dist. water
Sample application: 1 mL spiked serum
Column washing: 5 mL water
Elution: after drying 3 x 2 mL methanol

Further analysis: HPLC on NUCLEODUR® 100-5 C_{18} ec, see MN Appl. No. 117820

MN Appl. No. 304290

Standard protocol for CHROMABOND® HR-X

Column type:
CHROMABOND® HR-X, 3 mL, 200 mg
REF 730931

Sample pretreatment: if necessary, adjust pH value
Column conditioning: 5 mL methanol
Equilibration: 5 mL water
Sample application:
slowly aspirate the sample through the column
Column washing: 5 mL water – methanol (95:5, v/v)
Elution: after drying 3 x 2 mL methanol

Further analysis: if necessary, evaporate and redissolve in a suitable solvent; HPLC or GC

MN Appl. No. 304310

Ordering information

CHROMABOND® HR-X polypropylene columns (85 µm)

Volume	30 mg	60 mg	100 mg	200 mg	500 mg	1 g	Pack of
1 mL	730934		730935				30
3 mL		730936		730931	730937		30
6 mL				730938	730939		30
15 mL					730940	730941	20

CHROMABOND® HR-X polypropylene columns (85 µm) · BIGpacks

Volume	200 mg	500 mg	Pack of
3 mL	730931.250		250
6 mL	730938.250	730939.250	250

CHROMABOND® HR-X polypropylene columns (45 µm) · *NEW!*

Volume	30 mg	60 mg	100 mg	200 mg	Pack of
1 mL	730934P45		730935P45		30
3 mL		730936P45		730931P45	30

CHROMABOND® LV-HR-X (85 µm)

Volume	30 mg	60 mg	200 mg	Pack of
15 mL	732130	732131	732132	30

CHROMABOND® MULTI 96 HR-X

96 x 10 mg (45 µm)	96 x 25 mg (45 µm)	96 x 50 mg (85 µm)	96 x 100 mg (85 µm)	Pack of
738530.010M	738530.025M	738530.050M	738530.100M	1

CHROMABOND® HR-X adsorbent (85 µm)

			730663	20 g

Solid Phase Extraction

Polymer-based ion exchangers for SPE

HR-XC

strong cation exchanger

- Strong acidic benzenesulfonic acid cation exchanger
  exchange capacity 1.0 meq/g, pKa < 1

  Base material polystyrene-divinylbenzene copolymer
  pH stability 1–14; high purity material, highest reproducibility and lowest blank values due to an optimized production process

  Spherical particles, size 45 µm and 85 µm (standard); pore size 65–75 Å
  very large specific surface 800 m^2/g; pore volume 1.4 cm^3/g
  RP capacity 300 mg/g (caffeine in water)

  Outstanding recovery rates especially for the enrichment of basic analytes

- Recommended application:

  Basic active ingredients from heavily matrix-contaminated samples like, e.g., urine, plasma, serum

  Fungicides from food, melamine from milk

  Basic analytes like, e.g., amines; bases with **pKa 2–10**

Standard protocol for CHROMABOND® HR-XC

Column type:
CHROMABOND® HR-XC, 3 mL, 200 mg
REF 730952

Sample pretreatment: individual sample preparation with reference to analytes and matrix
Column conditioning: 5 mL methanol
Equilibration: 5 mL water
Sample application: slowly aspirate sample through the column
Washing 1: 2 mL 0.1 mol/L HCl in water
Washing 2 / Elution 1: 2 mL methanol (neutral and acidic compounds); if necessary, further washing steps
Elution 2: after drying 5 mL methanol – 5 % NH_3 (basic compounds)

Further analysis: if necessary, evaporate and redissolve in a suitable solvent; HPLC or GC

MN Appl. No. 304740

Fractionation of acidic, neutral and basic

Column type:
CHROMABOND® HR-XC, 3 mL, 200 mg
REF 730952

Sample: 1 mL spiked matrix, acidified with 200 µL 2 % H_3PO_4
Column conditioning: 5 mL methanol, then 5 mL water
Sample application: slowly aspirate sample through the column
Washing: 2 mL 0.1 mol/L HCl
Elution: 2.5 mL methanol (fraction A: neutral and acidic analytes); then 5 mL methanol – NH_3 90:10, v/v (fraction B: basic analytes)

Further analysis for fraction A: HPLC, e.g., on NUCLEODUR® C_{18} Gravity, see MN Appl. No. 122230; for fraction B: HPLC on NUCLEODUR® C_8 Gravity, see MN Appl. No. 118520

Recovery rates [%]

Fraction A: neutral and acidic analytes

Compound	HR-XC
Suprofen	108
Naproxen	85
Tolmetin	73
Phenobarbital	108
Indomethacin	33
Hexobarbital	80

Fraction B: basic analytes

Compound	HR-XC	Oasis® MCX	Strata™ X-C
1. Doxepin	101	68	82
2. Imipramine	95	71	85
3. Amitriptyline	94	72	78
4. Trimipramine	92	70	81

MN Appl. No. 304780

Ordering information

Volume	Adsorbent weight						Pack of
CHROMABOND® HR-XC polypropylene columns (85 µm)							
	30 mg	60 mg	100 mg	150 mg	200 mg	500 mg	
1 mL	**730969**		**730049**				30
3 mL		**730956**			**730952**	**730953**	30
6 mL				**730957**		**730955**	30
CHROMABOND® HR-XC polypropylene columns (45 µm) · *NEW!*							
1 mL	**730969P45**		**730049P45**				30
3 mL		**730956P45**			**730952P45**		30
CHROMAFIX® HR-XC cartridges (85 µm)							
Size		**S**		**M**		**L**	
adsorbent weight ∅		155 mg		240 mg		500 mg	
		731755		**731756**		**731757**	30
CHROMABOND® HR-XC adsorbent (85 µm)							
						730664	100 g

Polymer-based ion exchangers for SPE

HR-XA

strong anion exchanger

- Strong basic quaternary ammonium anion exchanger
  exchange capacity 0.25 meq/g, pKa ~ 18

  Base material polystyrene-divinylbenzene copolymer
  pH stability 1–14; high purity material with highest reproducibility and lowest blank values due to an optimized production process

  Spherical particles, size 45 µm and 85 µm (standard); pore size 55–65 Å
  very large specific surface 850 m^2/g; pore volume 1.4 cm^3/g
  RP capacity 350 mg/g (caffeine in water)

  Outstanding recovery rates especially for the enrichment of acidic analytes

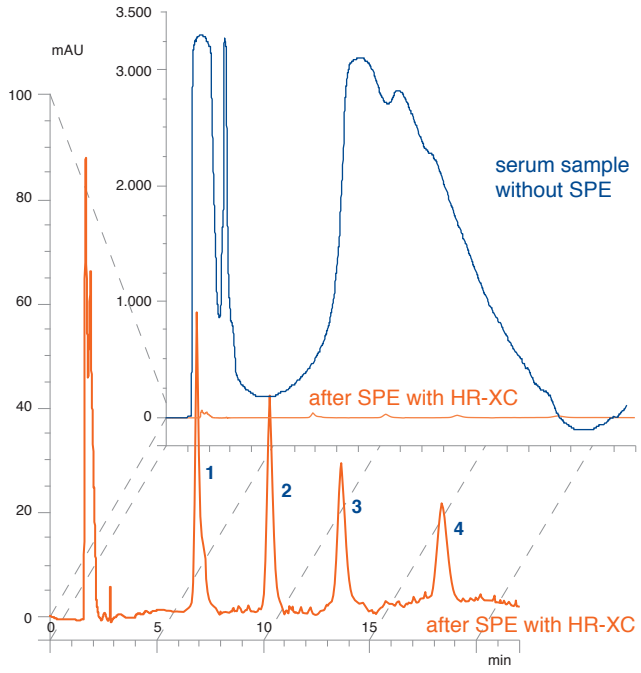
- Recommended application:

  Acidic active ingredients from heavily matrix-contaminated samples like, e.g., urine, plasma, serum

  Phenolic acids, acidic herbicides

  Weak/medium-strength acids with **pKa 2–8**

analytes from serum



Standard protocol for CHROMABOND® HR-XA

Column type:
CHROMABOND® HR-XA, 3 mL, 200 mg
REF 730951

Sample pretreatment: individual sample preparation with reference to analytes and matrix
Conditioning: 5 mL methanol
Equilibration: 5 mL water
Sample application: slowly aspirate sample through the column
Washing 1: 2 mL 0.1 mol/L NaOH in water
Washing 2/Elution 1: 2 mL methanol (neutral and basic compounds), if necessary, further washing steps
Elution 2: after drying 5 mL methanol – 1 to 10 % formic acid (acidic compounds)

Further analyses: if necessary, evaporate and redissolve in a suitable solvent; HPLC or GC

MN Appl. No. 304970

For further applications on CHROMABOND® polymer phases see our online application database at

www.mn-net.com/apps

Ordering information

	Volume	Adsorbent weight						Pack of
	CHROMABOND® HR-XA polypropylene columns (85 µm)							
		30 mg	60 mg	100 mg	150 mg	200 mg	500 mg	
	1 mL	**730968**		**730727**				30
	3 mL		**730950**			**730951**	**730954**	30
	6 mL				**730958**		**730966**	30
	CHROMABOND® HR-XA polypropylene columns (45 µm) · *NEW!*							
	1 mL	**730968P45**		**730727P45**				30
	3 mL		**730950P45**			**730951P45**		30
	CHROMAFIX® HR-XA cartridges (85 µm)							
	Size	**S**		**M**			**L**	
	adsorbent weight ∅	155 mg		240 mg			500 mg	
		731768		**731769**			**731770**	50
	CHROMABOND® HR-XA adsorbent (85 µm)							
							730671	100 g

Polymer-based ion exchangers for SPE

HR-XCW

weak cation exchanger

- Weak acidic carboxylic acid cation exchanger
  exchange capacity >0.7 meq/g, pKa ~ 5
  Base material spherical PS/DVB copolymer, pH stability 1–14
  high purity material, highest reproducibility and
  lowest blank values due to an optimized production process
  Spherical particles, size 45 µm and 85 µm (standard); pore size 50–60 Å
  very large specific surface 850 m^2/g; pore volume 1.2–1.4 cm^3/g
  RP capacity 350 mg/g (caffeine in water)
  Outstanding recovery rates especially for enrichment of strongly basic analytes
- Recommended application:
  Basic compounds like quaternary amines
  Active ingredients from heavily matrix-contaminated samples like, e.g., urine, plasma, serum
  Strong bases with **pKa > 10**

Standard protocol for CHROMABOND® HR-XCW

Column type:
CHROMABOND® HR-XCW, 3 mL, 200 mg
REF 730739

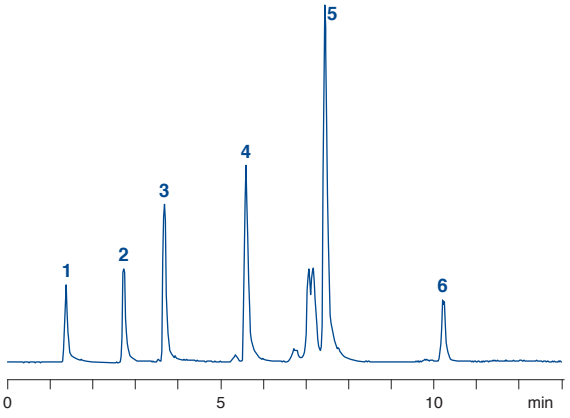
Sample pretreatment: individual sample preparation with reference to analytes and matrix
Column conditioning: 5 mL methanol
Equilibration: 5 mL acidified water
Sample application: slowly aspirate sample through the column
Washing 1: 2 mL acidified water
Washing 2 / Elution 1: 2 mL methanol (neutral and acidic compounds), if necessary, further washing steps
Elution 2: after drying 2 x 2 mL methanol – 1 to 5 % formic acid (strongly basic compounds)

Further analysis: if necessary, evaporate and redissolve in a suitable solvent; HPLC or GC

MN Appl. No. 305300

Analysis of perfluorinated

Column: 125 x 2 mm NUCLEODUR® Sphinx RP, 3 µm
Eluent: A) 10 mmol/L NH_4Ac in water – methanol (75:25, v/v); B) 10 mmol/L NH_4Ac in acetonitrile – methanol (75:25, v/v)
10–30 % B in 3 min, 30–55 % B in 8 min, 55–10 % B in 4 min
Flow rate: 0.30 mL/min, temperature 50 °C
Injection: 2.5 µL (5 mg/L each after SPE enrichment)
Detection: MS, ESI negative



MN Appl. No. 123340

Ordering information

Volume	Adsorbent weight						Pack of
CHROMABOND® HR-XCW polypropylene columns (85 µm)							
	30 mg	60 mg	100 mg	150 mg	200 mg	500 mg	
1 mL	**730731**		**730733**				30
3 mL		**730735**			**730739**	**730741**	30
6 mL				**730737**		**730743**	30
CHROMABOND® HR-XCW polypropylene columns (45 µm) · *NEW!*							
1 mL	**730731P45**		**730733P45**				30
3 mL		**730735P45**			**730739P45**		30
CHROMAFIX® HR-XCW cartridges (85 µm)							
Size		**S**		**M**		**L**	
adsorbent weight ∅		155 mg		240 mg		500 mg	
		731774		**731775**		**731776**	50
CHROMABOND® HR-XCW adsorbent (85 µm)							
						730674	100 g

HR-XAW

weak anion exchanger

- Weak basic secondary and tertiary ammonium anion exchanger
  exchange capacity >0.5 meq/g, pKa ~ 6
  Base material spherical PS/DVB copolymer, pH stability 1–14
  high purity material with highest reproducibility and
  lowest blank values due to an optimized production process
  Spherical particles, size 45 µm and 85 µm (standard); pore size 55–65 Å
  very large specific surface 850 m^2/g; pore volume 1.2–1.4 cm^3/g
  RP capacity 350 mg/g (caffeine in water)
  Outstanding recovery rates especially for enrichment of acidic analytes

- Recommended application:
  Perfluorinated surfactants
  Acidic compounds like sulfonates
  Active ingredients from heavily matrix-contaminated samples like, e.g., urine, plasma, serum
  Strong acids with **pKa < 1**

surfactants from water

Application in accordance with DIN 38407-42

Column type:
CHROMABOND® HR-XAW, 3 mL, 60 mg
REF 730747

Sample: 500 mL water, spiked with 1 mL standard solution (20 µg/L of each compound)
Conditioning: 2 mL methanol + 5 % ammonia, then 2 mL methanol, finally 2 mL water
Sample application: slowly aspirate sample through the column
Washing: 2 mL water, then 2 mL acetone – acetonitrile – formic acid (50:50:1, v/v/v), finally 2 mL methanol
Elution: 2 mL methanol with 5 % ammonia

Further analysis: evaporate to dryness in a stream of nitrogen under slight heating, and redissolve in a suitable solvent for HPLC

Recovery rates [%]:

Compound	Recovery
1 Perfluoropropionic acid (PFPrA)	103
2 Perfluoropentanoic acid (PFPeA)	94
3 Perfluorohexanoic acid (PFHxA)	94
4 Perfluorooctanoic acid (PFOA)	95
5 Perfluorooctane sulfonate K salt (PFOS)	81
6 Perfluorododecanoic acid (PFDoDA)	82

MN Appl. No. 305140

impregnated with fluorosurfactants?

Standard protocol for CHROMABOND® HR-XAW

Column type:
CHROMABOND® HR-XAW, 3 mL, 200 mg
REF 730748

Sample pretreatment: individual sample preparation with reference to analytes and matrix
Conditioning: 5 mL methanol
Equilibration: 5 mL water
Sample application: slowly aspirate sample through the column
Washing 1: 25 mmol/L ammonium acetate
Washing 2 / Elution 1: 2 mL methanol (neutral and basic compounds), if necessary, further washing steps
Elution 2: after drying 2 x 2 mL methanol – 1 to 5 % ammonia (strongly acidic compounds)

Further analyses: if necessary, evaporate and redissolve in a suitable solvent; HPLC or GC

MN Appl. No. 305200

Ordering information

Volume	Adsorbent weight						Pack of
CHROMABOND® HR-XAW polypropylene columns (85 µm)							
	30 mg	60 mg	100 mg	150 mg	200 mg	500 mg	
1 mL	**730728**		**730729**				30
3 mL		**730747**			**730748**	**730744**	30
6 mL				**730749**		**730745**	30
CHROMABOND® HR-XAW polypropylene columns (45 µm) · *NEW!*							
1 mL	**730728P45**		**730729P45**				30
3 mL		**730747P45**			**730748P45**		30
CHROMAFIX® HR-XAW cartridges (85 µm)							
Size		**S**		**M**		**L**	
adsorbent weight ∅		155 mg		240 mg		500 mg	
		731771		**731772**		**731773**	50
CHROMABOND® HR-XAW adsorbent (85 µm)							
						730673	100 g

Polymer-based reversed phases for SPE

Easy polar, bifunctionally modified polystyrene-divinylbenzene copolymer

- Polar modified polystyrene-divinylbenzene copolymer with a weak anion exchanger
  Specific surface 650–700 m^2/g, particle size 80 µm, pore size 50 Å, pH stability 1–14

The Easy effect:

- Without preconditioning
- Due to bifunctional modification much more hydrophilic than conventional polystyrene-divinylbenzene polymers
- Easily wettable with water

- Recommended application:
  polar herbicides and pesticides from water (acidic, neutral, basic)
  polar phenols from water
  polyaromatic compounds
  polychlorinated biphenyls
  drug analysis from urine, blood, serum, plasma, pharmaceuticals and active ingredients from tablets, creams

Recovery of pesticides

Private communication: Mr. Kühn, GUB, Waldshut Tiengen, Germany

Column type:
CHROMABOND® Easy, 3 mL, 200 mg
REF 730754
Column conditioning:
1 mL water, 3 mL methanol, 1 mL water
Sample application:
aspirate the sample through the column
Elution:
3 x 1 mL acetone

Further analysis:
HPLC with NUCLEOSIL® 120-5 C_{18}

MN Appl. No. 303220

Recovery rates [%]:

Compound	Recovery	Compound	Recovery
Desisopropylatrazine	90	Metalaxyl	96
2,6-Dichlorobenzamide	93	Isoproturon	94
Desethylatrazine	93	Diuron	94
Hexazinone	69	Metazachlor	97
Terbacil	65	Propazine	95
Simazine	81	Terbuthylazine	93
Cyanazine	93	Linuron	96
Desethylterbuthylazine	91	Metolachlor	97
Methabenzthiazuron	94	Triallate	61
Chlortoluron	91	Standard	64
Atrazine	92		

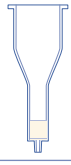
Ordering information

CHROMABOND® Easy polypropylene columns

Volume	30 mg	60 mg	100 mg	200 mg	500 mg	1 g	Pack of
1 mL	730751		730752				30
3 mL		730753		730754	730759		30
6 mL				730755	730756		30
15 mL					730757	730758	20

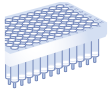
CHROMABOND® Easy polypropylene columns · BIGpacks

Volume	200 mg	Pack of
3 mL	730754.250	250
6 mL	730755.250	250



CHROMABOND® LV-Easy

Volume	200 mg	Pack of
15 mL	732472	30



CHROMABOND® MULTI 96 Easy

96 x 25 mg	96 x 50 mg	96 x 100 mg	
738520.025M	738520.050M	738520.100M	1

CHROMABOND® Easy adsorbent

730661		20 g

Glass columns on request.

HR-P

polystyrene-divinylbenzene adsorbent resin

- Highly porous polystyrene-divinylbenzene copolymer
  specific surface 1200 m^2/g
  particle size 50–100 µm
  very high binding capacity, up to 30% of adsorbent weight (for comparison: silica adsorbents about 3%)
- Recommended application:
  aromatic compounds
  phenols from water
  nitroaromatics from water
  pesticides from water
  PAHs from oil

Aromatic amines from water samples

Private communication M. Leß, T.C. Schmidt, Department of Chemistry, University Marburg, 1997

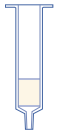
Compounds investigated: aromatic amines
Column type:
CHROMABOND® HR-P, 3 mL, 200 mg
REF 730108
Sample pretreatment: adjust to pH 9 using 10 mol/L NaOH
Column conditioning: 2 mL each of methanol, acetonitrile and 10^{-5} mol/L sodium hydroxide

Sample application:
aspirate sample through the column with about 10 mL/min
Column washing:
wash with 2 mL dist. water, dry 5 min under vacuum
Elution: 3 x 1 mL methanol – acetonitrile (1:1, v/v)

For recovery rates of numerous aromatic amines please see application 301810 at ***www.mn-net.com/apps***.

MN Appl. No. 301810

Ordering information



CHROMABOND® HR-P polypropylene columns

Volume	Adsorbent weight				Pack of
	100 mg	200 mg	500 mg	1 g	
1 mL	**730280**				30
3 mL		**730108**	**730117**		30
6 mL		**730119**	**730111**	**730118**	30

CHROMABOND® HR-P polypropylene columns · BIGpack

Volume	Adsorbent weight	Pack of
	200 mg	
3 mL	**730108.250**	250

CHROMABOND® HR-P glass columns

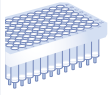
Volume	Adsorbent weight			Pack of
	200 mg	500 mg	1 g	
3 mL	**730108G**			30
6 mL		**730111G**	**730118G**	30

CHROMABOND® LV-HR-P

Volume	Adsorbent weight	Pack of
	200 mg	
15 mL	**732108**	30

CHROMAFIX® HR-P cartridges

Size	S	M	L	
Adsorbent weight ∅	200 mg	330 mg	680 mg	
	731839	**731840**	**731841**	50



CHROMABOND® MULTI 96 HR-P

	96 x 100 mg	
	738111.100M	1

CHROMABOND® HR-P adsorbent

	730615	20 g

Polymer-based phases for SPE

PS-RP / PS-OH⁻ / PS-H⁺ PS-Mix / PS-Ag⁺ / PS-Ba²⁺

phases for RP and ion chromatography

- Base material high purity polystyrene-divinylbenzene copolymers (PS/DVB), pore size 100 Å, particle size 100 µm

  Very low degree of swelling, thus very well suited for chromatography

  Reliable function over the whole pH range from 0–14

  Different modifications for different applications from elimination of nonpolar compounds up to the removal of specific polar components

- Recommended application:

  Removal of interfering compounds

  - Improves chromatographic separation, if the interfering components overlap with the analyte in the chromatogram
  - Improves lifetime of the chromatographic column, since interfering components can irreversibly block the column packing

  Enrichment of the analytes

Properties of the individual modifications:

PS-RP	hydrophobic PS/DVB copolymer	removal of organic interfering components from water
PS-OH⁻	strong PS/DVB anion exchanger, OH^- form capacity 0.6 meq/g	removal or concentration of anions from water increasing the pH value in acidic samples
PS-H⁺	strong PS/DVB cation exchanger, H^+ form capacity 2.9 meq/g	removal or concentration of cations from water decreasing the pH value of basic samples
PS-Mix	mixture of PS-OH⁻ and PS-H⁺	desalting of water
PS-Ag⁺	strong PS/DVB cation exchanger, Ag^+ form	removal of halide ions from water
PS-Ba²⁺	strong PS/DVB cation exchanger, Ba^{2+} form	removal of sulfate ions from water

Application 301930/302750: removal of halides from aqueous samples shown for the trace analysis of nitrate besides an excess of chloride or bromide

Compounds investigated: 20 ppm nitrate besides 2500 ppm chloride or 500 ppm bromide, respectively

Column type:
CHROMAFIX® PS-Ag⁺ (M)
0.8 mL, ∅ 480 mg, REF 731865

Column conditioning: 1 mL dist. water

Sample application and elution:
apply 4 x 1 mL sample fractions to the cartridge, discard 1st mL, collect 2nd, 3rd and 4th mL separately

Further analysis: HPLC with column 250 x 4 mm NUCLEOSIL® Anion II; eluent 2 mmol/L K H phthalate pH 6, 2 mL/min; detection: indirect UV, 280 nm (see applications 110440 and 110450 at ***www.mn-net.com/apps***)

Ordering information

CHROMABOND® PS polypropylene columns

Phase	3 mL 200 mg	3 mL 500 mg	6 mL 500 mg	6 mL 900 mg	Pack of
PS-RP	**730765**	**730692**	**730693**		30
PS-OH⁻	**730396**	**730344**	**730378**		30
PS-H⁺	**730690**	**730376**	**730377**		30
PS-Mix		**730394**		**730310**	30

CHROMAFIX® PS cartridges

Phase	Size S	Adsorbent weight ∅	Size M	Adsorbent weight ∅	Size L	Adsorbent weight ∅	Pack of
PS-RP	**731877**	200 mg	**731875**	320 mg			50
PS-OH⁻	**731868**	200 mg	**731860**	380 mg	**731862**	800 mg	50
PS-H⁺	**731867**	230 mg	**731861**	430 mg	**731863**	900 mg	50
PS-Mix	**731909**	230 mg					50
PS-Ag⁺	**731866**	240 mg	**731865**	480 mg			50
PS-Ba²⁺	**731871**	280 mg	**731870**	550 mg			50

C_{18} ec / C_{18} ec f (f = fast flow)

octadecyl silica, endcapped

- Base material silica, pore size 60 Å, particle size 45 µm for **C_{18} ec**, 100 µm for **C_{18} ec f** (for fast flow), specific surface 500 m^2/g, pH stability 2–8
- Octadecyl phases, endcapped, carbon content 14 %
- Very nonpolar, hydrophobic interactions with a wide variety of organic compounds
- Advantageous for clean-up of samples with large structural variations (polarity differences)
- Recommended application:
  nonpolar compounds
  aflatoxins, amphetamines, antibiotics, antiepileptics, barbiturates, caffeine, drugs, preservatives, fatty acids, nicotine, PAHs, pesticides, PCBs, heavy metals, vitamins
- very well suited for desalting of samples
- **C_{18} ec f** for viscous samples

Ordering information

CHROMABOND® C_{18} ec polypropylene columns

Volume	100 mg	200 mg	500 mg	1 g	2 g	5 g	10 g	Pack of
1 mL	**730011**							100
3 mL		**730012**	**730013**					50
6 mL			**730014**	**730015**	**730141**			30
15 mL					**730404**			20
45 mL						**730405**		20
70 mL							**730259**	10

CHROMABOND® C_{18} ec polypropylene columns · BIGpacks

Volume	500 mg	1 g	Pack of
3 mL	**730013.250**		250
6 mL	**730014.250**	**730015.250**	250

CHROMABOND® C_{18} ec glass columns

Volume	200 mg	500 mg	1 g	Pack of
3 mL	**730012G**	**730013G**		50
6 mL		**730014G**	**730015G**	30

CHROMABOND® LV-C_{18} ec

Volume	200 mg	500 mg	Pack of
15 mL	**732012**	**732013**	30

CHROMAFIX® C_{18} ec cartridges

Size	S	M	L	
Adsorbent weight ∅	270 mg	530 mg	950 mg	
	731804	**731805**	**731806**	50

CHROMABOND® MULTI 96 C_{18} ec

96 x 25 mg	96 x 50 mg	96 x 100 mg	
738011.025M	**738011.050M**	**738011.100M**	1

CHROMABOND® C_{18} ec adsorbent

		730611	100 g

CHROMABOND® C_{18} ec f polypropylene columns (fast flow)

Volume	200 mg	500 mg	1 g	Pack of
3 mL	**730269**	**730018**		50
6 mL		**730016**	**730010**	30

CHROMABOND® C_{18} ec f adsorbent (fast flow)

		730613	100 g

Silica-based reversed phases for SPE

C_{18} / C_{18} f (f = fast flow)

octadecyl silica

- Base material silica, pore size 60 Å, particle size 45 µm for **C_{18}**, 100 µm for **C_{18} f** (for fast flow), specific surface 500 m^2/g, pH stability 2–8
  Octadecyl phases, not endcapped, carbon content 14 %
  Similar to C_{18} ec, however possesses more free silanols (SiOH), which allow secondary interactions with polar groups of the analytes
- Recommended application:
  nonpolar compounds
  pesticides
  C_{18} f for viscous samples

Ordering information

CHROMABOND® C_{18} polypropylene columns

Volume	100 mg	200 mg	500 mg	1 g	2 g	5 g	10 g	Pack of
1 mL	730001							100
3 mL		730002	730003					50
6 mL			730004	730005	730130			30
15 mL					730028			20
45 mL						730400		20
70 mL							730261	10

CHROMABOND® C_{18} polypropylene columns · BIGpacks

Volume	500 mg	1 g	Pack of
3 mL	730003.250		250
6 mL	730004.250	730005.250	250

CHROMABOND® C_{18} glass columns

Volume	500 mg	1 g	Pack of
3 mL	730003G		50
6 mL	730004G	730005G	30

CHROMABOND® LV-C_{18}

Volume	200 mg	Pack of
15 mL	732002	30

CHROMAFIX® C_{18} cartridges

Size	S	M	L	
Adsorbent weight ∅	240 mg	480 mg	950 mg	
	731801	731802	731803	50

CHROMABOND® MULTI 96 C_{18}

96 x 25 mg	96 x 100 mg	
738001.025M	738001.100M	1

CHROMABOND® C_{18} adsorbent

730602	100 g

CHROMABOND® C_{18} f polypropylene columns (fast flow)

Volume	200 mg	500 mg	1 g	Pack of
3 mL	730402	730008		50
6 mL		730403	730009	30

CHROMABOND® C_{18} f adsorbent (fast flow)

730612	100 g

C_{18} Hydra

octadecyl silica for polar analytes

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2–8

  Special octadecyl phase for polar analytes, not end-capped, carbon content 15 %

- Recommended application:

  more polar compounds like pesticides and their polar degradation products, phenols, phenoxycarboxylic acids, nitroaromatics, pharmaceuticals

Pesticides from water

Compounds investigated: triazines and carboxylic amides

Column type:
CHROMABOND® C_{18} Hydra, 6 mL, 2 g
REF 730301

Sample pretreatment: adjust 1000 mL water to pH 7–8 with diluted NH_3 and add 100 µL of the internal standards (1 µg/L).

Column conditioning: 2 x 5 mL methanol, then 2 x 5 mL dist. water

Sample application: force or aspirate the sample through the column. Then dry for 2 h with 2 bar N_2.

Elution: slowly aspirate 10 mL methanol through the column. Evaporate the eluate to dryness in a tapered flask with a rotation evaporator at 30 °C and store in a refrigerator for ~ 15 min. Redissolve the residue in 200 µL cold, fresh *n*-hexane and transfer the solution to a conic HPLC vial (e.g., REF 702891). Store the solution in a refrigerator until chromatography.

Recovery rates: between 95 and 100 %

Further analysis: GC with OPTIMA® δ-3 or OPTIMA® δ-6 (e.g., application 250420) or HPLC in accordance with EN ISO 11369: 1997 on NUCLEOSIL® 120-3 C_{18} (application 110880)

MN Appl. No. 302060

Ordering information

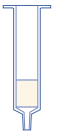
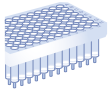
Volume	Adsorbent weight							Pack of
CHROMABOND® C_{18} Hydra polypropylene columns								
	50 mg	100 mg	200 mg	500 mg	1 g	2 g	3 g	
1 mL	**730294**	**730295**						100
3 mL			**730296**	**730297**	**730298**			50
6 mL				**730299**	**730300**	**730301**	**730302**	30
CHROMABOND® C_{18} Hydra glass columns								
			200 mg	500 mg	1 g			
3 mL			**730296G**	**730297G**	**730298G**			50
6 mL				**730299G**	**730300G**			30
CHROMABOND® LV-C_{18} Hydra								
			200 mg					
15 mL			**732295**					30
CHROMAFIX® C_{18} Hydra cartridges								
Size			**S**		**M**		**L**	
Adsorbent weight ∅			270 mg		530 mg		950 mg	
			731730		**731731**		**731732**	50
CHROMABOND® MULTI 96 C_{18} Hydra								
							96 x 100 mg	
							738294.100M	1
CHROMABOND® C_{18} Hydra adsorbent								
							730628	100 g

Silica-based reversed phases for SPE

C_8 — octyl silica

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2–8
  Octyl phase, not endcapped, carbon content 8%
  Similar to C_{18}, however slightly more polar secondary interactions with polar compounds are more pronounced due to shorter alkyl chains
- Recommended application: pesticides, PCB

Ordering information

	Volume	Adsorbent weight				Pack of
	**CHROMABOND® C_8 polypropylene columns**					
		100 mg	200 mg	500 mg	1 g	
	1 mL	**730021**				100
	3 mL		**730022**	**730023**		50
	6 mL			**730024**	**730134**	30
	CHROMABOND® C_8 glass columns					
				500 mg		
	6 mL			**730024G**		30
	**CHROMABOND® LV-C_8**					
				500 mg		
	15 mL			**732023**		30
	**CHROMAFIX® C_8 cartridges**					
	Size			M		
	Adsorbent weight ∅			520 mg		
				731808		50
	**CHROMABOND® MULTI 96 C_8**					
					96 x 100 mg	
					738021.100M	1
	**CHROMABOND® C_8 adsorbent**					
					730601	100 g

C_4 butyl silica

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2–8
  Butyl phase, not endcapped, carbon content 7%
  Slightly more polar than C_{18} or C_8, due to shorter alkyl chains the silica surface is not completely shielded
- Recommended application:
  compounds, which are too strongly retained on C_{18} or C_8
  e.g., analgetics from blood

Ordering information

Volume	Adsorbent weight			Pack of
CHROMABOND® C_4 polypropylene columns				
	100 mg	500 mg		
1 mL	**730225**			100
3 mL		**730227**		50
CHROMAFIX® C_4 cartridges				
Size	**S**	**M**		
Adsorbent weight ∅	220 mg	440 mg		
	731740	**731741**		50
CHROMABOND® C_4 adsorbent				
			730651	100 g

Glass columns, LV columns and MULTI 96 on request.

C_2 dimethyl silica

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2–8
  Dimethyl phase, not endcapped, carbon content 4%
  Similar to C_4
- Recommended application:
  e.g., antiepileptics from plasma

Ordering information

Volume	Adsorbent weight			Pack of
CHROMABOND® C_2 polypropylene columns				
	100 mg	500 mg	1 g	
1 mL	**730169**			100
3 mL		**730221**		50
6 mL		**730409**	**730410**	30
CHROMABOND® C_2 adsorbent				
			730652	100 g

Glass columns, LV columns, CHROMAFIX® cartridges and MULTI 96 on request.

Silica-based reversed phases for SPE

C_6H_{11} ec — cyclohexyl silica, endcapped

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2–8
  Cyclohexyl phase, endcapped, carbon content 9%
  Alternative phase for the midpolar range
- Recommended application:
  phenols from water
  chloroanilines from waste water
  anthelmintics from tissue

Comparison of different phases for phenol analysis

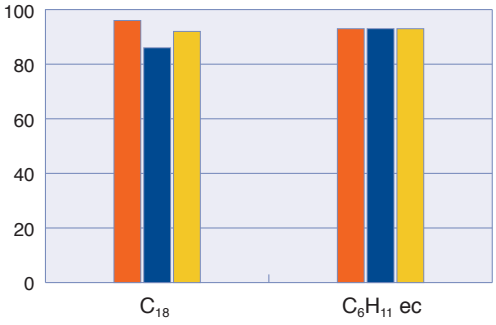
Compounds investigated:
phenol, 2,4-dinitrophenol, pentachlorophenol

Column types:
CHROMABOND® C_{18}, 6 mL, 2000 mg, REF 730130
CHROMABOND® C_6H_{11} ec, 6 mL, 2000 mg, REF 730469

Column conditioning:
10 mL acetone, 10 mL methanol, and 10 mL dist. water (pH 2)

Sample application:
aspirate the sample through the column.

Elution:
10 mL methanol



MN Appl. No. 302150

Ordering information

	Volume	Adsorbent weight		Pack of
	CHROMABOND® C_6H_{11} ec polypropylene columns			
		500 mg	1 g	
	3 mL	**730442**		50
	6 mL	**730443**	**730444**	30
	CHROMABOND® C_6H_{11} ec adsorbent			
			730631	100 g

Glass columns, LV columns, CHROMAFIX® cartridges and MULTI 96 on request.

For further applications on CHROMABOND® phases see our online application database at

www.mn-net.com/apps

C_6H_5 — phenyl silica

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2–8

  Phenyl phase, carbon content 8%

  Polarity similar to C_8

  In addition to hydrophobic interactions more selective adsorption is possible by π–π interactions due to the electron density of the phenyl ring.

- Recommended application:

  aflatoxins
  caffeine
  phenols

Flavor compounds from brandy

Compounds investigated: asarone, quinine, coumarin, quassin

Column type:
CHROMABOND® C_6H_5, 6 mL, 1000 mg
REF 730412

Sample pretreatment:
mix 10 mL sample with 90 mL water and 10 g sodium chloride and adjust to pH 7 with 0.1 mol/L sodium hydroxide solution

Column conditioning:
10 mL methanol, then 10 mL dist. water

Sample application:
slowly force or aspirate the sample through the column

Column washing:
2.5 mL water, then 2.5 mL pentane

Elution:
1) 2 x 2.5 mL pentane – diethyl ether (7:3, v/v): asarone, coumarin
2) 10 mL 1 mol/L basic methanol – diethyl ether (9:1, v/v): quinine
3) 5 mL chloroform: quassin

MN Appl. No. 300170

Ordering information

Volume	Adsorbent weight			Pack of
CHROMABOND® C_6H_5 polypropylene columns				
	100 mg	200 mg	500 mg	
1 mL	**730083**			100
3 mL		**730411**	**730084**	50
CHROMABOND® C_6H_5 adsorbent				
			730606	100 g

Glass columns, LV columns, CHROMAFIX® cartridges and MULTI 96 on request.

Silica-based normal phases for SPE

CN

cyanopropyl silica

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2–8
  Cyanopropyl phase, carbon content 5.5 %
  Polar to midpolar
  In addition to weak hydrophobic interactions selective interactions are possible due to the high electron density of the CN group.
- Recommended application:
  cyclosporins
  carbohydrates

Ordering information

Volume	Adsorbent weight			Pack of
CHROMABOND® CN polypropylene columns				
	100 mg	200 mg	500 mg	
1 mL	**730061**			100
3 mL		**730420**	**730063**	50
6 mL			**730421**	30
CHROMABOND® CN adsorbent				
			730607	100 g

Glass columns, LV columns, CHROMAFIX® cartridges and MULTI 96 on request.

OH (Diol)

diol silica

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2–8
  Diol phase, carbon content 5.5 %
  Polar
  Properties similar to SiOH
- Recommended application:
  antibiotics
  prostaglandins

Ordering information

Volume	Adsorbent weight			Pack of
CHROMABOND® OH (Diol) polypropylene columns				
	100 mg	200 mg	500 mg	
1 mL	**730051**			100
3 mL		**730417**	**730053**	50
6 mL			**730418**	30
CHROMABOND® OH (Diol) adsorbent				
			730605	100 g

Glass columns, LV columns, CHROMAFIX® cartridges and MULTI 96 on request.

Silica-based normal phases for SPE

NH_2 — aminopropyl silica

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2–8
  Aminopropyl phase, carbon content 3.5 %
  Polar, weak anion exchanger
- Recommended application:
  trace elements
  lipids

Metals: trace elements from water

Compounds investigated: Al, Be, Cu, Cr(VI), Mo(VI), V(V)

Column type:
CHROMABOND® NH_2, 3 mL, 500 mg
REF 730033

Sample pretreatment:
mix 100 mL water sample with 5 mL 0.001 % alizarinsulfonic acid solution and adjust to pH 5.5 with acetic acid or sodium acetate

Column conditioning:
2 column volumes 1 mol/L nitric acid, then 2 column volumes dist. water

Sample application:
force or aspirate sample through the column with 3–4 mL/min

Column washing:
2 mL dist. water; dry column under vacuum for 4 min

Elution:
2 column volumes 2 mol/L nitric acid

MN Appl. No. 301910

Ordering information

Volume	Adsorbent weight				Pack of
CHROMABOND® NH_2 polypropylene columns					
	100 mg	200 mg	500 mg	1 g	
1 mL	**730031**				100
3 mL		**730413**	**730033**		50
6 mL			**730180**	**730626**	30
CHROMABOND® NH_2 polypropylene columns · BIGpack					
			500 mg		
3 mL			**730033.250**		250
CHROMABOND® NH_2 glass columns					
			500 mg	1 g	
3 mL			**730033G**		50
6 mL			**730180G**	**730626G**	30
CHROMABOND® LV-NH_2					
			500 mg		
15 mL			**732033**		30
CHROMAFIX® NH_2 cartridges					
Size		**S**			
Adsorbent weight ∅		220 mg			
		731813			50
CHROMABOND® MULTI 96 NH_2					
				96 x 100 mg	
				738031.100M	1
CHROMABOND® NH_2 adsorbent					
				730603	100 g

Silica-based normal phases for SPE

SiOH

unmodified silica

- Unmodified, weakly acidic silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2–8

  Very polar

  Adsorbs humidity from air, for this reason it should be kept well closed and if necessary dried before use

  Due to its high affinity for polar compounds it should not be conditioned with polar (e.g., methanol) or water-containing solvents.

- Recommended application:

  aflatoxins
  chloramphenicol
  pesticides
  steroids
  vitamins

Ordering information

CHROMABOND® SiOH polypropylene columns

Volume	100 mg	200 mg	500 mg	1 g	2 g	5 g	10 g	50 g	Pack of
1 mL	**730071**								100
3 mL		**730214**	**730073**						50
6 mL			**730070**	**730075**	**730107**				30
15 mL					**730217**				20
45 mL						**730406**			20
70 mL							**730072**		10
150 mL								**730473**	10

CHROMABOND® SiOH polypropylene columns · BIGpacks

Volume	500 mg	1 g	2 g	Pack of
3 mL	**730073.250**			250
6 mL		**730075.250**	**730107.250**	250

CHROMABOND® SiOH glass columns

Volume	200 mg	500 mg	1 g	2 g	Pack of
3 mL	**730214G**	**730073G**			50
6 mL		**730070G**	**730075G**	**730107G**	30

CHROMABOND® LV-SiOH

Volume	200 mg	500 mg	Pack of
15 mL	**732072**	**732073**	30

CHROMAFIX® SiOH cartridges

Size	S	M	L	
Adsorb. weight ∅	230 mg	420 mg	880 mg	
	731828	**731829**	**731830**	50

CHROMABOND® MULTI 96 SiOH

96 x 100 mg	
738071.100M	1

CHROMABOND® SiOH adsorbent

730608	100 g

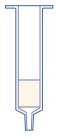
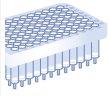
Alox A / Alox N / Alox B — aluminium oxide, acidic, neutral, basic

Aluminium oxide, high purity, pore volume 0.90 mL/g, particle size 60–150 µm, specific surface 150 m^2/g

Properties of the individual modifications:

Alox A:	aluminium oxide, acidic	pH value 4 ± 0.5
Alox N:	aluminium oxide, neutral	pH value 7 ± 0.5
Alox B:	aluminium oxide, basic	pH value 9.5 ± 0.5

Ordering information

	Phase	Volume	Adsorbent weight			Pack of
	**CHROMABOND® Alox polypropylene columns**					
			500 mg	1 g	4 g	
	Alox A	3 mL	**730452**			50
	Alox A	6 mL	**730453**	**730017**		30
	Alox A	45 mL			**730455**	20
	Alox N	3 mL	**730446**			50
	Alox N	6 mL	**730447**	**730139**		30
	Alox N	45 mL			**730250**	20
	Alox B	3 mL	**730429**			50
	Alox B	6 mL	**730466**	**730020**		30
	Alox B	45 mL			**730467**	20
	CHROMABOND® Alox glass columns					
				1 g		
	Alox N	6 mL		**730139G**		30
	Alox B	6 mL		**730020G**		30
	**CHROMABOND® LV-Alox**					
				1 g		
	Alox A	15 mL		**732210**		30
	Alox N	15 mL		**732091**		30
	Alox B	15 mL		**732205**		30
	**CHROMAFIX® Alox cartridges**					
		Size	**M**		**L**	
		Adsorb. weight ∅	850 mg		1700 mg	
	Alox N		**731844**		**731845**	50
	**CHROMABOND® MULTI 96 Alox**					
				96 x 100 mg		
	Alox A			**738253.100M**		1
	Alox N			**738251.100M**		1
	Alox B			**738252.100M**		1
	**CHROMABOND® Alox adsorbents**					
	Alox A				**730642**	100 g
	Alox N				**730641**	100 g
	Alox B				**730640**	100 g

Normal phases for SPE

Florisil®

magnesium silicate

- Matrix magnesium silicate (MgO – SiOH 15:85), high purity, particle size 150–250 µm
- Recommended application: organic tin compounds, aliphatic carboxylic acids, PCBs, PAHs

Ordering information

Volume	Adsorbent weight				Pack of
CHROMABOND® Florisil® polypropylene columns					
	200 mg	500 mg	1 g	2 g	
3 mL	**730457**	**730081**			50
6 mL		**730238**	**730082**	**730239**	30
CHROMABOND® Florisil® polypropylene columns · BIGpack					
			1 g		
6 mL			**730082.250**		250
CHROMABOND® Florisil® glass columns					
		500 mg	1 g	2 g	
6 mL		**730238G**	**730082G**	**730239G**	30
CHROMAFIX® Florisil® cartridges					
Size			**L**		
Adsorbent weight ∅			990 mg		
			731848		50
CHROMABOND® Florisil® adsorbent					
			730622		100 g

LV columns and MULTI 96 on request

PA

polyamide 6

- Matrix polyamide 6, unmodified, high purity, particle size 40–80 µm
- Recommended application: flavonoids, PAHs

Ordering information

Volume	Adsorbent weight			Pack of
CHROMABOND® PA polypropylene columns				
	200 mg	500 mg	1 g	
3 mL	**730384**	**730126**		50
6 mL		**730007**	**730127**	30
CHROMAFIX® PA cartridges				
Size	**S**		**L**	
Adsorbent weight ∅	170 mg		620 mg	
	731849		**731851**	50
CHROMABOND® PA adsorbent				
			730660	100 g

Glass columns, LV columns and MULTI 96 on request

PCA propylcarboxylic acid cation exchanger based on silica

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2–8
  Propylcarboxylic acid modified silica
  Weakly acidic cation exchanger (WCX)
- Recommended application: strong cations

Ordering information

	Volume	Adsorbent weight			Pack of
	CHROMABOND® PCA polypropylene columns				
		500 mg	1 g		
	3 mL	**730482**			50
	6 mL	**730483**	**730484**		30
	CHROMABOND® LV-PCA				
		500 mg			
	15 mL	**732482**			30
	CHROMABOND® PCA adsorbent				
				730629	100 g

Glass columns, CHROMAFIX® cartridges and MULTI 96 on request.

PSA propylsulfonic acid cation exchanger based on silica

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2–8
  Propylsulfonic acid modified silica
  Very strong cation exchanger (capacity ~ 0.7 meq/g)
  Contrary to the SA phase no π–π interactions
- Recommended application: weak cations

Ordering information

	Volume	Adsorbent weight				Pack of
	CHROMABOND® PSA polypropylene columns					
		100 mg	500 mg	1 g		
	1 mL	**730460**				100
	3 mL		**730462**			50
	6 mL			**730464**		30
	CHROMABOND® PSA adsorbent					
					730630	100 g

Glass columns, LV columns, CHROMAFIX® cartridges and MULTI 96 on request.

Silica-based ion exchangers for SPE

SA — benzenesulfonic acid cation exchanger based on silica (SCX)

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2–8
  Benzenesulfonic acid modified silica
  strongly acidic cation exchanger (capacity ~ 0.5 meq/g)
  adsorbent with hydrophobic and π–π interactions (benzene ring)
  Ion exchange of organic compounds from aqueous matrix
  elution of interesting compounds with solvent systems, which compensate the ionic and nonpolar interactions, e.g., methanolic HCl

- Recommended application:
  amino acids
  amines
  chlorophyll
  PCB

Sulfonamides in meat and kidney

B. Pacciarelli et al., Mitt. Gebiete Lebensm. Hyg. 82 (1991) 45–55

Compounds investigated: sulfaguanidine, sulfanilamide, sulfadiazine, sulfathiazole, sulfapyridine, sulfamerazine, sulfamethizole, sulfadimidine, sulfamethoxypyridazine, sulfachlorpyridazine, sulfadoxine, sulfadimethoxine

Column type:
CHROMABOND® SA (≡ SCX), 3 mL, 500 mg
REF 730077

Sample pretreatment: homogenize 10 g sample and 60 mL dichloromethane – acetone (1:1, v/v) for 30 s with a Polytron. Centrifuge the homogenate for 10 min at 2500 rpm. Filter the organic phase and wash the filter residue with a little dichloromethane – acetone. Add 5 mL glacial acetic acid to the filtered extract.

Column conditioning: apply 6 mL hexane and suck air until the column is dry (10 min). Then apply 6 mL dichloromethane – acetone – glacial acetic acid (10:10:1, v/v/v). Now the column must not run dry.

Sample application: 1/10 of the extract volume, flow rate about 2 mL/min; the column must not run dry

Column washing: 5 mL water, then 5 mL methanol; dry for 10 min under vacuum. Now suck NH_3 gas through the column until the acid is neutralized. To control the neutralization process, press air through the column: a wet pH paper should indicate a neutral or basic pH value.

Elution: 3 mL methanol (1–2 mL/min); carefully concentrate the eluate on a rotation evaporator (40 °C/100 mbar), dissolve the residue in 0.5 mL of 5.5 % acetonitrile in buffer (1.641 g sodium acetate in 1 L water, adjusted to pH 5 with glacial acetic acid) and centrifuge.

Further analysis: HPLC

MN Appl. No. 302710

Ordering information

Volume	Adsorbent weight				Pack of
CHROMABOND® SA polypropylene columns					
	100 mg	200 mg	500 mg	1 g	
1 mL	**730076**				100
3 mL		**730275**	**730077**		50
6 mL			**730425**	**730212**	30
CHROMABOND® SA polypropylene columns · BIGpack					
			500 mg		
3 mL			**730077.250**		250
CHROMABOND® LV-SA					
			500 mg		
15 mL			**732083**		30
CHROMAFIX® SA cartridges					
Size	**S**		**M**	**L**	
Adsorbent weight ∅	220 mg		450 mg	920 mg	
	731831		**731832**	**731833**	50
CHROMABOND® MULTI 96 SA					
				96 x 100 mg	
				738141.100M	1
CHROMABOND® SA adsorbent					
				730609	100 g

Glass columns on request

SB quaternary ammonium anion exchanger based on silica (SAX)

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2–8
  Silica modified with quaternary amine
  strongly basic anion exchanger (capacity ~ 0.3 meq/g)
  Not suited for very strong anions such as sulfonic acids, because these are difficult to elute
- Recommended application:
  organic acids
  caffeine
  saccharin

Vitamins: folic acid from food (e.g., wheat germs)

Column type:
CHROMABOND® SB (≡ SAX), 3 mL, 500 mg
REF 730079

Sample pretreatment:
homogenize 10 g food sample in 100 mL 0.01 mol/L phosphate buffer pH 7.4 and filter

Column conditioning: 2 column volumes *n*-hexane, then 2 column volumes methanol, finally 2 column volumes dist. water

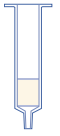
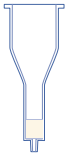
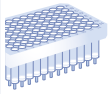
Sample application: force or aspirate 10 mL of the filtrate through the column

Column washing: 2 column volumes dist. water

Elution: 5 mL 10 % sodium chloride in 0.1 mol/L sodium acetate buffer

MN Appl. No. 300650

Ordering information

	Volume	Adsorbent weight				Pack of
	**CHROMABOND® SB polypropylene columns**					
		100 mg	200 mg	500 mg	1 g	
	1 mL	**730078**				100
	3 mL		**730322**	**730079**		50
	6 mL			**730426**	**730323**	30
	CHROMABOND® SB polypropylene columns · BIGpack					
				500 mg		
	3 mL			**730079.250**		250
	**CHROMABOND® LV-SB**					
				500 mg		
	15 mL			**732088**		30
	**CHROMAFIX® SB cartridges**					
	Size	**S**		**M**	**L**	
	Adsorbent weight ∅	230 mg		460 mg	920 mg	
		731834		**731835**	**731836**	50
	**CHROMABOND® MULTI 96 SB**					
					96 x 100 mg	
					738101.100M	1
	**CHROMABOND® SB adsorbent**					
					730610	100 g

Glass columns on request

Special SPE phases · pharmaceutical analyses

Drug

special silica phase for drug analysis

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2–8
  Special bifunctional modification – C_8 / SA (strong cation exchanger – benzenesulfonic acid)
- Recommended application:
  enrichment of acidic, neutral and basic drugs from urine or plasma

Drugs from blood serum

W. Weinmann, M. Renz, C. Pelz, P. Brauchle, S. Vogt, S. Pollak, Blutalkohol **35** (1998), 1–9

Compounds investigated:
benzoylecgonine, amphetamine, codeine, morphine

Column type:
CHROMABOND® Drug, 3 mL, 200 mg
REF 730168

Sample pretreatment:
0.1 mL blood serum are mixed with 1.4 mL of a 0.1 mol/L KH_2PO_4 buffer (pH 6) and centrifuged

Column conditioning:
2 mL methanol, then 2 mL 0.1 mol/L KH_2PO_4 buffer (pH 6)

Sample application:
slowly force or aspirate the supernatant from the sample pretreatment through the column

Column washing:
2 mL 0.1 mol/L KH_2PO_4 buffer (pH 6), then 1 mL 0.1 mol/L acetic acid, then 2 mL methanol;
finally dry the column first by centrifugation (2 min, 4000 U/min), then under vacuum for 10 min

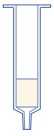
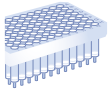
Elution:
1.5 mL dichloromethane – 2-propanol – 25 % ammonia solution (80:20:2, v/v/v)

Further analysis: HPLC with NUCLEOSIL® 100-5 C_{18} AB (application 110240) or GC/MS after derivatization with perfluoropropanoic acid anhydride/pentafluoropropanol, e.g., with column OPTIMA® 5 MS, 0.25 mm film, 30 m x 0.25 mm ID, (REF 726220.30)

MN Appl. No. 302020

Poppy seeds as source of opiates

Ordering information

	Volume	Adsorbent weight			Pack of
	**CHROMABOND® Drug polypropylene columns**				
		100 mg	200 mg	500 mg	
	1 mL	**730681**			100
	3 mL		**730168**	**730684**	50
	6 mL			**730682**	30
	CHROMABOND® Drug polypropylene columns · BIGpack				
			200 mg		
	3 mL		**730168.250**		250
	**CHROMABOND® LV-Drug**				
			200 mg		
	15 mL		**732168**		30
	**CHROMABOND® MULTI 96 Drug**				
				96 x 100 mg	
				738161.100M	1

Drug II

extraction of THC and derivatives, acidic analytes from biological fluids (urine, blood, etc.)

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2–8

  Special bifunctional modification – C_8 / SB (strong anion exchanger – quaternary amine $-NR_3^+$)

  Two primary retention mechanisms facilitate use of very strong interferant-eluting solvents, resulting in very pure extracts

- Recommended application:

  extraction of THC and derivatives from urine, blood, serum, plasma

  acidic analytes from biological fluids

11-nor-Δ9-THC-carboxylic acid from urine

Compounds investigated:
tetrahydrocannabinol, 11-nor-Δ9-THC-carboxylic acid

Column type:
CHROMABOND® Drug II, 3 mL, 200 mg
REF 730680

Sample pretreatment: add 300 µL 10 mol/L potassium hydroxide solution and internal standard (for GC/MS deuterium labeled 11-nor-9-THC-carboxylic acid) to 5 mL urine. Vortex the sample and then hydrolyze at 60 °C for 15 min. Cool sample and add 200 µL glacial acetic acid and 2 mL 50 mmol/L ammonium acetate solution. If necessary, adjust sample pH to 6–7.
Column conditioning: 2 mL methanol, 2 mL dist. water; equilibrate column with 2 mL 50 mmol/L ammonium acetate buffer
Sample application: slowly force or aspirate the sample through the column (1–2 mL/min)
Column washing: elute interferants with 10 mL methanol – water (1:1, v/v); dry the column for 10 min at high vacuum; further wash the column with 2 mL acetonitrile and dry for another 2 min
Elution: elute THC metabolites with 3 mL hexane – ethyl acetate – glacial acetic acid (75:25:1, v/v/v)

Further analysis: we recommend GC/MS on an OPTIMA® 5 MS column after derivatization with 50 µL SILYL-991 (REF 701480; BSTFA – TMCS 99:1) at 70 °C for 20 min; inject 1–2 µL onto the GC column.

Recovery rates: 70–80 %

MN Appl. No. 303880

Ordering information

Volume	Adsorbent weight			Pack of
CHROMABOND® Drug II polypropylene columns				
	100 mg	200 mg	500 mg	
1 mL	**730685**			100
3 mL		**730680**	**730686**	50
6 mL			**730683**	30
CHROMABOND® LV-Drug II				
		200 mg		
15 mL		**732681**		30
CHROMABOND® MULTI 96 Drug II				
			96 x 100 mg	
			738680.100M	1

SPE phases for pharmaceutical applications

Crosslinks — special phase for enrichment of collagen crosslinks

- Special cellulose phase for enrichment of collagen crosslinks
- Recommended application: collagen crosslinks in urine

Pyridinoline and deoxypyridinoline are collagen crosslinks occurring in bones and cartilage. If these substances are released, they can be detected in the urine. In cases of increased bone catabolism (e.g., during osteoporosis) the urine concentrations of pyridinoline and deoxypyridinoline are increased.

Pyridinium crosslinks from urine

Compounds investigated: pyridinoline, deoxypyridinoline

Column type:
CHROMABOND® Crosslinks, 3 mL, 300 mg
REF 730458

Sample pretreatment: 250 µL urine and 50 µL of an internal standard (e.g., pyridoxine) are hydrolyzed in 250 µL conc. HCl at about 100–105 °C for 12–16 h. Then 2.5 mL wash solution (*n*-butanol – glacial acetic acid 80:20, v/v) are added to the hydrolyzate.

Column conditioning:
5 mL of the wash solution

Sample application:
force or aspirate the pre-treated sample through the column. Discard the flow-through. Wash with 15–25 mL of the wash solution.

Elution:
force or aspirate 3–5 mL dist. water through the column

MN Appl. No. 302070

Ordering information

Volume	Adsorbent weight	Pack of
CHROMABOND® Crosslinks polypropylene columns		
	300 mg	
3 mL	**730458**	50

Product for research purposes only (see page 325)

Tetracycline — special phase for enrichment of tetracyclines

- Silica phase with special C_{18} modification, tested for tetracyclines
  Constant recovery rates for the title compounds (every batch individually tested)
- Recommended application: tetracyclines from biological samples

Tetracyclines from musculature

Private communication of Mr. Lippold, Chemisches Landesuntersuchungsamt (Chem. Research Agency) Freiburg, Germany

Compounds investigated:
tetracycline, oxytetracycline, chlorotetracycline (100–500 mg/kg)

Column type:
CHROMABOND® Tetracycline, 6 mL, 500 mg
REF 730315

Sample pretreatment:
see detailed description in appl. 302030 at
www.mn-net.com/apps

Column conditioning:
1 column volume methanol, 1 column volume dist. water, then 1 column volume EDTA – succinate buffer
CAUTION: DO NOT LET THE COLUMN RUN DRY!

Sample application:
force or aspirate 50 mL of the eluate from the sample pretreatment through the CHROMABOND® column

Column washing:
2 mL dist. water (removal of Cu ions), 2 mL *n*-hexane

Elution: 7.5 mL methanol into a 25-mL tapered flask. Add 1 mL of an ethylene glycol – methanol mixture (22 g ethylene glycol filled up to 100 mL with methanol) and evaporate to dryness with a rotation evaporator (max. 40 °C). Fill up the residue to 400 mL with 0.1 mol/L McIlvain-EDTA buffer (52.5 g citric acid · H_2O, 44.5 g $Na_2HPO_4 \cdot H_2O$ and 93 g Titriplex III dissolved in 2.5 L dist. water, adjusted to pH 4 with NaOH).

Further analysis:
HPLC with column 250 x 4 mm NUCLEOSIL® 100-5 C_{18} HD (application 110710)
Recovery rates: tetracycline, chlorotetracycline ~ 50–70 %, oxytetracycline ~ 60–80 %

MN Appl. No. 302030

Ordering information

	Volume	Adsorbent weight	Pack of
	CHROMABOND® Tetracycline polypropylene columns		
		500 mg	
	6 mL	**730315**	30
	Product for research purposes only (see page 325)		

HR-P-AOX

AOX from waters with high salt loads (DIN 38409 – H22)

- Special PS/DVB phase
- Recommended application:
  extraction of AOX (adsorbable organically bonded halogens) from waters containing high salt loads or organic pollutants in accordance with DIN 38409 – H22

AOX from water (DIN 38409 – H22)

Column type:
CHROMABOND® HP-P-AOX, 6 mL, 500 mg
REF 730111.AOX

Column conditioning:
5 mL methanol, 10 mL dist. water.
Do not let the column run dry!

Sample application:
force or aspirate 100 mL original or diluted sample (pH 1) through the column (3–5 mL/min).
Do not let the column run dry!

Column washing:
50 mL nitrate rinsing solution (dissolve 17 g $NaNO_3$ in 100 mL dist. water, add 1.4 mL HNO_3 10 mol/L, fill up to 1000 mL; take 50 mL and fill to 1000 mL with dist. water). Discard the flow-through.

Elution:
slowly aspirate 1 x 1 mL, then 1 x 4 mL methanol and 10 mL dist. water through the column.
Collect eluates in 100 mL volumetric flask and fill to 100 mL with dist. water.

MN Appl. No. 302080

Ordering information

	Volume	Adsorbent weight		Pack of
	CHROMABOND® HR-P-AOX polypropylene columns			
		200 mg	500 mg	
	6 mL	**730119.AOX**	**730111.AOX**	30

SPE phases for environmental analysis

C_{18} PAH

octadecyl silica for PAH analysis

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2–8
  Special octadecyl modification for enrichment of PAH, not endcapped, carbon content 14 %
- Recommended application:
  PAHs from water

PAHs from water

Column type:
CHROMABOND® C_{18} PAH, 6 mL, 2 g
REF 730166

Sample pretreatment:
mix 1000 mL water sample with 10 mL methanol

Column conditioning:
1 column volume methanol, then 1 column volume dist. water

Sample application: aspirate 1000 mL water sample through the column (~ 15–20 mL/min), then dry column (stream of nitrogen or 24 h in a desiccator over P_2O_5)

Elution: elute with 4 mL acetonitrile – toluene (3:1, v/v) and then evaporate or fill up to the volume required

Recovery rates (50 ng/L per component): naphthalene 87 %, acenaphthylene 89 %, acenaphthene 90 %, fluorene 82 %, phenanthrene 85 %, anthracene 90 %, fluoranthene 89 %, pyrene 89 %, benz[a]anthracene 87 %, chrysene 95 %, benzo[b]-fluoranthene 91 %, benzo[k]fluoranthene 89 %, benzo[a]pyrene 90 %, dibenz[ah]anthracene 97 %, benzo[ghi]perylene 91 %, indeno[1,2,3-cd]pyrene 96 %

MN Appl. No. 301250

Ordering information

	Volume	Adsorbent weight	Pack of
	CHROMABOND® C_{18} PAH polypropylene columns		
		2 g	
	6 mL	**730166**	30
	CHROMABOND® C_{18} PAH glass columns		
	6 mL	**730166G**	30
	**CHROMABOND® C_{18} PAH adsorbent**		
		730616	100 g

NH_2/C_{18}

combination phase for PAH analysis

- Special combination phase:
  aminopropyl phase for removal of interfering humic acids
  octadecyl phase for enrichment of PAH
- Recommended application:
  PAHs from water containing humic acids

PAHs from water containing humic acids

Column type:
CHROMABOND® NH_2/C_{18}, 6 mL, 500 mg/1 g glass column
REF 730620G

Sample pretreatment:
mix 500 mL water sample with 25 mL 2-propanol

Column conditioning: 10 mL dichloromethane, 10 mL methanol, then 10 mL dist. water – 2-propanol (9:1, v/v)

Sample application: aspirate 500 mL prepared water sample through the column (~ 5 mL/min)

Column washing: 2 mL dist. water – 2-propanol (9:1, v/v), then dry column (about 20 min, vacuum)

Elution: 4 x 0.5 mL CH_2Cl_2 (let percolate first 0.5 mL into the column packing without vacuum, then apply light vacuum), if necessary evaporate in a stream of N_2 and fill up with a suitable solvent

MN Appl. No. 301260

Ordering information

Volume	Adsorbent weight		Pack of
CHROMABOND® NH_2/C_{18} polypropylene columns			
	500/500 mg	500 mg/1 g	
6 mL	**730618**	**730620**	30
CHROMABOND® NH_2/C_{18} glass columns			
6 mL	**730618G**	**730620G**	30

Na_2SO_4/Florisil®

hydrocarbons from water in accordance with DIN H-53 / ISO DIS 9377-4

- Special combination phase of sodium sulfate and Florisil®
- Recommended application: hydrocarbons from drinking, surface and waste waters

Hydrocarbons from water

Column type:
CHROMABOND® Na_2SO_4/Florisil®, 6 mL, 2 g/2 g, glass column, REF 730249G

Internal standard solution:
dissolve 20 mg *n*-tetracontane ($C_{40}H_{82}$) in petroleum ether, add 20 mL *n*-decane ($C_{10}H_{22}$) and fill up to one liter with petroleum ether. For preparation of the extraction solution dilute standard solution 1:10 with petroleum ether.

Sample pretreatment:
adjust 900 mL water (10 °C) with HCl (12 mol/L) to pH 2 and add 80 g $MgSO_4$. Add 50 mL of the extraction solution, close the bottle and stir the suspension intensely for 30 min. Add enough dist. water to separate the organic from the aqueous phase.

Column conditioning: 5 mL petroleum ether

Sample application:
slowly aspirate or force the sample through the column

Elution:
wash with 10 mL petroleum ether. Evaporate the combined solution from sample application and elution to 1 mL at about 75 °C. If necessary, fill up to 1 mL again. (If the hydrocarbon content is high, evaporation to 1 mL may not be necessary.)

Recovery rates: must be > 80 % for *n*-tetracontane.

MN Appl. No. 302090

Ordering information

Volume	Adsorbent weight	Pack of
CHROMABOND® Na_2SO_4/Florisil® polypropylene columns		
	2 g/2 g	
6 mL	**730249**	30
CHROMABOND® Na_2SO_4/Florisil® glass columns		
	2 g/2 g	
6 mL	**730249G**	30
CHROMABOND® Na_2SO_4/Florisil® glass columns · BIGpack		
	2 g/2 g	
6 mL	**730249G.250**	250

SPE phases for environmental analysis

CN/SiOH — combination phase for PAH analysis

- Special combination phase
  cyanopropyl phase for selective adsorption of polycyclic aromatics via π–π interactions
  unmodified silica phase for removal of polar compounds
- Recommended application:
  extraction of the 16 PAHs according to EPA from soil samples

PAHs from soil

Column type:
CHROMABOND® CN/SiOH, 6 mL, 500/1000 mg
REF 730135

Sample pretreatment:
dry 30 g soil with sodium sulfate and reflux 4 h with 250 mL petroleum ether in a Soxhlet extractor. For low PAH contents (colorless or weakly colored extracts) concentrate extract to 1/10 of its volume in a rotation evaporator.

Column conditioning:
4 mL petroleum ether

Sample application:
aspirate 20 mL of the extract through the column

Column washing: 2 mL petroleum ether

Elution:
2 x 2 mL acetonitrile – toluene (3:1, v/v), then evaporate or fill to the volume required

Further analysis: HPLC, e.g., with column 100 x 4 mm NUCLEODUR® C_{18} PAH, 3 µm, REF 760783.40 according to application 123820 (see page 168)

For recovery rates see application 301310 at ***www.mn-net.com***

MN Appl. No. 301310

Ordering information

Volume	Adsorbent weight	Pack of
CHROMABOND® CN/SiOH polypropylene columns		
	500 mg/1 g	
3 mL	**730112**	50
6 mL	**730135**	30
CHROMABOND® CN/SiOH polypropylene columns · BIGpack		
	500 mg/1 g	
6 mL	**730135.250**	250
CHROMABOND® CN/SiOH glass columns		
	500 mg/1 g	
6 mL	**730135G**	30

NAN — special phase for PCB analysis

- Special combination phase:
  N: sodium sulfate for removal of trace water;
  A: SiOH/$AgNO_3$ phase for removal of sulfur, sulfur-containing and polar compounds
- Recommended application
  extraction of PCB from sludge

PCB from sludge

Compounds investigated: polychlorinated biphenyls (PCB)
This method can also be used for soil samples.

Column type:
CHROMABOND® NAN, 6 mL, 700/2000/700 mg
REF 730149

Sample pretreatment: extract 2 g lyophilized sludge with 70 mL *n*-hexane, evaporate extract and fill to 10 mL with *n*-hexane

Column conditioning: 10 mL *n*-hexane
Sample application: aspirate 2 mL extract into the column
Elution: slowly aspirate 40 mL *n*-hexane through the column with light vacuum, then evaporate and fill to 5 mL with *n*-hexane
Recovery rates:
PCB-28 104 %, PCB-52 100 %, PCB-101 99 %, PCB-138 98 %, PCB-153 101 %, PCB-180 98 %, PCB-209 104 %

MN Appl. No. 301400

Ordering information

Volume	Adsorbent weight		Pack of
CHROMABOND® NAN polypropylene columns			
	400/1400/400 mg	700/2000/700 mg	
3 mL	**730109**		50
6 mL		**730149**	30
CHROMABOND® NAN polypropylene columns · BIGpack			
		700/2000/700 mg	
6 mL		**730149.250**	250
CHROMABOND® NAN glass columns			
		700/2000/700 mg	
6 mL		**730149G**	30
CHROMABOND® NAN adsorbent			
		730619*	100 g

* This product contains harmful substances which must be specially labeled as hazardous. For detailed information please see MSDS.

SA/SiOH — combination phase for PCB analysis

- Special combination phase:
  SA: strongly acidic cation exchanger based on silica with benzenesulfonic acid modification
  SiOH: unmodified silica for removal of polar compounds
- Recommended application:
  extraction of PCBs from waste oil (hexane extract)

PCB from waste oil

Column type:
CHROMABOND® SA/SiOH, 3 mL, 500/500 mg
REF 730132

Column conditioning: 1 mL *n*-hexane
Sample application: apply 250 µL waste oil sample to the column and aspirate or force it into the adsorbent with 2 x 1 mL *n*-hexane

MN Appl. No. 301390

Elution: aspirate or force another 2 x 500 µL *n*-hexane through the column; collect all *n*-hexane fractions and if necessary adjust concentration for subsequent analysis by either evaporating *n*-hexane in a stream of nitrogen or by dilution with *n*-hexane
Recovery rates:
PCB-28 97 %, PCB-52 96 %. PCB-101 95 %, PCB-138 90 %, PCB-153 95 %, PCB-180 96 %, PCB-209 100 %

Ordering information

Volume	Adsorbent weight	Pack of
CHROMABOND® SA/SiOH polypropylene columns		
	500/500 mg	
3 mL	**730132**	50
6 mL	**730235**	50
CHROMABOND® SA/SiOH polypropylene columns · BIGpack		
	500/500 mg	
3 mL	**730132.250**	250

SPE phases for environmental analysis

SiOH-H_2SO_4/SA — combination phase for PCB analysis

- Special combination phase

  SiOH-H_2SO_4: H_2SO_4-impregnated silica phase for oxidation of accompanying compounds to ionic and/or polar compounds

  SA: strongly acidic cation exchanger based on silica with benzenesulfonic acid modification for removal of ionic and sulfur-containing compounds

This combination column is used together with a SiOH column. Both columns together are available as Kombi-Kit PCB.

- Recommended application:

  extraction of PCBs from oil with reference to German industrial standard DIN 51527, part 1

PCB in oil samples

determination with reference to German industrial standard DIN 51527

Column type:
CHROMABOND® SiOH-H_2SO_4/SA, 3 mL, 500/500 mg and CHROMABOND® SiOH, 3 mL, 500 mg
REF 730085 and 730073
or Kombi-Kit PCB, REF 730125

Sample pretreatment:
extract oil-contaminated solids with *n*-hexane. Homogenize other oil samples and dissolve 1.5 to 2.0 g in 50 mL *n*-hexane. Water which may cause turbidity can be removed with sodium sulfate.

Column conditioning:
let 1 mL *n*-hexane flow through the CHROMABOND® SiOH-H_2SO_4/SA column

Sample application:
aspirate or force 500 µL sample through the CHROMABOND® SiOH-H_2SO_4/SA column. This phase offers better removal of interfering substances due to sulfonation. Place CHROMABOND® SiOH-H_2SO_4/SA column on top of the SiOH column with the aid of an adapter and after at least 30 s flush sample into the SiOH column with 2 x 1 mL *n*-hexane.

Elution:
elute SiOH column with 3 x 0.5 mL *n*-hexane; adjust to a suitable concentration for subsequent GC analysis by evaporation of *n*-hexane in a stream of nitrogen or by dilution with *n*-hexane

Recovery rates:
PCB-28 99 %, PCB-52 95 %, PCB-101 99 %, PCB-138 94 %, PCB-153 99 %, PCB-180 96 %, PCB-209 101 %

MN Appl. No. 301380

Ordering information

Volume	Adsorbent weight		Pack of
CHROMABOND® SiOH-H_2SO_4/SA polypropylene columns			
	500/500 mg		
3 mL		**730085**	50
CHROMABOND® SiOH-H_2SO_4/SA polypropylene columns · BIGpack			
	500/500 mg		
3 mL		**730085.250**	250
CHROMABOND® SiOH-H_2SO_4/SA glass columns			
	500/500 mg		
3 mL		**730085G**	50
Kombi-Kit for extraction of PCB from oil with reference to DIN 51527, part 1			
	25 columns each of CHROMABOND® SiOH-H_2SO_4/SA and CHROMABOND® SiOH	**730125**	1 kit

Dry (Na_2SO_4)

special phase for drying of organic samples

- Anhydrous high-purity sodium sulfate which forms Glauber's salt with traces of water

  For removal of larger quantities of water several cartridges can be combined in series.
- Recommended application:

  removal of traces of water from organic solutions

Ordering information

	Adsorbent weight			Pack of
CHROMAFIX® Dry cartridges				
Size	**S**	**M**	**L**	
Adsorbent weight ∅	780 mg	1500 mg	2800 mg	
	731852	**731853**	**731854**	50

ABC18

special phase for analysis of acrylamide in food

- Octadecyl silica phase with ion exchange functions for acrylamide analysis
- Recommended application:

  clean-up of acrylamide from ultra-heated starch-containing food, such as potato chips and other snacks, french fries, crispbread, cereals etc.

Important notes:

- For "Determination of Acrylamide in Foods, SPE Clean-up Procedure for LC-MS-MS" please see application 303580 at ***www.mn-net.com/apps***.
- Acrylamide is created at temperatures above 100 °C from sugar and proteins, e.g., from potatoes or grain during the process of frying, baking, roasting or grilling. The formation depends on temperature, starting at 120 °C and increasing with more elevated temperatures. In cooked food, no acrylamide is found.
- Minimum concentration of acrylamide should be 70 µg/kg.
- The procedure includes no concentration step.
- Acrylamide and the isotopically labeled form, is carcinogenic, mutagenic and neurotoxic.

Ordering information

Volume	Adsorbent weight	Pack of
CHROMABOND® ABC18 polypropylene columns		
	500 mg	
6 mL	**730533**	30

SPE phases for food analysis

Diamino

special silica phase for determination of pesticides in food samples

- Base material silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2–8
  Primary and **S**econdary **A**mine functions (PSA), 5 % C
  Removes polar compounds (e.g., organic acids, pigments, sugars) from matrices like fruit or vegetables
  Similar phases: Supelclean™ PSA, Bond Elut® PSA
- Recommended application:
  special SPE phase for quick and cheap determination of pesticides in strongly matrix-contaminated samples by GC or HPLC (**QuEChERS** method = **Qu**ick **E**asy **Ch**eap **E**ffective **R**ugged **S**afe)

QuEChERS method and pre-mixes

Within a few years after its development by Anastassiades et al. the QuEChERS method has gained a leading position for determination of pesticide residues in food samples by GC–MS or LC–MS, allowing rapid and cheap clean-up of strongly matrix-contaminated samples.

Standard clean-up of food samples

10 g sample are homogenized with 10 mL acetonitrile. After adding the internal standard the sample is shaken with 4 g $MgSO_4$ and 1 g NaCl and afterwards centrifuged.
1 mL of the supernatant is spiked with 25 mg CHROMABOND® Diamino and 150 mg $MgSO_4$ and shaken again. After centrifugation the supernatant is injected into GC/MS.

MN Appl. No. 303770

For optimizing the extraction of pH-dependent compounds, for minimizing decomposition of sensitive substances, and for broadening the matrix spectrum, different modifications of the QuEChERS method have been elaborated.

In addition to the required adsorbent CHROMABOND® Diamino MACHEREY-NAGEL offers a number of individually weighed and premixed extraction and buffer mixtures, specially composed for different sample matrices.

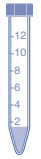
For extraction, the European standard EN 15662 recommends a citrate extraction mix (Mix I), while AOAC standard 2007.1 uses an acetate extraction mix (Mix II).

For clean-up, the Diamino phase (PSA) removes, e.g., sugars and organic acids. $MgSO_4$ removes water, C_{18} ec removes nonpolar interferences such as fats and the Carbon phase removes pigments, sterols, and nonpolar interferences.

For selection of the proper clean-up mix see table on opposite page.

For detailed instructions please visit ***www.mn-net.com*** or the original references at ***www.quechers.com***.

Ordering information

	Volume	Description		Composition	REF	Pack of
	**CHROMABOND® QuEChERS extraction buffer mixes**					
	15 mL*	Mix I	citrate extraction mix	4 g $MgSO_4$, 1 g NaCl, 0.5 g Na_2H citrate · 1.5 H_2O, 1 g Na_3 citrate · 2 H_2O	**730970**	50
	15 mL*	Mix II	acetate extraction mix	6 g $MgSO_4$, 1.5 g Na acetate	**730971**	50
	CHROMABOND® QuEChERS clean-up mixes					
	15 mL*	Mix III	Diamino clean-up mix	0.15 g CHROMABOND® Diamino with 0.9 g $MgSO_4$	**730972**	50
	15 mL*	Mix IV	Diamino/Carbon clean-up mix	0.15 g CHROMABOND® Diamino with 0.9 g $MgSO_4$ and 15 mg Carbon	**730973**	50
	15 mL*	Mix V	Diamino/Carbon clean-up mix	0.15 g CHROMABOND® Diamino with 0.9 g $MgSO_4$ and 45 mg Carbon	**730975**	50
	15 mL*	Mix VI	Diamino/C_{18} ec clean-up mix	0.15 g CHROMABOND® Diamino with 0.9 g $MgSO_4$ and 150 mg C_{18} ec	**730974**	50
	**CHROMABOND® Diamino polypropylene columns**					
	3 mL	adsorbent weight 200 mg			**730561**	50
	6 mL	adsorbent weight 500 mg			**730562**	30
	**CHROMABOND® Diamino adsorbent**					
					730653.20	20 g
					730653	100 g
	CHROMABOND® QuEChERS accessories					
		50 mL polypropylene centrifuge tube with screw cap			**730223**	50

* 15 mL centrifuge tubes with screw cap (2 mL or 50 mL centrifuge tubes on request)

A number of custom-made QuEChERS mixes is available on request.

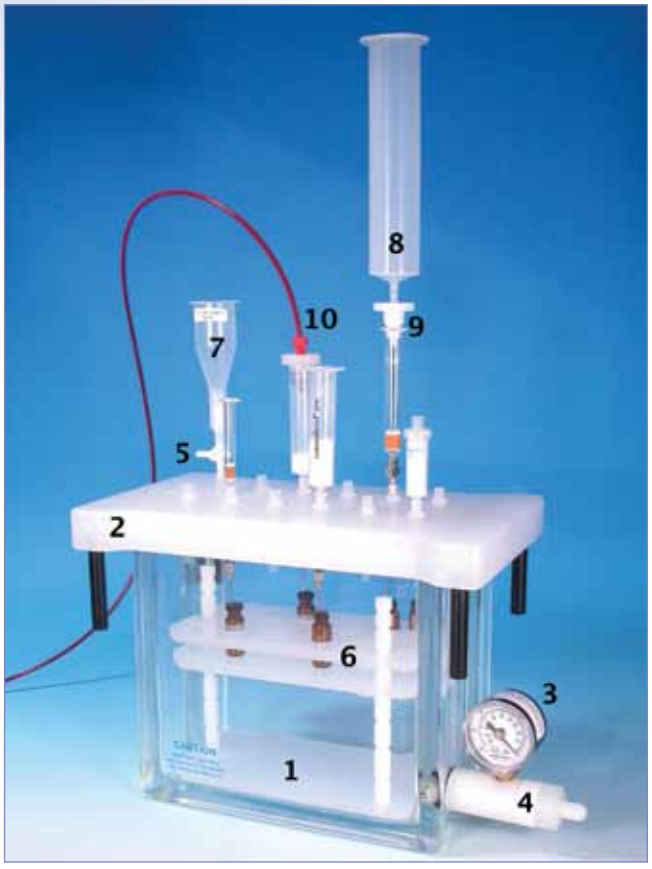
QuEChERS mixes

Sample property			
Low fat content (e.g., apples, strawberries)	Moderate content of chlorophyll and carotinoids (e.g., carrots, lettuce)	Higher content of chlorophyll and carotinoids (e.g., bell peppers, spinach)	Higher fat content (e.g., avocado)
CHROMABOND® QuEChERS extraction mixes			
Citrate or acetate extraction	Citrate or acetate extraction	Citrate extraction	Citrate extraction
Mix I or Mix II	Mix I or Mix II	Mix I	Mix I
CHROMABOND® QuEChERS clean-up mixes			
Diamino clean-up	Diamino/Carbon clean-up	Diamino/Carbon clean-up (higher Carbon content)	Diamino/C_{18} ec clean-up
Mix III	Mix IV	Mix V	Mix VI
			

Accessories for SPE

CHROMABOND® vacuum manifolds

- For simultaneous preparation of up to 12, 16 or 24 samples
- Replacement parts and accessories for special applications



Vacuum manifold for 12 columns

1 Rectangular glass cabinet; 2 sizes available:
small for up to 12 CHROMABOND® columns or CHROMAFIX® cartridges;
large for up to 16 CHROMABOND® LV columns or up to 24 CHROMABOND® columns or CHROMAFIX® cartridges (depending on lid)

2 Polypropylene lid

3 Vacuum gauge for pressure reading

4 Control valve for adjustment of vacuum

5 Replaceable valves for vacuum control of individual SPE columns

6 Variable rack with exchangeable partitions, which accept a wide variety of vessels like test tubes, measuring flasks, scintillation vials, autosampler vials, plastic vials etc.

7 CHROMABOND® LV columns with 15 mL sample reservoir for medium size samples

8 Polypropylene sample reservoirs (30 or 70 mL)

9 Adapter for sample reservoirs

10 CHROMABOND® tubing adapters

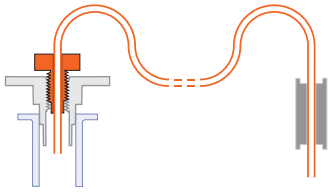
Full description and manual can be downloaded from ***www.mn-net.com***

Ordering information

Description	Pack of	REF
Vacuum manifold complete consists of glass cabinet with lid and lid gasket, removable needles on lower side of lid, vacuum gauge, control valve, valves and caps, variable rack:		
for up to 12 columns or cartridges (including PP tank)	1	**730150**
for up to 16 LV columns	1	**730360**
for up to 24 columns or cartridges	1	**730151**
Glass cabinets without accessories (1)		
for 12 columns	1	**730173**
for 16 LV or 24 columns	1	**730174**
Lids with gaskets (2)		
for 12 columns (including Luer fittings and valves **(5)**)	1	**730175**
for 16 LV columns (including Luer fittings and valves **(5)**)	1	**730365**
for 24 columns (including Luer fittings and valves **(5)**)	1	**730176**
Gaskets for lid, for 12 columns	2	**730177**
Gaskets for lid, for 24 columns	2	**730178**

Accessories for SPE

Ordering information

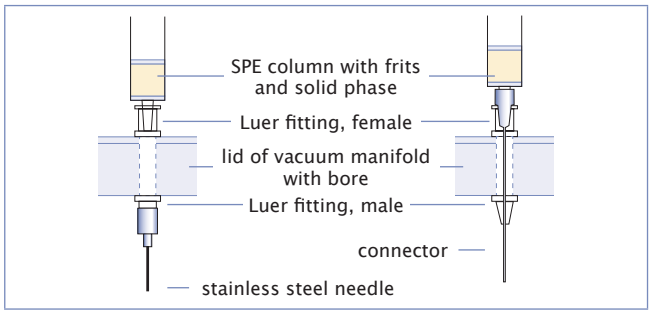
Description		Pack of	REF
General accessories for vacuum manifolds			
Luer stoppers for vacuum manifold, blue		12	**730194**
Luer fittings for lid, female	 female	12	**730183.12**
Luer fittings for lid, male	 male	12	**730184.12**
Valves, plastic		12	**730185**
Stainless steel needles		12	**730152**
Polypropylene needles		12	**730154**
PP tanks for vacuum manifold for 12 columns	(not available for 16- or 24-position manifold)	2	**730233**
Vacuum gauge, complete with accessories **(3+4)**		1	**730179**
Drying attachment and collecting racks for evaporation of eluates			
Drying attachment, with 12 positions **(11)**		1	**730187**
Drying attachment, with 16 positions		1	**730990**
Drying attachment, for 24 columns		1	**730188**
Collecting rack for 12 columns **(6)**		1	**730157**
Collecting rack for 16 LV columns		1	**730366**
Collecting rack for 24 columns		1	**730153**
Products for protection from cross contamination			
Valve, brass, tarnished		1	**730189.1**
Valves, as above		12	**730189.12**
Stainless steel connectors	(application of connectors see below)	12	**730106**
PTFE connectors		12	**730564**
Tubing adapters for application of large sample volumes (10)			
for 3 and 6 mL glass columns		4	**730387**
for 1, 3 and 6 mL polypropylene columns		4	**730243**
for 15, 45 and 70 mL polypropylene columns		4	**730386**
(PTFE tube length approx. 1 m)			

Protection from cross contamination

For special applications, which require maximum protection from cross contamination we supply chrome-plated brass valves and stainless steel or PTFE connectors, the application of which is shown below. These special connectors are fitted through the lid; thus the sample only has contact with the inert connector and can flow directly into the receptacle.

Drying attachment

If the eluate has to be evaporated, this can be performed with the so-called drying attachment (**11**, see below). This special lid has a gas connector on one side (**12**), from which the gas is fed simultaneously to the 12, 16, or 24 stations (**13**). Thus 12, 16, or 24 eluates can be evaporated simultaneously by just changing the lid and applying a stream of inert gas, e.g., nitrogen.



Accessories for SPE

CHROMABOND® empty columns and accessories

For individual packing of SPE columns with CHROMABOND® adsorbents

Ordering information

Description		Pack of	REF
Empty polypropylene columns with PE frits, 1 mL		100	**730159**
Empty polypropylene columns with PE frits, 3 mL		50	**730160**
Empty polypropylene columns with PE frits, 6 mL		30	**730161**
Empty polypropylene columns with PE frits, 15 mL	one filter element is already inserted in the polypropylene column	20	**730230**
Empty polypropylene columns with PE frits, 30 mL		20	**730380**
Empty polypropylene columns with PE frits, 45 mL		20	**730355**
Empty polypropylene columns with PE frits, 70 mL		20	**730158**
Empty polypropylene columns with PE frits, 150 mL		20	**730474**
PE frits for polypropylene columns 1 mL		250	**730164**
PE frits for polypropylene columns 3 mL		250	**730162**
PE frits for polypropylene columns 6 mL		250	**730163**
PE frits for polypropylene columns 15 mL		250	**730351**
PE frits for polypropylene columns 30 mL		250	**730034**
PE frits for polypropylene columns 45 mL		250	**730356**
PE frits for polypropylene columns 70 mL		250	**730026**
PE frits for polypropylene columns 150 mL		250	**730475**
Empty glass columns with glass fiber frits, 3 mL	one filter element is already inserted in the glass column	50	**730171**
Empty glass columns with glass fiber frits, 6 mL		30	**730172**
Glass fiber frits for glass columns 3 mL		250	**730191**
Glass fiber frits for glass columns 6 mL		250	**730192**
Empty LV polypropylene columns with PE frits, 15 mL, for 100 mg adsorbent weight		50	**732500**
Empty LV polypropylene columns with PE frits, 15 mL, for 200/500 mg adsorbent weight		50	**732501**
PE frits for LV polypropylene columns 15 mL for 100 mg adsorbent weight		250	**732019**
PE frits for LV polypropylene columns 15 mL for 200/500 mg adsorbent weight		250	**732020**
Adapters (PVDF) for glass columns (3 and 6 mL)		4	**730104.4**
Adapters as above		10	**730105**
Adapters (PP) for polypropylene columns (1, 3 and 6 mL)		4	**730100.4**
Adapters as above		10	**730101**
Adapters (PE) for polypropylene columns (15, 45, 70 mL)		4	**730350.4**
Adapters as above		10	**730385**
Adapter (PE) for polypropylene columns (30 and 70 mL)		1	**730566**
Reservoir columns for application of medium-size samples			
Reservoir column 30 mL, polypropylene, with one adapter for 1, 3, 6 mL CHROMABOND® polypropylene columns		1	**730102**
10 Reservoir columns 30 mL, polypropylene with one adapter for 1, 3, 6 mL CHROMABOND® polypropylene columns		1 kit	**730103**
Reservoir column 70 mL, polypropylene, with one adapter for 1, 3, 6 mL CHROMABOND® polypropylene columns		1	**730381**
10 Reservoir columns 70 mL, polypropylene with one adapter for 1, 3, 6 mL CHROMABOND® polypropylene columns		1 kit	**730382**
Reservoir column 70 mL, polypropylene, with one adapter for 15, 45, 70 mL CHROMABOND® polypropylene columns		1	**730388**
10 Reservoir columns 70 mL, polypropylene with one adapter for 15, 45, 70 mL CHROMABOND® polypropylene columns		1 kit	**730389**

Automated and on-line SPE

Performing Solid Phase Extraction (SPE) manually can be time consuming and nerve-racking, especially when recovery and reproducibility are lacking due to sample variability. If SPE can be reliably automated, it becomes a much more efficient and reproducible process.

On-line SPE is a powerful method in automated sample preparation where the SPE hardware is technically integrated into a HPLC system. Crude samples are placed in an autosampler and processed fully automatic prior to injection into a GC (MS) or LC (MS) system. MN offers different on-line column configurations designed to fit your on-line SPE needs and filled with a choice of different adsorbents, modifications and particle sizes:

- Ready-to-use EC columns or ChromCart® cartridges for on-line SPE (standard dimensions 20 x 2 mm or 20 x 4 mm, resp.), filled with CHROMABOND® HR-X*pert* phases (15 µm particles) or with NUCLEODUR® C_{18} ec, C_8 ec, CN (20 µm particles)

EC columns

CC cartridges

- Columns for Gilson ASPEC™ systems are ready-to-use assembled with caps. In addition to the columns and phases listed below, all 1, 3 and 6 mL CHROMABOND® polypropylene columns from our program can be supplied assembled with ASP caps.

Columns for the Gilson ASPEC™

Ordering information

Gilson ASPEC™ columns

Column size	Weight [mg]	Pack of [columns]	REF
CHROMABOND® SiOH			
1 mL	100	100	**730071ASP**
3 mL	500	100	**730073ASP**
6 mL	1000	100	**730075ASP**

Other dimensions and adsorbents on request

- Special SPE columns equipped with caps and needles to be used in the SPE unit of the Gerstel MultiPurposeSampler (MPS), available in 1, 3, 6 mL.

SPE cartridges for Gerstel MPS system

Gerstel MPS system

Ordering information

Gerstel MPS columns

Column size	Weight [mg]	Pack of [columns]	REF
CHROMABOND® SiOH			
3 mL	200	50	**730214MPS**
3 mL	500	50	**730073MPS**
6 mL	1000	30	**730075MPS**
CHROMABOND® C_{18} ec			
1 mL	100	100	**730011MPS**
3 mL	200	50	**730012MPS**
3 mL	500	50	**730013MPS**
CHROMABOND® HR-X			
1 mL	100	30	**730935MPS**
3 mL	200	30	**730931MPS**
6 mL	500	30	**730939MPS**

CHROMABOND® MULTI 96 for robot systems

Alternatively CHROMABOND® MULTI 96 plates provide a means of high throughput sample preparation by processing 96 samples in a standard 8 x 12 microcolumn plate format compatible with standard 96-well plate liquid handling technologies and injection systems. MULTI 96 plates are available for solid phase extraction (SPE) and for filtration (see page 76).

CHROMABOND® MULTI 96 · SPE in microtiter format

- 96-well PP microtiter plates with PE filter elements
- Cavity volume 1.5 mL
- Adsorbent weights 10, 25, 50, 100 mg per microcolumn
- Supplied with any CHROMABOND® SPE adsorbents
- For simultaneous preparation of 96 samples
- Easy method transfer from CHROMABOND® columns or CHROMAFIX® cartridges to CHROMABOND® MULTI 96

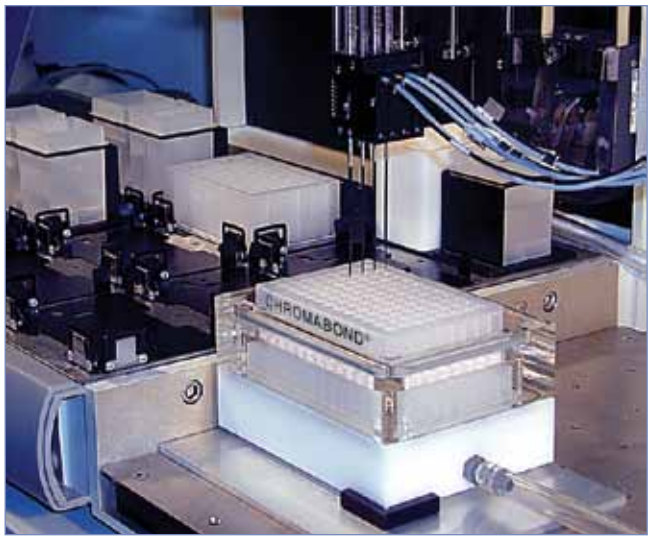
Advantages of this high-throughput system:

- Simultaneous preparation of 96 samples; this means a 4-fold increase over traditional 24-position SPE processors
- Economical by saving time and solvent
- Use of multi-channel pipettors facilitates liquid transfer steps
- Readily adaptable to all common automated and robotic handling systems
- Minimized dead volume (≤ 40 µL)

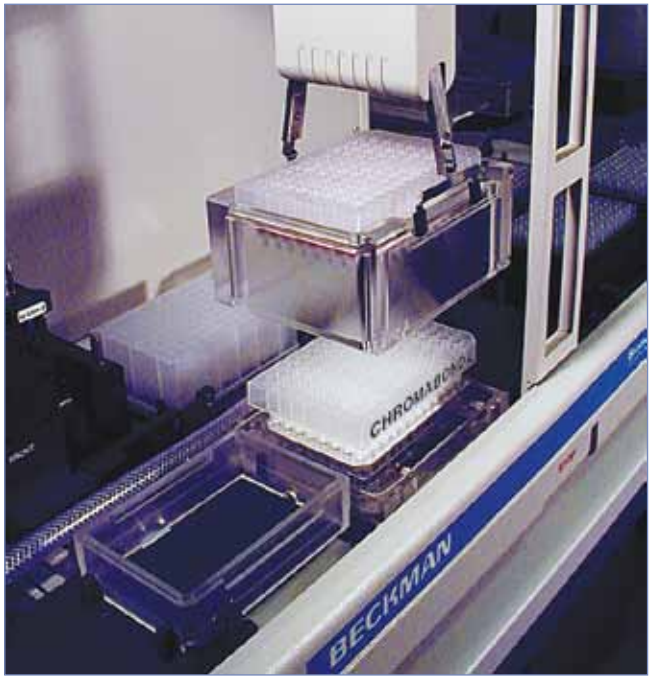
Instrument compatibility

CHROMABOND® MULTI 96 SPE microtiter plates as well as CHROMAFIL® MULTI 96 filtration plates are compatible with, e.g., the following liquid handling and SPE automation systems:

- Perkin Elmer MultiProbe® II
- Tomtec Quadra 3® and Quadra 3® SPE
- Hamilton Microlab® SPE Workstation
- Beckman Coulter Biomek® 2000
- Caliper Life Science RapidTrace®
- Gilson ASPEC™ XL4 and ASPEC™ XL
- Gilson 215 SPE Liquid Handler
- Tecan Genesis™ FE500
- Eppendorf ep*Motion*®



Multiprobe® II (Perkin-Elmer)



Biomek® 2000 (Beckman Coulter)

CHROMABOND® MULTI 96 vacuum manifold

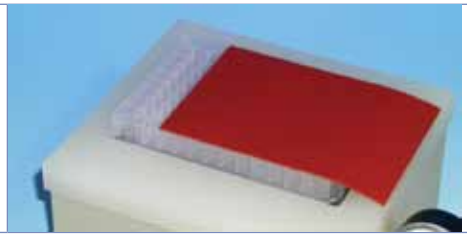
For handling of CHROMABOND® MULTI 96 SPE plates for up to 96 samples

CHROMABOND® MULTI 96 is designed for use in common robotic workstations or commercially available liquid handling systems. Alternatively, use of multichannel pipetters facilitates a manual liquid transfer. Extraction is carried our using the CHROMABOND® MULTI 96 vacuum manifold. With the help of the control valve the vacuum of the manifold can be adjusted leading to an optimum flow rate through the CHROMABOND® MULTI 96 SPE plate.

A reservoir tank and 96-well collection plates (96 x 0.5 or 96 x 2 mL) made of polypropylene can be supplied as accessories. An interesting alternative for collection of the eluates is a collection rack, which can be fitted with twelve 8-well strips of polypropylene tubes (each 1 mL). If you have to work on less than 96 samples, you can seal individual rows of the 96-well plate with a PTFE-covered rubber pad.

Ordering information

Description	Pack of	REF
CHROMABOND® MULTI 96 vacuum manifold with reservoir tank, vacuum gauge, and control valve	1	**738630.M**
96-well microtiter plates (polypropylene) 96 x 0.25 mL	10	**738651**
96-deep-well collecting plate (polypropylene) 96 x 2 mL	5	**738650.5**
Collection racks with polypropylene tube strips (twelve 8-well strips) 96 x 1.0 mL	5	**738637**
Polypropylene tube strips (twelve 8-well strips) 96 x 1.0 mL	10	**738652**
8-well strip sealing caps for PP tube strips (REF 738652)	30	**738638**
Reservoir tanks (polypropylene)	2	**738639.M**
Butyl rubber pad, PTFE covered for sealing of individual rows of the 96-well plate, 125 x 85 mm	1	**738645**



For CHROMAFIL® MULTI 96 filter plates see page 76. The ordering information of 96-well plates packed with individual CHROMABOND® adsorbents is listed with the respective phases.

Kieselguhr phase for liquid–liquid extraction

CHROMABOND® XTR — for liquid–liquid extraction

- Base material coarse-grained kieselguhr (also known as diatomaceous earth, hydromatrix, celite)
  Large pore size, high pore volume, constantly high batch-to-batch quality
  pH working range 1–13
- **Application:**
  liquid–liquid extraction of highly viscous aqueous solutions such as physiological fluids (blood, plasma, and serum) in clinical chemistry, dyes in textiles, environmental and food analysis without use of a separation funnel
  High water loadability without breakthrough of water during elution with organic solvents
  also suited for removing small amounts of water from solvents which are not miscible with water
- **Advantages:**
  fast, reproducible and economical
  simultaneous preparation of several samples
  no problems with phase separation · no formation of emulsions
  high recovery rates
  saving of time and solvents
  organic solutions need not to be dried after separation

Solvents applicable for elution

- ✓ diethyl ether
- ✓ tert-butyl methyl ether
- ✓ ethyl acetate
- ✓ *n*-hexane
- ✓ cyclohexane
- ✓ toluene
- ✓ dichloromethane (methylene chloride)
- ✓ trichloromethane (chloroform)
- ✓ trichloromethane – methanol (90:10, v/v)
- ✓ trichloromethane – methanol (85:15, v/v)
- ✓ diethyl ether – ethanol (90:10, v/v)
- ✓ diethyl ether – ethanol (80:20, v/v)
- ✓ dichloromethane – 2-propanol (90:10, v/v)
- ✓ dichloromethane – 2-propanol (85:15, v/v)

Eluents with too high alcohol contents cause an increase in volume of the aqueous phase on the CHROMABOND® XTR. Here the column could be overloaded and the aqueous phase displaced from the column. In this case, a greater capacity column should be used.

Depending on the concentration of the analytes eluates can be analyzed immediately, or the organic solvent is evaporated. The pH value of the aqueous solution can be altered on the column, which enables elution of different compounds of a sample under optimized conditions. Under certain circumstances, acidic, neutral, and basic compounds can be fractionated in this way.

General column parameters

CHROMABOND® XTR Volume	Amount of adsorbent	Max. volume capacity of aq. solution	Waiting period before elution	Elution volume
1 mL	250 mg	0.25 mL	5 min	3 mL
3 mL	500 mg	0.5 mL	5 min	6 mL
6 mL	1 g	1 mL	5–10 min	8 mL
15 mL	3 g	3 mL	5–10 min	12 mL
30 mL	4.5 g	5 mL	5–10 min	16 mL
45 mL	8.3 g	10 mL	10–15 min	24 mL
70 mL	14.5 g	20 mL	10–15 min	40 mL
150 mL	37.5 g	50 mL	10–15 min	90 mL

Sample application

Adsorption of the sample

Sample elution

Kieselguhr phase for liquid–liquid extraction

Determination of azo dyes and aromatic amines in colored textile materials with reference to § 64 LFGB (formerly § 35 LMBG)

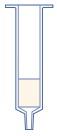
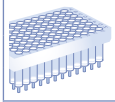
Sample pretreatment:
Weigh about 1 g cut-up textile sample (colored textiles about 0.1 g) in a 100 mL threaded vial. (Degrease leather samples before processing: cover sample with technical purity *n*-hexane and put the vial in an ultrasonic bath for 20 min. After decanting the *n*-hexane rinse with little *n*-hexane and dry sample by gentle heating and blowing with air or N_2.)
Add 250 µL internal standard (IS: 1.2 mg/mL tetramethylbenzidine in methanol – ethyl acetate (1:1, v/v)), 17.0 mL citrate buffer (pH 6) (25.05 g citric acid and 12.64 g NaOH, fill up with deionized water to 2 L) and heat 30 min at 70 °C. Then add 3 mL of a freshly prepared solution of 0.2 g/mL sodium dithionite in water and heat for exactly 30 min to 70 °C while shaking occasionally.
Sample application:
Cool the solution immediately (put vial in water – stopping of reductive cleavage). After 5–10 min pour it onto the CHROMABOND® XTR column (squeeze textile remains).

Elution:
Allow solution to be soaked up by the adsorbent for 15 min. Then elute four times with 20 mL each of diethyl ether or diethyl ether – ethanol (90:10, v/v) (depending on recovery rates), using the first 40 mL to rinse the sample remains. Evaporate eluates to 3 mL with a rotation evaporator and transfer the solution into a 10 mL measuring flask using a pasteur pipette and rinsing with methanol. Fill up to the marking with methanol, shake, and pipette about 1 mL into a vial.

Further analysis: Fast GC on OPTIMA® δ-3, 10 m, 0.1 mm ID, 0.1 µm film, REF 726410.10 (application 210820) or HPLC on NUCLEOSIL® 100-5 C_{18} HD (application 110500 at ***www.mn-net.com/apps***)

MN Appl. No. 302100

Ordering information

	Column volume	1 mL	3 mL	6 mL	15 mL	30 mL	45 mL	70 mL	150 mL
	Adsorbent weight	250 mg	500 mg	1 g	3 g	4.5 g	8.3 g	14.5 g	37.5 g
	Max. volume capacity of aqueous solution	0.25 mL	0.5 mL	1 mL	3 mL	5 mL	10 mL	20 mL	50 mL
	Pack of	100	50	30	30	30	30	30	10
	**CHROMABOND® XTR polypropylene columns**								
		730501	**730502**	**730487**	**730489**	**730505**	**730506**	**730507**	**730509**
	CHROMABOND® XTR polypropylene columns · BIGpacks								
				730487.250 (250 col.)				**730507.100** (100 col.)	
	**CHROMABOND® MULTI 96 XTR**								
	96-well plates 96 x 150 mg, packs of 1 plate, for max. 96 x 0.2 mL aqueous solution								
				738131.150M					
	**CHROMABOND® XTR adsorbent**								
	50 bags of 14.5 g, for max. 20 mL aqueous solution each)								
	for 70 mL PP columns with 100 PE filter elements	for NT20 with 50 PE filter elements (10 mm dia.)		500 g		1 kg		5 kg	
	730585	**730586**		**730595.500**		**730595.1000**		**730595.5000**	
	Accessories for liquid–liquid extraction with CHROMABOND® XTR								
	variable polypropylene rack for 24 positions, incl. 24 PP stopcocks and 24 PP needles								**730508**

For parallel processing of up to 24 CHROMABOND® XTR columns 1–150 mL we recommend the polypropylene rack REF 730508 consisting of:

two side walls (1), middle part including stopcocks and needles (2), bottom part (3), top part for stabilizing 45 mL and 70 mL CHROMABOND® XTR columns (4).

This rack can be adjusted to various heights depending on the CHROMABOND® XTR columns and the collection vials used. Each position of the middle part is equipped with a polypropylene stopcock on the top (REF 730185) and a polypropylene needle on the bottom (REF 730154).

For collection of the sample, vessels such as vials, test tubes, round bottom or tapered flasks, can be used. For our program of sample vials, please see the chapter "Vials and accessories" from page 77.

Columns for gravity flow phase separation

CHROMABOND® PTS and PTL — columns for phase separation

- Automatic separation of a two-phase mixture without separation funnel

  Two-phase mixtures are completely applied to the column and the phase boundary is determined without further work. The special membrane automatically stops the flow when the lower phase has passed. The upper phase remains in the column, thus both phases are available for further analysis.

  Columns **must not** be run with vacuum or pressure

- **PTS**

  for solvents **heavier** than water, e.g., trichloromethane, dichloromethane

  maximum size 150 mL

- **PTL**

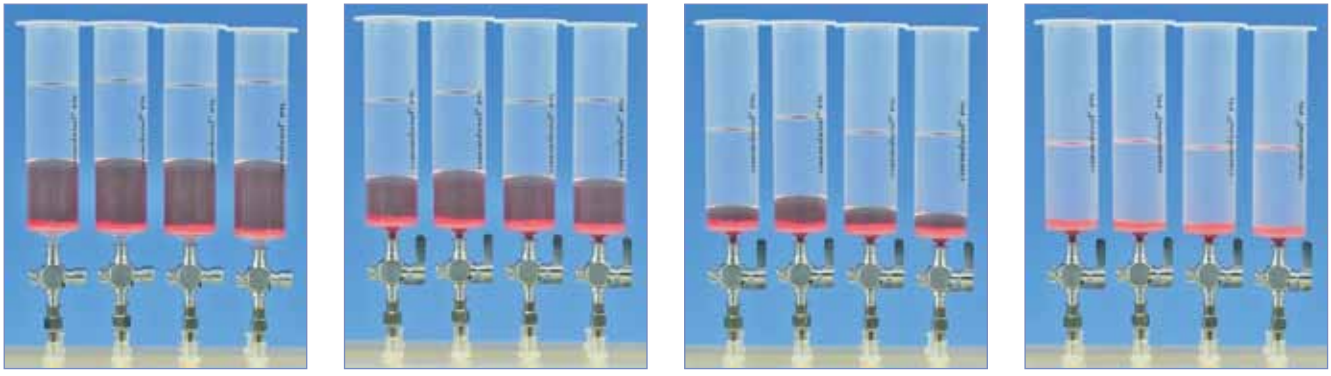
  for solvents **lighter** than water, e.g., diethyl ether, hexane

  maximum size 70 mL

Ordering information

Column volume [mL]	Pack of [columns]	REF
CHROMABOND® PTS for solvents heavier than water		
1	100	**730710**
3	100	**730712**
6	100	**730714**
15	100	**730716**
30	100	**730718**
45	50	**730720**
70	50	**730722**
150	20	**730724**
CHROMABOND® PTL for solvents lighter than water		
1	100	**730730**
3	100	**730732**
6	100	**730734**
15	100	**730736**
30	100	**730738**
45	50	**730740**
70	50	**730742**

Ideal tool for breaking emulsions



CHROMABOND® PTL in action: organic upper phase (colorless), aqueous lower phase (red)

Phase separation

Glass columns and accessories for Flash chromatography

- Economic low-tech method for the synthesis laboratory
  Suited for the separation of compounds up to gram levels
  No expensive equipment required
- MN flash chromatography kits include a glass column, eluent reservoir, silica 60 and accessories.
  Glass columns of different sizes and accessories can be ordered separately.
  These columns are normally filled to a height of about 15 cm, working pressures are 1.5 to 2 bar.
  The most used adsorbent is silica 60 with particle size 40–63 µm (see page 204), however, you may also use our ranges of other LC adsorbents and of POLYGOPREP silica phases (see page 203). Particle sizes < 25 µm should only be used with very low-viscosity mobile phases, because otherwise flow rates will be very low.
  These columns are to be packed by the user.

Ordering information

Designation	Pack of	REF
Flash chromatography kits		
Flash chromatography kit I, consists of 1 glass column 20 mm ID x 400 mm length, one 1-L eluent reservoir, 100 g silica 60 (40–63 µm), sea sand, silanized glass fiber wadding, 1 m PTFE tubing	1 kit	**727450**
Flash chromatography kit II, consists of 1 glass column 40 mm ID x 450 mm length, one 2-L eluent reservoir, 100 g silica 60 (40–63 µm), sea sand, silanized glass fiber wadding, 1 m PTFE tubing	1 kit	**727451**
Flash chromatography columns complete with adapter and PTFE tap, fitted with a polyethylene net to protect against bursting		
20 mm ID x 200 mm length	1 column	**727400**
20 mm ID x 400 mm length	1 column	**727401**
25 mm ID x 200 mm length	1 column	**727402**
25 mm ID x 400 mm length	1 column	**727403**
30 mm ID x 300 mm length	1 column	**727404**
30 mm ID x 400 mm length	1 column	**727405**
40 mm ID x 300 mm length	1 column	**727406**
40 mm ID x 450 mm length	1 column	**727407**
Accessories for flash chromatography glass columns		
1-L eluent reservoir with adapter, covered with a protective plastic sleeve for burst protection; this also prevents build-up of UV-induced radicals in the eluent	1	**727420**
2-L eluent reservoir as above	1	**727421**
Pressure gauge for controlling flow rates	1	**727422**
PTFE tubing, 3 mm OD, 2 mm ID, length 1 m	1 m	**727424**
Sea sand, acid washed and calcined	1000 g	**727423**
Glass fiber wadding, silanized	25 g	**718002**

CHROMABOND® Flash RS cartridges

CHROMABOND® Flash RS cartridges

ideal for Flash separations from 10 mg up to 160 g

- **For convenient operation and reliable upscaling**
  the complete program of ready-to-use Flash cartridges for the ISCO® Companion® and other Teledyne Isco CombiFlash® systems, or as stand-alone version for all pump/detector combinations, e.g., from Biotage®, Büchi®

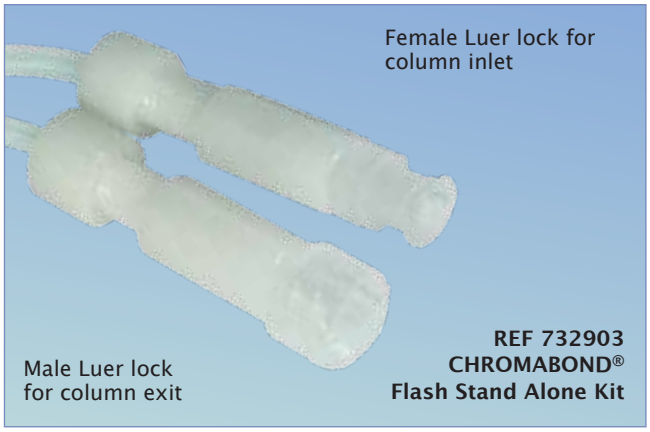
  Adsorbent weights of 4 g to 1600 g from one of the leading companies in silica and TLC business
- **Increases flexibility**
  considerable program of different phases and modifications
- **Saves time and money**
  convenient prices, short delivery times
- **Increases analytical safety**
  high pressure stability of 15 bar/220 psi (12 bar for cartridges > 200 g), excellent separation efficiency, good reproducibility

Technical features

- **Distribution of eluent stream** via highly porous frits
- **Cartridge material and geometry:**
  organic solvent resistant, low bleed polypropylene, thick column walls, one piece body, sophisticated length to diameter ratio for high plate numbers and excellent separation efficiencies
- **Column connections**

  CHROMABOND® RS cartridges are 100% compatible with the ISCO® Companion®, no additional hardware is needed for this type of purification systems.

  CHROMABOND® RS cartridges (except RS 800 and RS 1600 with Maxi Luers) can also be used as stand alone system with any pump/detector/fraction collector combination using the CHROMABOND® Flash Starter Kit (REF 730798) or the CHROMABOND® Flash Stand Alone Kit (REF 732903).



Accessories for CHROMABOND® Flash columns · Ordering information

Description	Pack of	REF
CHROMABOND® Flash Starter Kit		
consists of 1/8" PTFE tubing, 1.5 mm ID, 3 m long; 5 x 1/4"-28 PP nuts; 5 x 1/8" ETFE ferrules; 5 x 1/4"-28 nylon unions; 2 x 1/4"-28 PP Luer lock, female; 1 x 1/4"-28 PP Luer lock, male; 1 x 1/4"-28 PP Luer tip, male	1 kit	**730798**

CHROMABOND® Flash RS cartridges

Description	Pack of	REF
CHROMABOND® Flash Stand Alone Kit, Luer		
consist of 1 x 1/4"-28 PP Luer lock, female; 1 x 1/4"-28 PP Luer lock, male; 2 x 1/8" ETFE ferrules; 2 x 1/4"-28 nylon unions; 2 x 1/4"-28 PP nuts	1 kit	**732903**

CHROMABOND® Flash solutions for Flash instruments

- Product range designed for use in the Teledyne Isco CombiFlash® systems (Companion®, Rf etc.) and Flash systems of Biotage® AB (FlashMaster™) without additional connectors or capillaries

  On request all column types listed below can be packed with any adsorbent as described on page 8 (please note that other packings often result in differing adsorbent weights).

Ordering information

Designation	Column length [cm]	ID [mm]	Adsorbent weight [g]	Pack of [columns]	REF
CHROMABOND® Flash RS columns for Teledyne Isco® systems					
All CHROMABOND® Flash RS cartridges can be directly used in the Teledyne Isco Companion®, Rf, etc.					
CHROMABOND® Flash RS 4 SiOH	9.8	12.4	4	20	**732800**
CHROMABOND® Flash RS 15 SiOH	11.6	21.2	15	20	**732801**
CHROMABOND® Flash RS 25 SiOH	16.5	21.2	25	15	**732802**
CHROMABOND® Flash RS 40 SiOH	17.1	26.4	40	15	**732803**
CHROMABOND® Flash RS 80 SiOH	24.0	30.8	80	12	**732804**
CHROMABOND® Flash RS 120 SiOH	25.5	36.0	120	10	**732805**
CHROMABOND® Flash RS 200 SiOH	20.0	60.0	200	6	**732806**
CHROMABOND® Flash RS 330 SiOH	27.0	60.0	330	4	**732807**
CHROMABOND® Flash RS 800 SiOH	38.5	82.0	800	2	**732808**
CHROMABOND® Flash RS 1600 SiOH	43.0	104.0	1600	2	**732809**
Corresponding TLC plates: silica, see page 213					
CHROMABOND® Flash RS 4 C_{18} ec	9.8	12.4	4.3	2	**732810**
CHROMABOND® Flash RS 15 C_{18} ec	11.6	21.2	16.4	1	**732811**
CHROMABOND® Flash RS 25 C_{18} ec	16.5	21.2	26	1	**732812**
CHROMABOND® Flash RS 40 C_{18} ec	17.1	26.4	43	1	**732813**
CHROMABOND® Flash RS 80 C_{18} ec	24.0	30.8	86	1	**732814**
CHROMABOND® Flash RS 120 C_{18} ec	25.5	36.0	130	1	**732815**
CHROMABOND® Flash RS 200 C_{18} ec	20.0	60.0	220	1	**732816**
CHROMABOND® Flash RS 330 C_{18} ec	27.0	60.0	360	1	**732817**
CHROMABOND® Flash RS 800 C_{18} ec	38.5	82.0	880	1	**732818**
CHROMABOND® Flash RS 1600 C_{18} ec	43.0	104.0	1760	1	**732819**
Corresponding TLC plates: RP-18 W/UV_{254}, see page 220					
CHROMABOND® Flash RS 4 NH_2	9.8	12.4	4.3	2	**732820**
CHROMABOND® Flash RS 15 NH_2	11.6	21.2	16.4	1	**732821**
CHROMABOND® Flash RS 25 NH_2	16.5	21.2	26	1	**732822**
CHROMABOND® Flash RS 40 NH_2	17.1	26.4	43	1	**732823**
CHROMABOND® Flash RS 80 NH_2	24.0	30.8	86	1	**732824**
CHROMABOND® Flash RS 120 NH_2	25.5	36.0	130	1	**732825**
CHROMABOND® Flash RS 200 NH_2	20.0	60.0	220	1	**732826**
CHROMABOND® Flash RS 330 NH_2	27.0	60.0	360	1	**732827**
Corresponding TLC plates: Nano-SIL NH_2, see page 222					

CHROMABOND® Flash RS cartridges

Designation	Column length [cm]	ID [mm]	Adsorbent weight [g]	Pack of [columns]	REF
CHROMABOND® Flash RS 4 OH (Diol)	9.8	12.4	4.3	2	**732830**
CHROMABOND® Flash RS 15 OH (Diol)	11.6	21.2	16.4	1	**732831**
CHROMABOND® Flash RS 25 OH (Diol)	16.5	21.2	26	1	**732832**
CHROMABOND® Flash RS 40 OH (Diol)	17.1	26.4	43	1	**732833**
CHROMABOND® Flash RS 80 OH (Diol)	24.0	30.8	86	1	**732834**
CHROMABOND® Flash RS 120 OH (Diol)	25.5	36.0	130	1	**732835**
CHROMABOND® Flash RS 200 OH (Diol)	20.0	60.0	220	1	**732836**
CHROMABOND® Flash RS 330 OH (Diol)	27.0	60.0	360	1	**732837**
Corresponding TLC plates: Nano-SIL DIOL, see page 223					
CHROMABOND® Flash RS 4 CN	9.8	12.4	4.3	2	**732840**
CHROMABOND® Flash RS 15 CN	11.6	21.2	16.4	1	**732841**
CHROMABOND® Flash RS 25 CN	16.5	21.2	26	1	**732842**
CHROMABOND® Flash RS 40 CN	17.1	26.4	43	1	**732843**
CHROMABOND® Flash RS 80 CN	24.0	30.8	86	1	**732844**
CHROMABOND® Flash RS 120 CN	25.5	36.0	130	1	**732845**
CHROMABOND® Flash RS 200 CN	20.0	60.0	220	1	**732846**
CHROMABOND® Flash RS 330 CN	27.0	60.0	360	1	**732847**
Corresponding TLC plates: Nano-SIL CN, see page 221					
CHROMABOND® Flash RS 4 Alox A	9.8	12.4	8	20	**732870**
CHROMABOND® Flash RS 4 Alox N	9.8	12.4	8	20	**732871**
CHROMABOND® Flash RS 4 Alox B	9.8	12.4	8	20	**732872**
CHROMABOND® Flash RS 15 Alox A	11.6	21.2	30	20	**732874**
CHROMABOND® Flash RS 15 Alox N	11.6	21.2	30	20	**732873**
CHROMABOND® Flash RS 15 Alox B	11.6	21.2	30	20	**732875**
CHROMABOND® Flash RS 25 Alox A	16.5	21.2	50	15	**732876**
CHROMABOND® Flash RS 25 Alox N	16.5	21.2	50	15	**732877**
CHROMABOND® Flash RS 25 Alox B	16.5	21.2	50	15	**732878**
CHROMABOND® Flash RS 40 Alox A	17.1	26.4	80	15	**732879**
CHROMABOND® Flash RS 40 Alox N	17.1	26.4	80	15	**732881**
CHROMABOND® Flash RS 40 Alox B	17.1	26.4	80	15	**732880**
Corresponding TLC plates: Alox, see page 224					

CHROMABOND® Flash columns for Biotage® FlashMaster™ systems					
CHROMABOND® Flash FM 15/2 SiOH	9.0	15.8	2.0	50	**730881**
CHROMABOND® Flash FM 25/5 SiOH	10.0	20.5	5.0	50	**730891**
CHROMABOND® Flash FM 25/10 SiOH	10.0	20.5	10.0	50	**730666**
CHROMABOND® Flash FM 70/10 SiOH	15.4	26.8	10.0	30	**730885**
CHROMABOND® Flash FM 70/20 SiOH	15.4	26.8	20.0	30	**730915**
CHROMABOND® Flash FM 70/25 SiOH	15.4	26.8	25.0	30	**730892**
CHROMABOND® Flash FM 150/25 SiOH	17.0	38.2	25.0	20	**730667**
CHROMABOND® Flash FM 150/50 SiOH	17.0	38.2	50.0	20	**730887**
CHROMABOND® Flash FM 150/70 SiOH	17.0	38.2	70.0	10	**730880**
CHROMABOND® Flash FM 15/2 C_{18} ec	9.0	15.8	2.0	50	**730890**
CHROMABOND® Flash FM 25/5 C_{18} ec	10.0	20.5	5.0	20	**730884**
CHROMABOND® Flash FM 70/10 C_{18} ec	15.4	26.8	10.0	20	**730886**
CHROMABOND® Flash FM 150/50 C_{18} ec	17.0	38.2	50.0	10	**730888**
CHROMABOND® Flash FM 70/10 NH_2	15.4	26.8	10.0	20	**730768**
CHROMABOND® Flash FM 70/20 NH_2	15.4	26.8	20.0	20	**730767**

CHROMABOND® Flash RS cartridges

Technical support

Loadability

Due to the narrow particle size distribution, the excellent packing quality and the optimized stationary phases (acid washed silica, reduced particulate matter) our cartridges can realize highest loadability at best possible separation efficiency. Additionally, the large range of different cartridge lengths and diameters eases to find the optimum in loadability for a given sample amount.

Rule of thumb for the loadability

Separation	Loadability	g sample / g adsorbent
difficult	low	≤ 1%
easy	high	≥ 10%

Loadability table CHROMABOND® Flash RS

SiOH cartridge	Average loadability per cartridge [g] **difficult** separation	**easy** separation
RS 4	0.04	0.4
RS 15	0.15	1.5
RS 25	0.25	2.5
RS 40	0.4	4
RS 80	0.8	8
RS 120	1.2	12
RS 200	2	20
RS 330	3.3	33
RS 800	8	80
RS 1600	16	160

Upscaling of the optimum flow rate

This depends on the eluent and the separation problem.

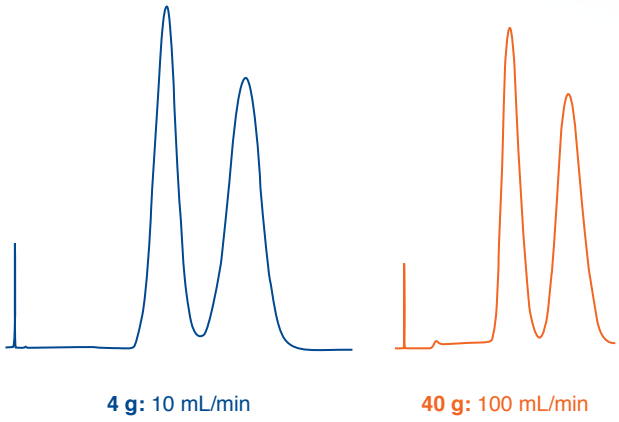
For RS cartridges the upscaling relation is simple:

The silica weight in g is proportional to the flow rate (for equal eluent polarity), e.g.,

4 g silica → optimum flow: ~ 6–12 mL/min

40 g silica → optimum flow: ~ 60–120 mL/min

Upscaling of the flow rate



Back pressure and pressure stability

The back pressure always depends on flow rate and viscosity of the eluent mixture, column length and diameter and the particle size. The high performance CHROMABOND® Flash RS cartridges up to 200 g silica are stable up to 15 bar (220 psi, > 200 g: 12 bar). We recommend using a pressure guard, because short time pressure peaks (viscosity of eluent or gradient changes) can exceed the pressure limit.

Back pressure of CHROMABOND® Flash RS SiOH cartridges (eluent hexane – ethyl acetate 9:1 or 8:2)

	Flow rate						
Cartridge	20 mL/min	40 mL/min	80 mL/min	120 mL/min	160 mL/min	200 mL/min	240 mL/min
RS 4	0.75 bar	1.5 bar					
RS 15	0.25 bar	0.75 bar	1.5 bar	2.0 bar			
RS 25	0.5 bar	1.0 bar	1.75 bar	3.0 bar	4.0 bar	5.0 bar	
RS 40		0.75 bar	1.5 bar		3.0 bar		3.5 bar
RS 80			1.5 bar	2.5 bar	3.0 bar	3.5 bar	4.0 bar
RS 120			1.0 bar	1.5 bar	2.0 bar	2.5 bar	3.0 bar
RS 200			1.0 bar		2.0 bar		3.0 bar
RS 330			1.5 bar		3.0 bar		4.0 bar

Conditioning volumes for CHROMABOND® Flash RS cartridges (normally 1.5 column volumes of the eluent)

Cartridge	Volume of eluent for conditioning
RS 4	20 mL
RS 15	60 mL
RS 25	90 mL
RS 40	140 mL
RS 80	280 mL

Cartridge	Volume of eluent for conditioning
RS 120	440 mL
RS 200	750 mL
RS 330	1100 mL
RS 800	2900 mL
RS 1600	5000 mL

CHROMABOND® Flash RS cartridges

TLC upscaling

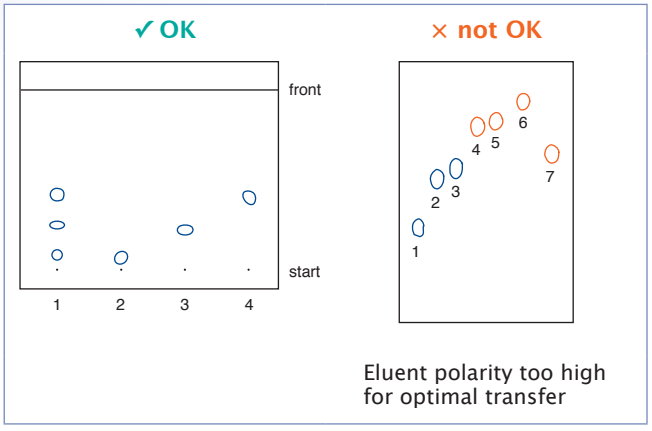
TLC is often used for the development of a selective and reproducible method in Flash chromatography, because it is often necessary to test a large number of eluent and/or adsorbent combinations. MN TLC plates and sheets are coated with the same base silica, which is used in our CHROMABOND® Flash cartridges. This is an important prerequisite for the reproducible transfer of a TLC separation to the Flash column, because the parameters are identical in both systems.

MN TLC and Flash product ensure:

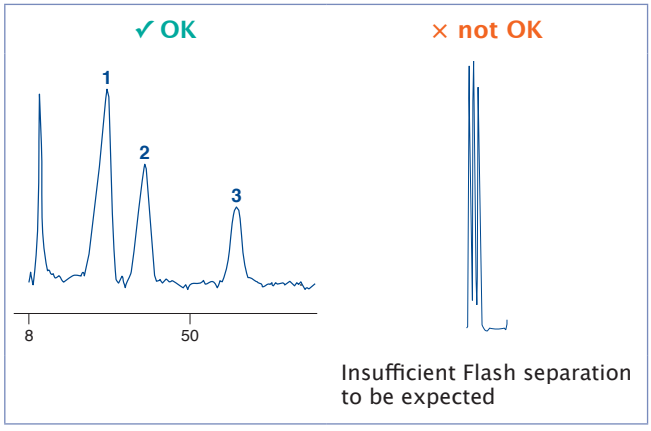
- Same selectivity and easy upscaling from TLC to Flash separations
- Saving time and money, because expensive optimizations are not required

Examples for transfer of a TLC separation to a Flash column:

R_f values of the TLC separation should be in the range of 0.1–0.4 (low height).



ΔR_f values on the TLC plate should be as high as possible.



During TLC optimization always use solvents, which are well suited for the following Flash chromatography!

MN adsorbents — a unique variety of phases

- As with our SPE products, all Flash columns and cartridges from MN are available with our whole range of CHROMABOND® phases (more than 40, e.g., C_{18}, C_8, OH, Alox as listed on page 8)

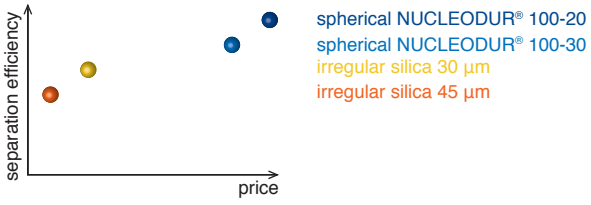
  Additionally you can choose from our range of POLYGOPREP silica packings in particle sizes from 20 to 130 µm and pore sizes from 60 to 4000 Å (see page 203).
- For high performance Flash separations you can order columns packed with spherical NUCLEODUR® featuring very high separation efficiency and extremely increased column lifetime (particle size > 20 µm as listed on page 198)

Technical silica information

Specification of modified and plain silica:
acid-washed irregular silica, pore size 60 Å, particle size 45 µm, specific surface 500 m^2/g, pH stability 2–8

Additionally available silicas and particle sizes:

- Irregular POLYGOPREP silica with particle sizes of 20 to 130 µm and pore sizes of 60 to 4000 Å
- Spherical high performance silica (NUCLEODUR®, 110 Å) with particle sizes of 20 or 30 µm for high separation efficiency and very long column life



Comparison of separation efficiency and price of irregular versus spherical silica

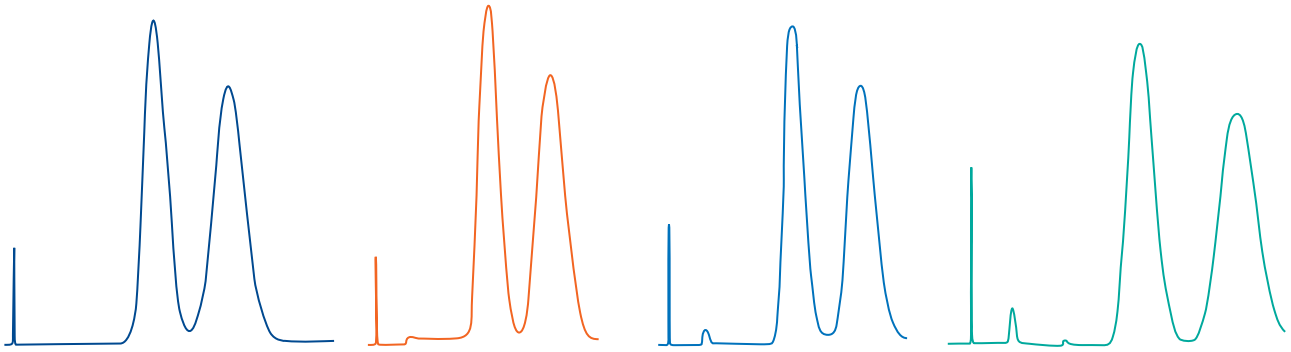
Separation efficiency and reproducibility

Our optimized automatic packing process leads to an excellent packing quality, irrespective of the phase or particle size distribution (normal phase or reversed phase, spherical or irregular particles).

MN, as a manufacturer of silicas, has decades of experience in the production of first class separation phases and columns. This leads to highest separation efficiencies of the columns, a constant back pressure (via controlled narrow particle size distribution) and good reproducibilities from cartridge to cartridge.

The separation efficiency is in the first step not influenced by the dimension or the geometry of the Flash RS cartridges. The chromatograms below show an identical resolution and peak form for different column dimensions, when flow and sample amount is adjusted correctly. This is advantageous for optimization and upscaling experiments.

Resolution and peak shape for different column dimensions



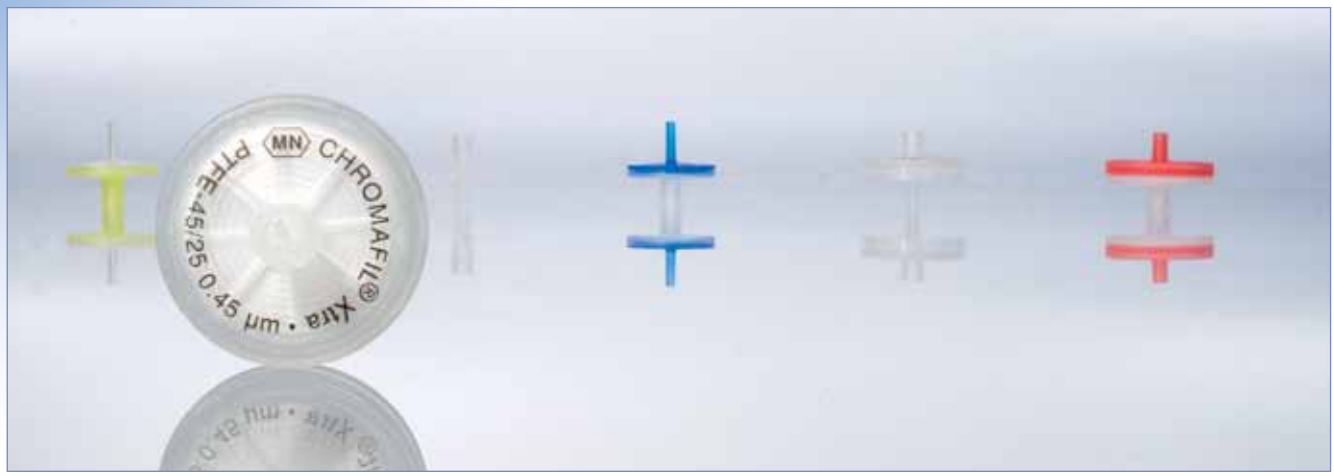
4 g, 0.25 mL sample, 10 mL/min

15 g, 1 mL sample, 40 mL/min

25 g, 1 mL sample, 80 mL/min

40 g, 1 mL sample, 160 mL/min

Syringe filters CHROMAFIL®



Syringe filters are used for filtration of suspended matter from liquid samples or gases. With CHROMAFIL®, rapid purification and removal of particles is very simple: just place the filter on the syringe, and you are ready for filtration. Special manipulations are not required. Contamination of sensitive instrumentation by solid impurities can be avoided, thus increasing lifetime of chromatographic columns and equipment.

Advantages:

Polypropylene housing

Considerably better solvent stability compared to acrylate and polystyrene filters, featuring a low content of extractable substances

Lowest content of extractable substances

The housing of every CHROMAFIL® filter is **ultrasonically sealed (welded), not glued,** because glue may have extractable ingredients. Welding leads to a tight connection between both parts, thus the filter can be used in both directions. The special **thick rim** of the housing is ideal for use in laboratory robots (e.g., SOTAX®, Benchmate™).

Luer lock on the side of entry

For a safe connection on the high-pressure side every filter provides a Luer lock on the side of entry.

Luer exit

For 25 and 3 mm filters: standard Luer exit
For 15 mm filters: minispike · This Luer configuration offers a low hold-up volume and easy filtration into autosampler vials and NMR tubes.

With the aid of a special adapter, filter inlet and filter exit can be fitted to all CHROMABOND® columns and accessories for selective sample preparation.

No rupture of membrane due to the impact plate

The input solvent stream is broken and distributed by the impact plate, and does not directly hit the membrane: this prevents rupture of the membrane. The high pressure stream is diverted into four lanes.

Optimum flow geometry because of the star-shaped distribution device

The stream of liquid is broken into 4 lanes by the impact plate and then further distributed to 8 slots in the form of a star connected with 5 or 8 circular channels (for 15 mm and 25 mm filters, respectively). Thus, the fluid is able to penetrate the membrane on the whole surface, not only on a small region; the filter is not plugged up rapidly, which results in a high flow efficiency.

Color coded filters

Filters with 0.2 µm pores have a yellow upper shell, that of filters with 0.45 µm pores is colorless; the different membrane types are distinguished by different colors of the lower shell.

Different pore sizes for versatile filtration

Standard pore sizes 0.2 and 0.45 µm (additionally: PET filters with 1.2 µm, glass fiber filters with 1 µm, PES filters with 5 µm). Filters with 0.45 µm pore size efficiently remove fine particles that can plug chromatography columns. Filters with 0.2 µm pore size are excellent for filtration of UHPLC samples or other techniques requiring high purity samples.

Filter sizes

25, 15 and 3 mm diameter: the small diameter filters are especially recommended for very small samples, which require extremely low dead volumes: 5 µL for 3 mm ∅, 35 µL for 15 mm ∅, 80 µL for 25 mm ∅

Recommended filter size depending on sample volume

Sample volume	Recommended filter diameter
≤ 1 mL	3 mm
1–5 mL	15 mm
5–100 mL	25 mm

Filters can be **autoclaved** at **121 °C, 1.1 bar** for 30 min.

All 25 mm CHROMAFIL® filters are designed to be 100% compatible and reliable for use with the SOTAX® AT70 smart fully automated dissolution testing systems.

Syringe filters CHROMAFIL®

Depending on your filtration task you can choose filter membranes made from different materials:

CHROMAFIL® BIG-BOX

- 400 (25 mm) or 800 (15 mm) color-coded quality syringe filters · 400 labeled Xtra syringe filters
- Food safe PE box with screw cap
- Economical prices

CHROMAFIL® Xtra

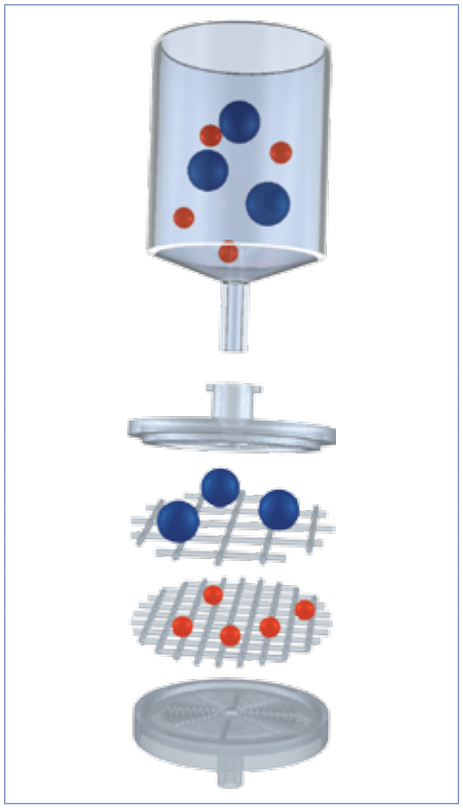
labeled for method validation and certification

Xtra: imprint for direct identification of the membrane type, diameter and pore size

Xtra: low bleeding PP housing

Xtra: color-free plain polypropylene

CHROMAFIL® Combi filters



Combi syringe filters with a coarse glass fiber prefilter and a small-pore membrane as main filter

User benefits:

- For solutions with a high load of particulate matter: lower back pressure, easy filtration
- For high yields of filtrate: more mL of pure filtrate per filter

The technology:

The glass fiber membrane (1.0 µm) removes coarse particles, before they can block the fine main membrane. This results in a better filtration efficiency, especially for highly contaminated samples.

Housing:	Solvent-resistant, ultra low bleed polypropylene
Inlet:	Luer lock
Exit:	Luer
Pore diameter:	1.0 / 0.20 µm or 1.0 / 0.45 µm
Filter diameter:	25 mm
Void volume:	< 80 µL
Packing unit:	100 filters; BIG-BOX with 400 filters

Sample clarification

CHROMAFIL® Combi filters

Polyester with glass fiber prefilter (GF/PET)

- Hydrophilic multipurpose membrane
  for polar as well as nonpolar solvents
  The HPLC filter with glass fiber prefilter, especially suited for mixtures of water and organic solvents
- Recommended for solutions with a high load of particulate matter or for highly viscous solutions

Ordering information

Type	Pore size [µm]	Membrane diameter [mm]	Color code top	Color code bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
GF/PET-20/25	1.0/0.20	25	blue	orange	100	**729032**	400	**729032.400**
GF/PET-45/25	1.0/0.45	25	black	orange	100	**729033**	400	**729033.400**

Regenerated cellulose with glass fiber prefilter (GF/RC)

- Hydrophilic membrane
  for aqueous and organic-aqueous liquids,
  i.e. polar and medium polar sample solutions
- Recommended for solutions with a high load of particulate matter or for highly viscous aqueous solutions

Ordering information

Type	Pore size [µm]	Membrane diameter [mm]	Color code top	Color code bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
GF/RC-20/25	1.0/0.20	25	blue	blue	100	**729050**	400	**729050.400**
GF/RC-45/25	1.0/0.45	25	black	blue	100	**729051**	400	**729051.400**

Polyvinylidene difluoride with glass fiber prefilter (GF/PVDF)

- Hydrophilic membrane
- Recommended for filtration of biological samples with high particle loads. This filter features a high binding capacity for proteins.
- Also suited for filtration of polar and nonpolar solutions

Ordering information

Type	Pore size [µm]	Membrane diameter [mm]	Color code top	Color code bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
GF/P-45/25	1.0/0.45	25	black	white	100	**729039**	400	**729039.400**

Polyester (PET)

- Hydrophilic multipurpose membrane
  for polar as well as nonpolar solvents
  The HPLC filter, especially suited for mixtures of water and organic solvents
  For TOC/DOC determination
  Not cytotoxic, does not inhibit the growth of microorganisms and higher cells

Ordering information · CHROMAFIL® Xtra

Type	Pore size [µm]	Membrane diameter [mm]		Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
PET-20/25	0.20	25	labeled	100	**729221**	400	**729221.400**
PET-45/25	0.45	25	labeled	100	**729220**	400	**729220.400**
PET-120/25	1.2	25	labeled	100	**729229**	400	**729229.400**

Ordering information · CHROMAFIL®

Type	Pore size [µm]	Membrane diameter [mm]	Color code top	Color code bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
PET-20/15 MS	0.20	15	yellow	orange	100	**729022**	800	**729022.800**
PET-45/15 MS	0.45	15	colorless	orange	100	**729023**	800	**729023.800**
PET-20/25	0.20	25	yellow	orange	100	**729021**	400	**729021.400**
PET-45/25	0.45	25	colorless	orange	100	**729020**	400	**729020.400**

MS = minispike on filter exit

Regenerated cellulose (RC)

- Hydrophilic membrane with very low adsorption
  for aqueous and organic-aqueous liquids, i.e. polar and medium polar sample solutions
- Binding capacity for proteins 84 µg per 25 mm filter

Ordering information · CHROMAFIL® Xtra

Type	Pore size [µm]	Membrane diameter [mm]		Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
RC-20/25	0.20	25	labeled	100	**729230**	400	**729230.400**
RC-45/25	0.45	25	labeled	100	**729231**	400	**729231.400**

Ordering information · CHROMAFIL®

Type	Pore size [µm]	Membrane diameter [mm]	Color code top	Color code bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
RC-20/15 MS	0.20	15	yellow	blue	100	**729036**	800	**729036.800**
RC-45/15 MS	0.45	15	colorless	blue	100	**729037**	800	**729037.800**
RC-20/25	0.20	25	yellow	blue	100	**729030**	400	**729030.400**
RC-45/25	0.45	25	colorless	blue	100	**729031**	400	**729031.400**

MS = minispike on filter exit

CHROMAFIL® syringe filters

Polytetrafluoroethylene (PTFE)

- Hydrophobic membrane
  for nonpolar liquids and gases
- Very resistant towards all kinds of solvents as well as acids and bases
  Flushing with alcohol, followed by water, makes the originally hydrophobic membrane more hydrophilic.

Ordering information · CHROMAFIL® Xtra

Type	Pore size [µm]	Membrane diameter [mm]		Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
PTFE-20/25	0.20	25	labeled	100	**729207**	400	**729207.400**
PTFE-45/25	0.45	25	labeled	100	**729205**	400	**729205.400**
PTFE-100/25	1.0	25	labeled	100	**729247**	400	**729247.400**

Ordering information · CHROMAFIL®

Type	Pore size [µm]	Membrane diameter [mm]	Color code top	Color code bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
O-20/3	0.20	3	colorless	colorless	100	**729014**		
O-45/3	0.45	3	colorless	colorless	100	**729015**		
O-20/15 MS	0.20	15	yellow	colorless	100	**729008**	800	**729008.800**
O-45/15 MS	0.45	15	colorless	colorless	100	**729009**	800	**729009.800**
O-20/25	0.20	25	yellow	colorless	100	**729007**	400	**729007.400**

MS = minispike on filter exit

Cellulose mixed esters (MV)

- Hydrophilic membrane with very low adsorption
  for aqueous or polar solutions

Ordering information · CHROMAFIL® Xtra

Type	Pore size [µm]	Membrane diameter [mm]		Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
MV-20/25	0.20	25	labeled	100	**729206**	400	**729206.400**
MV-45/25	0.45	25	labeled	100	**729204**	400	**729204.400**

Ordering information · CHROMAFIL®

Type	Pore size [µm]	Membrane diameter [mm]	Color code top	Color code bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
A-20/25	0.20	25	yellow	yellow	100	**729006**	400	**729006.400**
A-45/25	0.45	25	colorless	yellow	100	**729004**	400	**729004.400**

Sample clarification

Cellulose acetate (CA)

- Hydrophilic membrane
  for filtration of water-soluble oligomers and polymers, especially suited for biological macromolecules
- Very high shape stability in aqueous solutions
- Extremely low binding capacity for proteins (21 µg/filter)

- Also available in a sterile package (S) for filtration under sterile conditions (each filter individually sealed)

Ordering information · CHROMAFIL® Xtra

Type	Pore size [µm]	Membrane diameter [mm]		Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
CA-20/25	0.20	25	labeled	100	**729226**	400	**729226.400**
CA-45/25	0.45	25	labeled	100	**729227**	400	**729227.400**

Ordering information · CHROMAFIL®

Type	Pore size [µm]	Membrane diameter [mm]	Color code top	Color code bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
CA-20/15 MS	0.20	15	yellow	red	100	**729054**	800	**729054.800**
CA-45/15 MS	0.45	15	colorless	red	100	**729055**	800	**729055.800**
CA-20/25	0.20	25	yellow	red	100	**729026**	400	**729026.400**
CA-45/25	0.45	25	colorless	red	100	**729027**	400	**729027.400**
Sterile filters								
CA-20/15 MS (S)	0.20	15	yellow	red	50	**729052**		
CA-45/15 MS (S)	0.45	15	colorless	red	50	**729053**		
CA-20/25 (S)	0.20	25	yellow	red	50	**729024**		
CA-45/25 (S)	0.45	25	colorless	red	50	**729025**		

MS = minispike on filter exit

Polyethersulfone (PES)

- Hydrophilic membrane
  for aqueous liquids and aqueous liquids with low organic contents
- Very low adsorption for pharmaceuticals and proteins
  good stability against acids and bases
- Binding capacity for proteins 29 µg per 25 mm filter

Ordering information · CHROMAFIL® Xtra

Type	Pore size [µm]	Membrane diameter [mm]		Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
PES-20/25	0.20	25	labeled	100	**729240**	400	**729240.400**
PES-45/25	0.45	25	labeled	100	**729241**	400	**729241.400**
PES-500/25	5.0	25	labeled	100	**729242**	400	**729242.400**

Syringe filters CHROMAFIL®

Polyamide (PA) = Nylon

- Rather hydrophilic membrane
  for aqueous and organic-aqueous medium polar liquids

Ordering information · CHROMAFIL® Xtra

Type	Pore size [µm]	Membrane diameter [mm]		Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
PA-20/25	0.20	25	labeled	100	**729212**	400	**729212.400**
PA-45/25	0.45	25	labeled	100	**729213**	400	**729213.400**

Ordering information · CHROMAFIL®

Type	Pore size [µm]	Membrane diameter [mm]	Color code top	Color code bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
AO-20/3	0.20	3	light beige	light beige	100	**729010**		
AO-45/3	0.45	3	light beige	light beige	100	**729011**		
AO-20/15 MS *	0.20	15	yellow	green	100	**729048**	800	**729048.800**
AO-45/15 MS *	0.45	15	colorless	green	100	**729049**	800	**729049.800**
AO-20/25	0.20	25	yellow	green	100	**729012**	400	**729012.400**
AO-45/25	0.45	25	colorless	green	100	**729013**	400	**729013.400**

Polyvinylidene difluoride (PVDF)

- Hydrophilic membrane
  for polar and nonpolar solutions, water-soluble oligomers and polymers like proteins
- Binding capacity for proteins 82 µg per 25 mm filter

Ordering information · CHROMAFIL® Xtra

Type	Pore size [µm]	Membrane diameter [mm]		Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
PVDF-20/25	0.20	25	labeled	100	**729218**	400	**729218.400**
PVDF-45/25	0.45	25	labeled	100	**729219**	400	**729219.400**

Ordering information · CHROMAFIL®

Type	Pore size [µm]	Membrane diameter [mm]	Color code top	Color code bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
PVDF-20/15 MS	0.20	15	yellow	white	100	**729043**	800	**729043.800**
PVDF-45/15 MS	0.45	15	colorless	white	100	**729044**	800	**729044.800**

MS = minispike on filter exit

Glass fiber (GF)

- Inert filter, nominal pore size 1 µm, allows higher flow rates than small pore filters
- For solutions with high loads of particulate matter or for highly viscous solutions (e.g., soil samples, fermentation broths)
- As prefilters for other CHROMAFIL® filters, they prevent plugging of the membrane.

Ordering information · CHROMAFIL® Xtra

Type	Pore size [µm]	Membrane diameter [mm]		Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
GF-100/25	nom. 1.0	25	labeled	100	**729228**	400	**729228.400**

Ordering information · CHROMAFIL®

Type	Pore size [µm]	Membrane diameter [mm]	Color code top	Color code bottom	Standard pack filters/pack	Standard pack REF	BIG-BOX filters/pack	BIG-BOX REF
GF-100/15 MS	nom. 1.0	15	blue	colorless	100	**729034**		
GF-100/25	nom. 1.0	25	yellow	black	100	**729028**	400	**729028.400**
MS = minispike on filter exit								

CHROMAFIL® materials · compatibility

Chemical compatibility of filter materials

The following table lists the chemical compatibility of our CHROMAFIL® materials. The chemical compatibility depends on several parameters such as time, pressure, temperature and concentration. In most cases, CHROMAFIL® filters will have only short contact with a solvent. In these cases they may be used despite of limited compatibility.

For example, a PTFE filter with PP housing does not liberate any UV-detectable substances during filtration of 5 mL THF, although PP shows only limited resistance towards THF.

Solvent	Material									
	MV	CA	RC	PA	PTFE	PVDF	PES	PET	GF	PP
Acetaldehyde	⊖	⊖	⊕	○	⊕	⊕		⊕	⊕	○
Acetic acid, 100 %	⊖	⊖	⊖	⊖	⊕	⊕	⊕	⊕	⊕	⊕
Acetone	⊖	⊖	⊕	⊕	⊕	⊖	⊖	⊕	⊕	⊕
Acetonitrile	⊖	⊖	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕
Ammonia, 25 %	⊖	⊖	○	⊖	⊕	⊕	⊕	○	⊕	⊕
Benzene	⊕	⊕	⊕	⊕	⊕	○		⊕	⊕	○
n-Butanol	⊕	⊕	⊕	○	⊕	⊕	⊕	⊕	⊕	⊕
Cyclohexane	⊕	⊕	⊕	○	⊕	⊕	⊕	⊕	⊕	⊕
Dichloromethane	⊕	⊖	⊕	⊖	⊕	⊕	⊖	⊕	⊕	⊖
Diethyl ether	○	○	⊕	⊕	⊕	⊕	⊕	⊕	⊕	○
Dimethylformamide	⊖	⊖	○	⊕	⊕	⊖	⊖	⊕	⊕	⊕
1,4-Dioxane	⊖	⊖	⊕	⊕	⊕	○	⊖	⊕	⊕	○
Ethanol	⊖	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕
Ethyl acetate	⊖	⊖	⊕	⊕	⊕	⊕	⊕	⊕	⊕	○
Ethylene glycol	○	○	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕
Formic acid, 100 %	⊕	⊖	○	⊖	⊕	⊕	⊕	○	⊕	⊕
Hydrochloric acid, 30 %	⊖	⊖	⊖	⊖	⊕	⊕	⊕	⊖	⊕	⊕
Methanol	⊖	⊖	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕
Nitric acid, 65 %	⊖	⊖	⊖	⊖	○	○		○	⊕	⊖
Oxalic acid, 10 % aqueous	⊕	⊖	⊕	⊖	⊕	⊕		⊕	⊕	⊕
Petroleum ether	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕
Phosphoric acid, 80 %	⊖	⊖	○	⊖	⊕	○		⊕	⊕	⊕
Potassium hydroxide, 1 mol/L	⊖	⊖	○	⊕	⊕	○	⊕	○	⊕	⊕
2-Propanol	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕
Sodium hydroxide, 1 mol/L	⊖	⊖	○	⊕	⊕	○	○	○	○	⊕
Tetrachloromethane	⊕	⊖	⊕	⊕	⊕	○		⊕	⊕	○
Tetrahydrofuran	⊖	⊖	⊕	○	⊕	⊕	⊖	⊕	⊕	○
Toluene	⊕	⊖	⊕	⊕	⊕	⊕	⊕	⊕	⊕	○
Trichloroethene	⊕	⊕	⊕	○	⊕	⊕		⊕	⊕	○
Trichloromethane (chloroform)	⊕	⊖	⊕	⊖	⊕	⊕	⊖	⊕	⊕	⊖
Urea	⊕	⊕	⊕	⊕	⊕	⊕		⊕	⊕	⊕
Water	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕
Xylene	⊕	⊕	⊕	⊕	⊕	○		⊕	⊕	○

Data not guaranteed.

⊕ resistant, ⊖ not resistant, ○ limited resistance

MV = cellulose mixed esters, CA = cellulose acetate, RC = regenerated cellulose, PA = polyamide, PTFE = polytetrafluoroethylene, PVDF = polyvinylidene difluoride, PES = polyethersulfone, PET = polyester, GF = glass fiber, PP = polypropylene (housing material)

Hints for using CHROMAFIL® syringe filters

For optimum filtration results we recommend to keep the following in mind:

- Either discard the first mL or rinse the filter unit with 1 mL of the solvent prior to filtration
- Before filling the syringe, draw about 1 mL air into the syringe in order to minimize the liquid remaining in the filter
- Start filtration with a slight pressure; this will optimize the throughput of the filter. As soon as particles accumulate on the filter, filtration will become more difficult and the pressure on the filter will increase.
- Change the filter, whenever the resistance becomes too large in order to prevent rupture of the housing.
- Do not apply CHROMAFIL® syringe filters on humans; they are only intended for lab use!
- Always use syringes ≥ 10 mL; smaller syringes can easily cause pressures above the 6 bar limit of the filters.
- The temperature should not exceed 55 °C.
- Do not re-use the filters.

CHROMAFIL® filtration cartridges

- Filtration cartridges for sample clarification under vacuum (e.g., using the CHROMABOND® vacuum manifold or SPE automation systems like Gilson Aspec™, Rapidtrace®) or by gravity
- Cartridge sizes 3 mL and 6 mL
- Different membranes (PET, RC, PTFE, PVDF, GF) and pore sizes (0.2, 0.45 and 1.0 µm). Membrane materials correspond to the respective CHROMAFIL® syringe filters.

Ordering information

Description	Pore size [µm]	Pack of [cartridges]	Column volume 3 mL	Column volume 6 mL
Filtration cartridges PET (polyester)	0.20	100	**730578.320**	**730578.620**
Filtration cartridges PET (polyester)	0.45	100	**730578.345**	**730578.645**
Filtration cartridges RC (regenerated cellulose)	0.20	100	**730068.320**	**730068.620**
Filtration cartridges RC (regenerated cellulose)	0.45	100	**730068.345**	**730068.645**
Filtration cartridges PTFE (polytetrafluoroethylene)	0.20	100	**730570.320**	**730570.620**
Filtration cartridges PTFE (polytetrafluoroethylene)	0.45	100	**730570.345**	**730570.645**
Filtration cartridges PVDF (polyvinylidene difluoride)	0.20	100	**730579.320**	**730579.620**
Filtration cartridges PVDF (polyvinylidene difluoride)	0.45	100	**730579.345**	**730579.645**
Filtration cartridges GF (glass fiber)	nom. 1.0	100	**730517.3100**	**730517.6100**

96-well filter plates CHROMAFIL® MULTI 96

CHROMAFIL® MULTI 96 filter plates

- 96-well polypropylene plates for simultaneous filtration of 96 samples
- Advantages of this high-throughput system are:
  - Economical by saving time and solvent
  - Use of multi-channel pipetters facilitates liquid transfer steps
  - Readily adaptable to all common automated and robotic handling systems
  - Minimized dead volume (≤ 40 µL)
- Membrane materials correspond to the respective CHROMAFIL® syringe filters.

Sample clarification

Ordering information

Description	Pack of	REF
Filter plates with cellulose mixed ester filter elements (0.20 µm)	1	**738770.M**
Filter plates with cellulose mixed ester filter elements (0.45 µm)	1	**738771.M**
Filter plates with RC filter elements (regenerated cellulose, 0.2 µm)	1	**738656.M**
Filter plates with RC filter elements (regenerated cellulose, 0.45 µm)	1	**738657.M**
Filter plates with PTFE filter elements (0.2 µm)	1	**738660.M**
Filter plates with PTFE filter elements (0.45 µm)	1	**738661.M**
Filter plates with PTFE filter elements (1.0 µm)	1	**738662.M**
Filter plates with PTFE filter elements (3.0 µm)	1	**738663.M**
Filter plates with PE filter elements (20 µm)	1	**738655.M**
Filter plates with PE filter elements (50 µm)	1	**738659.M**
Filter plates with glass fiber filter elements (nominal 1 µm)	1	**738655.2M**
Filter plates with glass fiber filter elements (nominal 3 µm)	1	**738658.M**
CHROMABOND® MULTI 96 vacuum manifold for monoblocks, with reservoir tank, vacuum gauge, and control valve, for filtration with 96-well filter plates	1	**738630.M**

Disposable syringes with Luer tip (non-sterile, body and piston made from polypropylene)

Volume	Pack of	REF
2 mL	100	**729100**
5 mL	100	**729101**
10 mL	100	**729102**

Glass vials and inserts

According to the high requirements of chemical analyses, especially with regard to reproducibility combined with high detection sensitivity, the container material for the respective samples is of great importance. In chromatography generally vials made from 1st hydrolytic class glass are being used. This type includes borosilicate glasses like Duran®, Pyrex®, Fiolax®, and others. Glass of this class, often called neutral glass, has a very good chemical resistance towards acidic and neutral solutions. The relatively low alkali content permits good values for the resistance towards alkaline solutions, too. Except for the snap cap vials for storage of powdery samples the vials of our program are made from glass of 1st hydrolytic class (manufactured in accordance with Eu.Ph., U.S.P., DAB, Ph. Jap.).

The dimensions stated in this catalog with respect to vial diameter and height are exact values. Please note that other suppliers often list rounded values (e.g., 12 x 32 mm instead of 11.6 x 32 mm), the actual dimensions are, however, identical due to the required fit in the instrument. Our data concerning the volume are defined realistically usable volumes, not calculated values. For reasons of safety we state rather low values. Here, too, deviations from data of other suppliers may occur, which either use the calculated volume (e.g., 2 mL instead of 1.5 mL) or a defined, realistically usable volume in the upper range (e.g., 1.8 mL instead of 1.5 mL).

Septa guide

	Temperature resistance from / to	Analytical purity	Fragmentation due to hardness and molecular structure (coring)	Hardness (needle penetration)	Resealability (in case of multiple injections)
PTFE virginal	-200 °C / 260 °C	very high		very hard (but very thin material)	no resealability
Natural rubber / PTFE	-40 °C / 120 °C	low	high, big particles	very hard	high
Red Rubber / TEF (FEP)	-40 °C / 110 °C	medium	medium	medium hard	medium
Butyl	-40 °C / 120 °C	medium	medium	medium hard	medium
Butyl / PTFE	-40 °C / 120 °C	medium	medium	medium hard	medium
Silicone / PTFE	-60 °C / 200 °C	high	low to medium	soft	low to medium
PTFE / Silicone / PTFE	-60 °C / 200 °C	high	very low	soft	very low

In HPLC the septa often need to have a (cross-) slit as a penetration aid for thick and blunt needles. Furthermore, the slit avoids a vacuum in the vial during sample removal and thus guarantees constant volumes in case of multiple injections. The PTFE lamination protects the elastomeric carrier material of the septa from decomposition by aggressive samples or solvents, but also – in the other direction – the sample from possible contaminations through substances of the carrier material.

Autosampler compatibility charts (see page 103)

The autosampler compatibility charts generally show the most typical vials and closures for use on the instruments of a given manufacturer. In addition to the products listed in those charts, our catalog may contain other technically and functionally suitable products for use on a given autosampler which are not marketed actively as accessories by the respective manufacturer. We look forward to recommend any suitable product.

Compatibility charts have been compiled for the following instrument manufacturers: Agilent, CTC, Dionex, PerkinElmer, Shimadzu, Thermo Scientific, Varian (Agilent), VWR (Merck® / Hitachi), Waters®. Where applicable, each chart is divided into fields of use (GC, HPLC, Headspace).

We generally recommend that you ask for cost-free samples for testing purposes, as even technically comparable products may differ in their optical appearance.

We kindly ask for your understanding that we do not take over any guarantee for the correctness and completeness of the data indicated here.

Miscellaneous

Should you need more information concerning this product range, you can ask for our separate brochure "Vials and caps", which – among others – features 1:1 drawings of all glass products.

Except where explicitly mentioned, septa are assembled ready to use. Septa beneath or beside a cap are shown for illustration purposes only, and they are pictured upside down.

All drawings in this chapter are scale 1:2.

Should you wish to translate article numbers of other manufacturers into MACHEREY-NAGEL REFs, we recommend to use our VialFinder on the internet under ***www.mn-net.com***. Detailed information for its use are available as download.

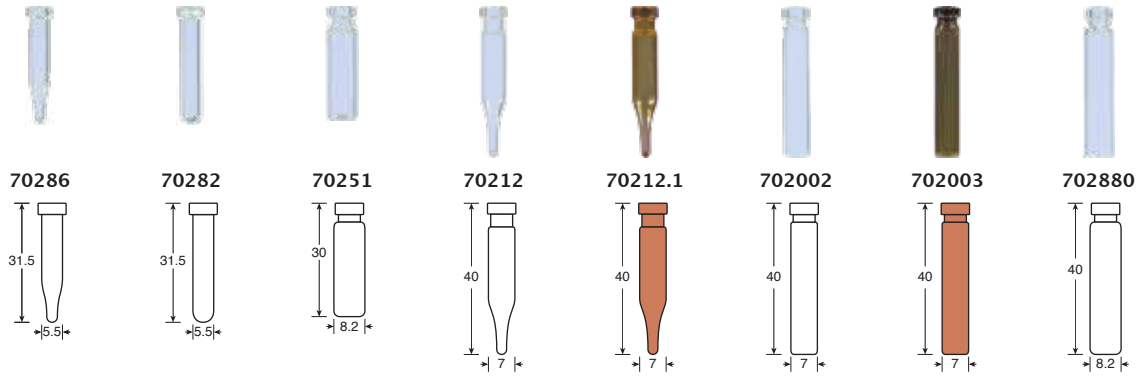
Crimp neck vials and closures N 8

Crimp neck vials and closures N 8

- **Micro-vials with 8 mm crimp neck**
  0.2–1.2 mL usable volume
  Adapter required for use in an autosampler
  Available with flat, round or conical bottom, made of clear and amber glass
- **Aluminium crimp closures N 8**
  Economic versions: three-layer septum Natural rubber / Butyl / TEF or two-layer septum Red Rubber / FEP
  For more demanding analyses: high purity Silicone / PTFE septa

Description	Dimensions (scale 1:2)	Pack of	REF

Crimp neck vials N 8



Type of vial	Usable volume	OD x height		
Clear, conical	0.2 mL	5.5 x 31.5 mm	100	**70286**
Clear, round bottom	0.3 mL	5.5 x 31.5 mm	100	**70282**
Clear, flat bottom	0.8 mL	8.2 x 30 mm	100	**70251**
Clear, conical	0.6 mL	7 x 40 mm	100	**70212**
Amber, conical	0.6 mL	7 x 40 mm	100	**70212.1**
Clear, flat bottom	0.7 mL	7 x 40 mm	100	**702002**
Amber, flat bottom	0.7 mL	7 x 40 mm	100	**702003**
Clear, flat bottom	1.2 mL	8.2 x 40 mm	100	**702880**

Ready assembled crimp closures N 8 and plain crimp caps N 8

70283	70252.1	702025	70289	702878	702800

Cap description	Septum description	Hardness	Thickness		
N 8 aluminium crimp cap, silver, center hole	PTFE virginal, white	53° shore D	0.25 mm	100	**70283**
N 8 aluminium crimp cap as above	Natural rubber / Butyl red-orange / TEF colorless	45° shore A	1.0 mm	100	**70252.1**
N 8 aluminium crimp cap as above	Red Rubber / FEP colorless	40° shore A	1.0 mm	100	**702025**
N 8 aluminium crimp cap as above	Silicone white / PTFE red	40° shore A	1.0 mm	100	**70289**
N 8 aluminium crimp cap as above	PTFE red / Silicone white / PTFE red	40° shore A	1.0 mm	100	**702878**
N 8 aluminium crimp cap as above	no liner	–	–	100	**702800**

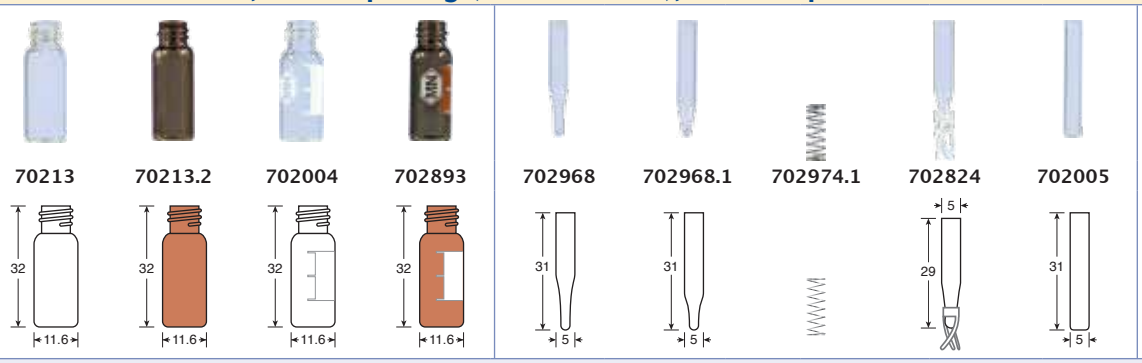
Crimping tools N 8

Manual crimper for 8 mm aluminium crimp caps	1	**735126**
Manual decapper for 8 mm aluminium crimp caps	1	**735408**

Screw neck vials and closures N 8

- Are among the oldest vials for HPLC and GC (besides crimp neck vials N 11)
- More and more replaced by screw neck vials N 9, which are easier to fill due to the wide opening compared to screw neck vials N 8 with small opening
- Due to the cap design not universally usable on all autosamplers in GC and HPLC – however, often used on instruments of VWR (Merck®) / Hitachi, Varian, Knauer, Gilson, Shimadzu and others
- In combination with closed top screw closures also used for sample storage (see page 92)

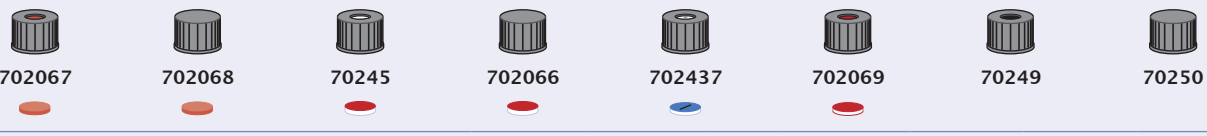
Screw neck vials N 8, small opening (8-425 thread), and compatible inserts



Type of vial	Usable volume	OD x height	Pack of	REF
Clear, flat bottom	1.5 mL	11.6 x 32 mm	100	**70213**
Amber, flat bottom	1.5 mL	11.6 x 32 mm	100	**70213.2**
Clear, flat bottom, label and scale	1.5 mL	11.6 x 32 mm	100	**702004**
Amber, flat bottom, label and scale	1.5 mL	11.6 x 32 mm	100	**702893**
Insert for small opening vials, clear, conical, 15 mm tip	0.1 mL	5 x 31 mm	100	**702968***
Insert for small opening vials, clear, conical, 9 mm tip	0.15 mL	5 x 31 mm	100	**702968.1***
Metal spring for conical inserts 5 x 31 mm	–	–	100	**702974.1**
Insert for small opening vials, clear, with plastic spring	0.1 mL	5 x 29 mm	100	**702824**
Insert for small opening vials, clear, flat bottom	0.25 mL	5 x 31 mm	100	**702005**
Micro-vial, clear, conical	1.1 mL	11.6 x 32 mm	100	**702860**

* Optionally you may use metal springs 702974.1 in combination with these products to push them up in the vial.

Ready assembled screw closures N 8 and plain screw caps N 8



Cap description	Septa description	Hardness	Thickness	Pack of	REF
N 8 PP screw cap, black, center hole	Red Rubber / FEP colorless	40° shore A	1.0 mm	100	**702067**
as above, but with closed top	Red Rubber / FEP colorless	40° shore A	1.0 mm	100	**702068**
N 8 PP screw cap, black, center hole	Silicone white / PTFE red	40° shore A	1.3 mm	100	**70245**
as above, but with closed top	Silicone white / PTFE red	40° shore A	1.3 mm	100	**702066**
N 8 PP screw cap, black, center hole	Silicone white / PTFE blue, slit	40° shore A	1.0 mm	100	**702437**
N 8 PP screw cap, black, center hole	PTFE red / Silicone white / PTFE red	40° shore A	1.0 mm	100	**702069**
N 8 PP screw cap, black, center hole	no liner	–	–	100	**70249**
as above, but with closed top	no liner	–	–	100	**70250**

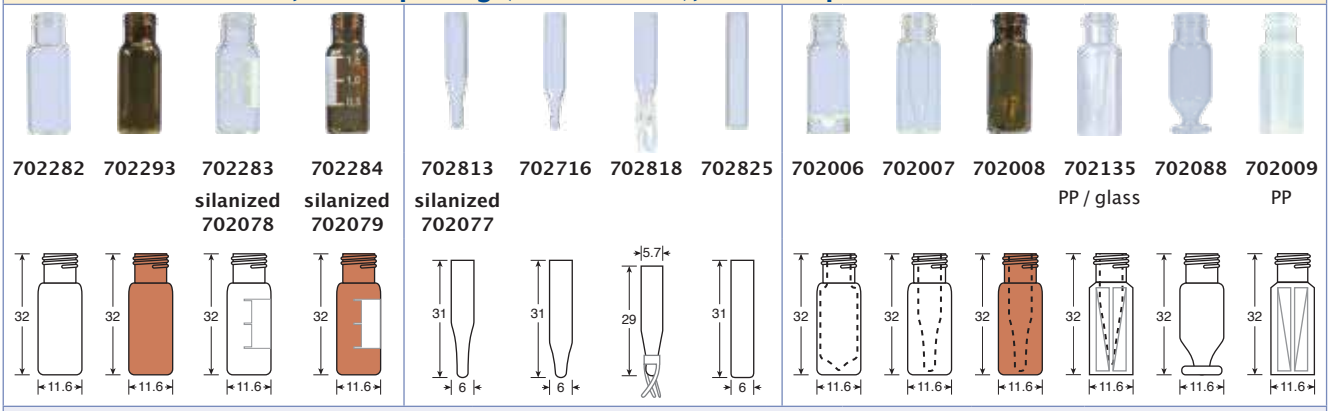
Screw neck vials, inserts, and closures N 9

Description	Dimensions (scale 1:2)			Pack of	REF
N 8 Septa for screw caps N 8					
Material	Illustration	Hardness	Thickness		
PTFE virginal, white		53° shore D	0.25 mm	100	**70261**
Red Rubber / FEP colorless		40° shore A	1.0 mm	100	**702070**
Silicone white / PTFE red		40° shore A	1.3 mm	100	**70248**
Silicone white / PTFE blue, slit		40° shore A	1.0 mm	100	**702481**

Screw neck vials and closures N 9

- Can be used on almost all HPLC and GC autosamplers
- Large range of vials and closures
- Also available as bonded closures (advantage: thick (blunt) HPLC needles cannot push the septum into the vial)
- Also available as convenient Vial Kits with 100 vials and 100 caps and as presealed vial-closure combinations

Description	Dimensions (scale 1:2)			Pack of	REF
Screw neck vials N 9, wide opening (short thread), and compatible inserts					



Type of vial	Usable volume	OD x height		
Clear, flat bottom	1.5 mL	11.6 x 32 mm	100	**702282**
Amber, flat bottom	1.5 mL	11.6 x 32 mm	100	**702293**
Clear, flat bottom, label and scale	1.5 mL	11.6 x 32 mm	100	**702283**
as above, silanized	1.5 mL	11.6 x 32 mm	100	**702078**
Amber, flat bottom, label and scale	1.5 mL	11.6 x 32 mm	100	**702284**
as above, silanized	1.5 mL	11.6 x 32 mm	100	**702079**
Insert for wide opening vials, clear, conical, 15 mm tip	0.2 mL	6 x 31 mm	100	**702813**
as above, silanized	0.2 mL	6 x 31 mm	100	**702077**
Insert for wide opening vials, clear, conical, 12 mm tip	0.25 mL	6 x 31 mm	100	**702716**
Insert for wide opening vials, clear, with plastic spring	0.1 mL	5.7 x 29 mm	100	**702818**
Insert for wide opening vials, clear, flat bottom	0.3 mL	6 x 31 mm	100	**702825**
Micro-vial, clear, 15 µL funnel in solid glass bottom	1.1 mL	11.6 x 32 mm	100	**702006**
Micro-vial, clear, with integrated 0.2 mL insert	0.2 mL	11.6 x 32 mm	100	**702007**
Micro-vial, amber, with integrated 0.2 mL insert	0.2 mL	11.6 x 32 mm	100	**702008**
Micro-vial, polypropylene, transparent, with integrated 0.15 mL glass insert, conical	0.15 mL	11.6 x 32 mm	100	**702135**
Micro-vial, clear, conical, with a round pedestal glass plate	1.1 mL	11.6 x 32 mm	100	**702088**
Micro-vial, polypropylene, transparent, with inner cone	0.3 mL	11.6 x 32 mm	100	**702009**

Bonded screw closures N 9 (septa firmly connected with the cap, cannot be removed)


702028


702026


702027

Cap description	Septa description	Hardness	Thickness		
N 9 PP bonded screw cap, blue, center hole	Red Rubber / TEF colorless	65° shore A	1.0 mm	100	**702028**
N 9 PP bonded screw cap, blue, center hole	Silicone beige / PTFE white	45° shore A	1.3 mm	100	**702026**
N 9 PP bonded screw cap, blue, center hole	Silicone beige / PTFE white, slit	45° shore A	1.3 mm	100	**702027**

Ready assembled screw closures N 9

702029


702031


702032

Cap description	Septa description	Hardness	Thickness		
N 9 PP screw cap, transparent, center hole	PTFE virginal, white	53° shore D	0.25 mm	100	**702029**
N 9 PP screw cap, blue, center hole	PTFE virginal, white	53° shore D	0.25 mm	100	**702031**
N 9 PP screw cap blue, closed top	PTFE virginal, white	53° shore D	0.25 mm	100	**702032**

702030


702732


702080


702081


702082


702033

N 9 PP screw cap, transparent, center hole	Red Rubber / FEP colorless	40° shore A	1.0 mm	100	**702030**
N 9 PP screw cap, blue, center hole	Red Rubber / FEP colorless	40° shore A	1.0 mm	100	**702732**
N 9 PP screw cap, black, center hole	Red Rubber / FEP colorless	40° shore A	1.0 mm	100	**702080**
N 9 PP screw cap, red, center hole	Red Rubber / FEP colorless	40° shore A	1.0 mm	100	**702081**
N 9 PP screw cap, green, center hole	Red Rubber / FEP colorless	40° shore A	1.0 mm	100	**702082**
N 9 PP screw cap blue, closed top	Red Rubber / FEP colorless	40° shore A	1.0 mm	100	**702033**

702287


702287.1


702036


702037


702038


702034


702107

N 9 PP screw cap, transparent, center hole	Silicone white / PTFE red	40° shore A	1.0 mm	100	**702287**
N 9 PP screw cap, blue, center hole	Silicone white / PTFE red	40° shore A	1.0 mm	100	**702287.1**
N 9 PP screw cap, black, center hole	Silicone white / PTFE red	40° shore A	1.0 mm	100	**702036**
N 9 PP screw cap, red, center hole	Silicone white / PTFE red	40° shore A	1.0 mm	100	**702037**
N 9 PP screw cap, green, center hole	Silicone white / PTFE red	40° shore A	1.0 mm	100	**702038**
N 9 PP screw cap, yellow, center hole	Silicone white / PTFE red	40° shore A	1.0 mm	100	**702107**
N 9 PP screw cap blue, closed top	Silicone white / PTFE red	40° shore A	1.0 mm	100	**702034**

702288


702288.1


702039


702040


702083


702109

N 9 PP screw cap, transparent, center hole	Silicone white / PTFE blue, slit	40° shore A	1.0 mm	100	**702288**
N 9 PP screw cap, blue, center hole	Silicone white / PTFE blue, slit	40° shore A	1.0 mm	100	**702288.1**
N 9 PP screw cap, black, center hole	Silicone white / PTFE blue, slit	40° shore A	1.0 mm	100	**702039**
N 9 PP screw cap, red, center hole	Silicone white / PTFE blue, slit	40° shore A	1.0 mm	100	**702040**
N 9 PP screw cap, green, center hole	Silicone white / PTFE blue, slit	40° shore A	1.0 mm	100	**702083**
N 9 PP screw cap, yellow, center hole	Silicone white / PTFE blue, slit	40° shore A	1.0 mm	100	**702109**

702286


702035


702084


702085

N 9 PP screw cap, transparent, center hole	PTFE red / Silicone white / PTFE red	40° shore A	1.0 mm	100	**702286**
N 9 PP screw cap, blue, center hole	as above	40° shore A	1.0 mm	100	**702035**
N 9 PP screw cap, red, center hole	as above	40° shore A	1.0 mm	100	**702084**
N 9 PP screw cap, green, center hole	as above	40° shore A	1.0 mm	100	**702085**

Screw neck vials, inserts, and closures N 9

Description	Dimensions (scale 1:2)			Pack of	REF
N 9 septa for screw caps N 9					
Material	Illustration	Hardness	Thickness		
PTFE virginal, white		53° shore D	0.25 mm	100	**702043**
Red Rubber / FEP colorless		40° shore A	1.0 mm	100	**702041**
Silicone white / PTFE red		40° shore A	1.0 mm	100	**702042**

Vial Kits screw neck N 9

Packs of 100 vials and 100 closures, each

Closure → / Vial ↓	702287.1	702288.1	702732	702026	702027
702282: 1.5 mL, clear, flat bottom	**702201**	**702204**	**702207**		
702283: 1.5 mL, clear, flat bottom, label and scale	**702202**	**702205**	**702208**	**702211**	**702213**
702284: 1.5 mL, amber, flat bottom, label and scale	**702203**	**702206**	**702209**	**702212**	**702214**
702009: 0.3 mL, PP, transparent, with inner cone		**702226**			

Other Vial Kits on request

Pre-sealed vial-closure combinations with screw neck N 9

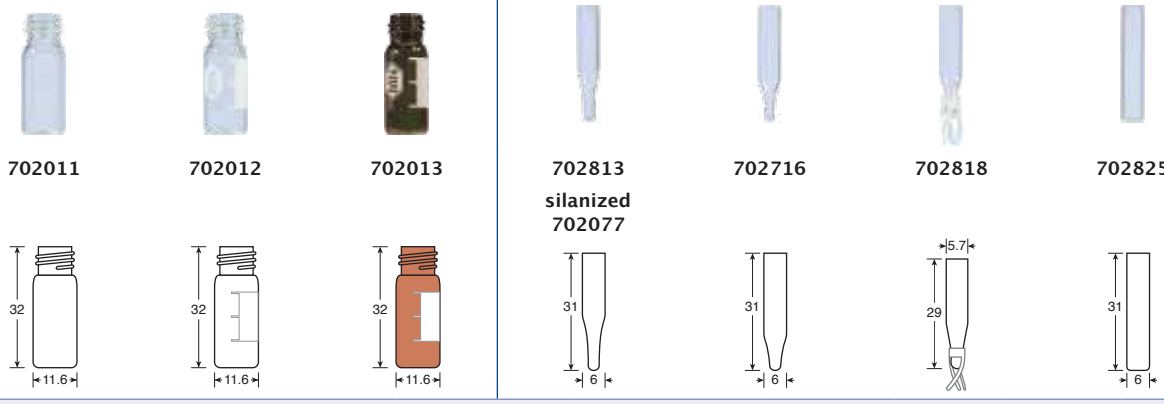
Vial description	Closure description	Pack of	REF
Pre-sealed vials 702282: 1.5 mL screw neck vial N 9, 11.6 x 32 mm, clear, flat bottom, wide opening	pre-screwed with 702732: N 9 PP screw cap, blue, center hole, Red Rubber / FEP colorless, 40° shore A, 1.0 mm	100	**702857**
Pre-sealed vials 702283: 1.5 mL screw neck vial N 9, 11.6 x 32 mm, clear, flat bottom, wide opening, label and scale	pre-screwed with 702732: N 9 PP screw cap, blue, center hole, Red Rubber / FEP colorless, 40° shore A, 1.0 mm	100	**702858**
Pre-sealed vials 702282: 1.5 mL screw neck vial N 9, 11.6 x 32 mm, clear, flat bottom, wide opening	pre-screwed with 702287.1: N 9 PP screw cap, blue, center hole, Silicone white / PTFE red, 40° shore A, 1.0 mm	100	**702874**
Pre-sealed vials 702283: 1.5 mL screw neck vial N 9, 11.6 x 32 mm, clear, flat bottom, wide opening, label and scale	pre-screwed with 702288.1: N 9 PP screw cap, blue, center hole, Silicone white / PTFE blue, slit, 40° shore A, 1.0 mm	100	**702863**
Pre-sealed vials 702284: 1.5 mL screw neck vial N 9, 11.6 x 32 mm, amber, flat bottom, wide opening, label and scale	pre-screwed with 702288.1: N 9 PP screw cap, blue, center hole, Silicone white / PTFE blue, slit, 40° shore A, 1.0 mm	100	**702873**

Other pre-sealed vial-closure combinations on request

Screw neck vials and closures N 10

- Wide opening for easy filling
- Due to the cap height not universally suitable for all instruments
- Often used on Waters®, Shimadzu, PerkinElmer and Jasco instruments

Screw neck vials N 10, wide opening (10–425 thread), and compatible inserts



			702813	702716	702818	702825
			silanized 702077			
702011	702012	702013				

Type of vial	Usable volume	OD x height	Pack of	REF
Clear, flat bottom	1.5 mL	11.6 x 32 mm	100	**702011**
Clear, flat bottom, label and scale	1.5 mL	11.6 x 32 mm	100	**702012**
Amber, flat bottom, label and scale	1.5 mL	11.6 x 32 mm	100	**702013**
Insert for wide opening vials, clear, conical, 15 mm tip	0.2 mL	6 x 31 mm	100	**702813**
as above, silanized	0.2 mL	6 x 31 mm	100	**702077**
Insert for wide opening vials, clear, conical, 12 mm tip	0.25 mL	6 x 31 mm	100	**702716**
Insert for wide opening vials, clear, with plastic spring	0.1 mL	5.7 x 29 mm	100	**702818**
Insert for wide opening vials, clear, flat bottom	0.3 mL	6 x 31 mm	100	**702825**

Screw closures N 10 and plain screw caps N 10

702044	702045	702046	702047	702048	702049

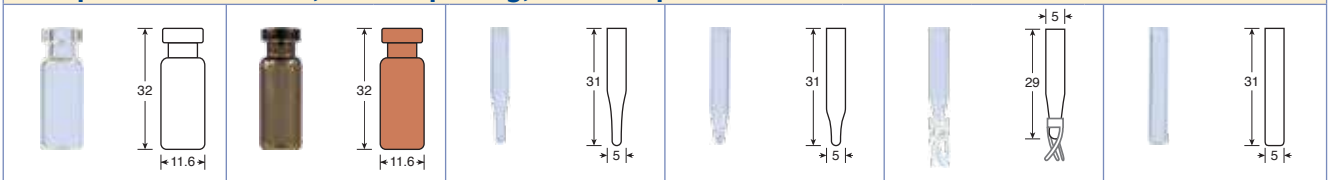
Cap description	Septa description	Hardness	Thickness	Pack of	REF
N 10 PP bonded screw cap*, black, center hole	Red Rubber / TEF colorless	65° shore A	1.0 mm	100	**702044**
N 10 PP bonded screw cap* as above	Silicone white / PTFE beige	45° shore A	1.5 mm	100	**702045**
N 10 PP bonded screw cap* as above	Silicone white / PTFE red	45° shore A	1.5 mm	100	**702046**
N 10 PP bonded screw cap* as above	Silicone white / PTFE blue, slit	45° shore A	1.5 mm	100	**702047**
* Septum firmly connected with the cap, cannot be removed					
N 10 PP screw cap, black, center hole	PTFE red / Silicone white / PTFE red	45° shore A	1.0 mm	100	**702048**
N 10 PP screw cap, black, center hole	no liner	–	–	100	**702049**

Crimp neck vials, inserts, and closures N 11

Crimp neck vials and closures N 11

- Broad variety of standard crimp neck vials (with small or wide opening), as well as crimp neck micro-vials for smaller sample volumes
- Economic closures: Natural rubber / TEF (2 layers), Natural rubber / Butyl / TEF (3 layers) and Red Rubber / FEP (2 layers)
- For more demanding analyses: analytically pure Silicone / PTFE septa with lower fragmentation
- Magnetic closure: REF 702879 for use on CTC GC PAL

Crimp neck vials N 11, small opening, and compatible inserts

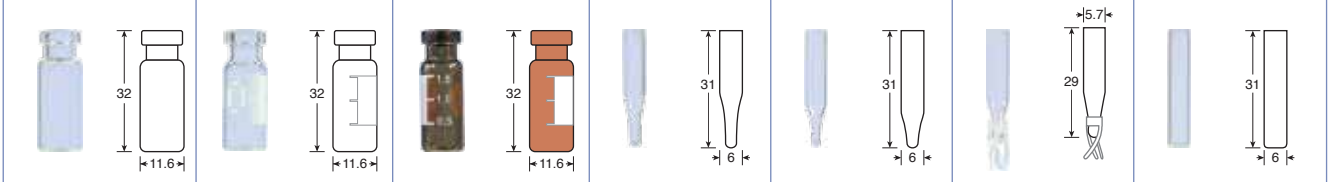


70201CG	70214CG	702968	702968.1	702824	702005

Type of vial	Usable volume	OD x height	Pack of	REF
Clear, flat bottom, small opening	1.5 mL	11.6 x 32 mm	100	**70201CG**
Amber, flat bottom, small opening	1.5 mL	11.6 x 32 mm	100	**70214CG**
Insert for small opening vials, clear, conical, 15 mm tip	0.1 mL	5 x 31 mm	100	**702968***
Insert for small opening vials, clear, conical, 9 mm tip	0.15 mL	5 x 31 mm	100	**702968.1***
Insert for small opening vials, clear, with plastic spring	0.1 mL	5 x 29 mm	100	**702824**
Insert for small opening vials, clear, flat bottom	0.25 mL	5 x 31 mm	100	**702005**

* Optionally you may use metal springs 702974.1 in combination with these products to push them up in the vial.

Crimp neck vials N 11, wide opening, and compatible inserts



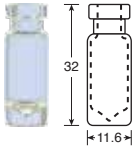
70201HP	702885 silanized 702075	702892 silanized 702076	702813 silanized 702077	702716	702818	702825

Type of vial	Usable volume	OD x height	Pack of	REF
Clear, flat bottom, wide opening	1.5 mL	11.6 x 32 mm	100	**70201HP**
Clear, flat bottom, wide opening, label and scale	1.5 mL	11.6 x 32 mm	100	**702885**
as above, silanized	1.5 mL	11.6 x 32 mm	100	**702075**
Amber, flat bottom, wide opening, label and scale	1.5 mL	11.6 x 32 mm	100	**702892**
as above, silanized	1.5 mL	11.6 x 32 mm	100	**702076**
Insert for wide opening vials, clear, conical, 15 mm tip	0.2 mL	6 x 31 mm	100	**702813**
as above, silanized	0.2 mL	6 x 31 mm	100	**702077**
Insert for wide opening vials, clear, conical, 12 mm tip	0.25 mL	6 x 31 mm	100	**702716**
Insert for wide opening vials, clear, with plastic spring	0.1 mL	5.7 x 29 mm	100	**702818**
Insert for wide opening vials, clear, flat bottom	0.3 mL	6 x 31 mm	100	**702825**

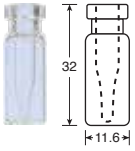
Crimp neck vials, inserts, and closures N 11

Description	Dimensions (scale 1:2)	Pack of	REF

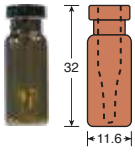
Crimp neck micro-vials N 11



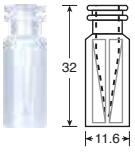
702888



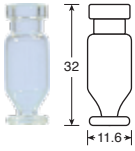
702891



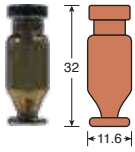
702014



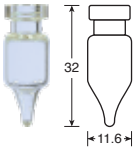
702134 PP / glass



702015



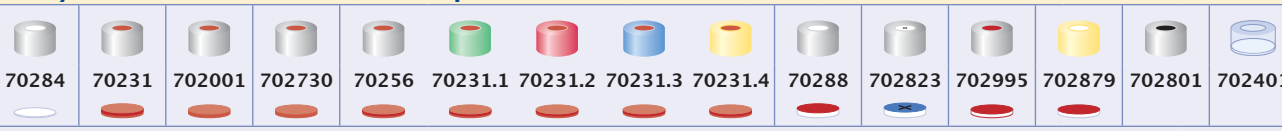
702016



702141

Type of vial	Usable volume	OD x height		
Micro-vial, clear, flat bottom 15 µL funnel in solid glass bottom	1.1 mL	11.6 x 32 mm	100	**702888**
Micro-vial, clear, with integrated 0.2 mL insert	0.2 mL	11.6 x 32 mm	100	**702891**
Micro-vial, amber, with integrated 0.2 mL insert	0.2 mL	11.6 x 32 mm	100	**702014**
Micro-vial, polypropylene, transparent, with integrated 0.15 mL glass insert, conical	0.15 mL	11.6 x 32 mm	100	**702134**
Micro-vial, clear, conical with round pedestal glass plate	1.1 mL	11.6 x 32 mm	100	**702015**
Micro-vial, amber, conical with round pedestal glass plate	1.1 mL	11.6 x 32 mm	100	**702016**
Micro-vial, clear, conical	1.1 mL	11.6 x 32 mm	100	**702141**

Ready assembled aluminium crimp closures N 11



Cap description	Septa description	Hardness	Thickness		
N 11 aluminium crimp cap, silver, center hole	PTFE virginal, white	53° shore D	0.25 mm	100	**70284**
N 11 crimp cap as above, silver	Natural rubber / Butyl red-orange / TEF colorless	45° shore A	1.3 mm	100	**70231**
N 11 crimp cap as above, silver	Natural rubber red-orange / TEF colorless (corresponds to Agilent quality)	60° shore A	1.0 mm	100	**702001**
N 11 crimp cap as above, silver	Red Rubber / FEP colorless	40° shore A	1.0 mm	100	**702730**
N 11 crimp cap as above, silver	Natural rubber / Butyl red-orange / TEF colorless	45° shore A	1.0 mm	100	**70256**
N 11 crimp cap as above, green	as above	45° shore A	1.0 mm	100	**70231.1**
N 11 crimp cap as above, red	as above	45° shore A	1.0 mm	100	**70231.2**
N 11 crimp cap as above, blue	as above	45° shore A	1.0 mm	100	**70231.3**
N 11 crimp cap as above, gold	as above	45° shore A	1.0 mm	100	**70231.4**
N 11 crimp cap as above, silver	Silicone white / PTFE red	40° shore A	1.3 mm	100	**70288**
N 11 crimp cap as above, silver	Silicone white / PTFE blue, cross-slit	40° shore A	1.5 mm	100	**702823**
N 11 crimp cap as above, silver	PTFE red / Silicone white / PTFE red	40° shore A	1.0 mm	100	**702995**
N 11 **magnetic** crimp cap, gold, center hole	Silicone white / PTFE red	55° shore A	1.0 mm	100	**702879**
N 11 aluminium crimp cap, silver, center hole	no liner	-	-	100	**702801**

N 11 PE cap, transparent, closed top, with thin piercing area	100	**702401**

N 11 Septa for crimp caps N 11

Material	Illustration	Hardness	Thickness		
PTFE virginal, white		53° shore D	0.25 mm	100	**70262**
Red Rubber / FEP colorless		40° shore A	1.0 mm	100	**702065**
Silicone white / PTFE red		40° shore A	1.3 mm	100	**70263**
PTFE red / Silicone white / PTFE red		40° shore A	1.0 mm	100	**70264**

Crimp neck vials, inserts, and closures N 11

Vial Kits crimp neck N 11

Packs of 100 vials and 100 closures, each

Closure → / Vial ↓	70288	702995	70256
70201HP: 1.5 mL, clear, flat bottom	**702215**	**702218**	**702222**
702885: 1.5 mL, clear, flat bottom, label and scale	**702216**	**702219**	**702223**
702892: 1.5 mL, amber, flat bottom, label and scale	**702217**	**702221**	**702224**

Other Vial Kits on request

Pre-sealed vial-closure combinations with crimp neck N 11

Vial description	Closure description	Pack of	REF
Pre-sealed vials 70201CG: 1.5 mL crimp neck vial N 11, 11.6 x 32 mm, clear, flat bottom, small opening	crimped with 70256: N 11 aluminium crimp cap, silver, center hole, Natural rubber / Butyl red-orange / TEF colorless, 45° shore A, 1.0 mm	100	**702881**
Pre-sealed vials 70201HP: 1.5 mL crimp neck vial N 11, 11.6 x 32 mm, clear, flat bottom, wide opening	crimped with 70256: N 11 aluminium crimp cap, silver, center hole, Natural rubber / Butyl red-orange / TEF colorless, 45° shore A, 1.0 mm	100	**702101HP**
Pre-sealed vials 702892: 1.5 mL crimp neck vial N 11, 11.6 x 32 mm, amber, flat bottom, wide opening, label and scale	crimped with 70256: N 11 aluminium crimp cap, silver, center hole, Natural rubber / Butyl red-orange / TEF colorless, 45° shore A, 1.0 mm	100	**702859**

Other pre-sealed vial-closure combinations on request

Crimping tools N 11

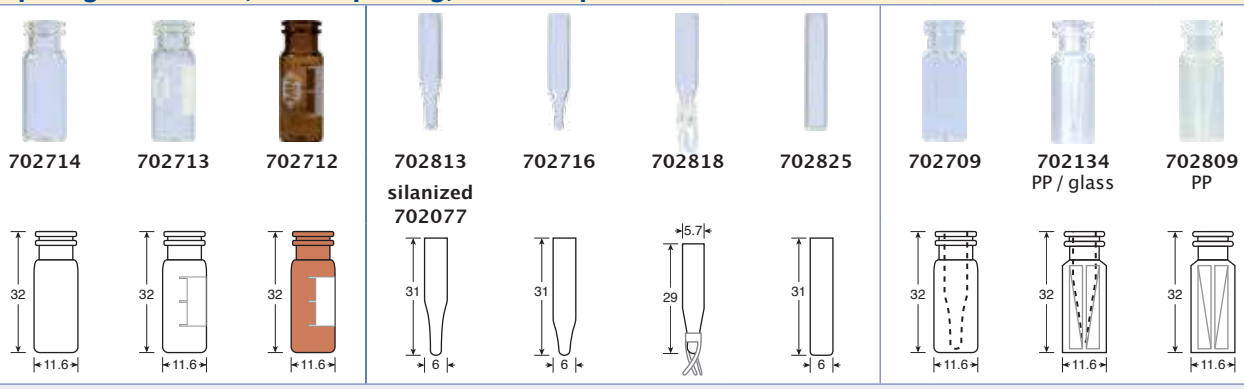
Description	Pack of	REF
Manual ergonomic crimper for 11 mm aluminium crimp caps	1	**735211**
Manual ergonomic decapper for 11 mm aluminium crimp caps	1	**735311**
Manual crimper, height adjustable, for 11 mm aluminium crimp caps	1	**735111**
Manual decapper for 11 mm aluminium crimp caps	1	**735911**
Pneumatic crimping tool for 11 mm aluminium crimp caps (complete with **hand switch**)	1	**735114**
Pneumatic crimping tool for 11 mm aluminium crimp caps (complete with **foot switch**)	1	**735117**
Crimping head N 11 (without pneumatic basic tool)	1	**735121**
Decapping head N 11 (without pneumatic basic tool)	1	**735434.1**
Pneumatic basic tool with **hand switch**	1	**735124**
Pneumatic basic tool with **foot switch**	1	**735125**

For more crimping tools N 11 see pages 100 and 101

Snap ring vials and closures N 11

- Quick, convenient sealing method which, however, should only be used in HPLC
- Can be used on all common HPLC autosamplers
- Alternatively crimp closures N 11 can be used (see preceding pages).
- 0.3 mL PP snap ring vial for special applications, e.g., in ion chromatography
- Most frequent closure: with cross-slit Silicone / PTFE septum, which supports easy penetration with the relatively thick, blunt HPLC needle

Snap ring vials N 11, wide opening, and compatible inserts



Description	Usable volume	OD x height	Pack of	REF
702714 Clear, flat bottom	1.5 mL	11.6 x 32 mm	100	**702714**
702713 Clear, flat bottom, label and scale	1.5 mL	11.6 x 32 mm	100	**702713**
702712 Amber, flat bottom, label and scale	1.5 mL	11.6 x 32 mm	100	**702712**
702813 Insert for wide opening vials, clear, conical, 15 mm tip	0.2 mL	6 x 31 mm	100	**702813**
silanized 702077 as above, silanized	0.2 mL	6 x 31 mm	100	**702077**
702716 Insert for wide opening vials, clear, conical, 12 mm tip	0.25 mL	6 x 31 mm	100	**702716**
702818 Insert for wide opening vials, clear, with plastic spring	0.1 mL	5.7 x 29 mm	100	**702818**
702825 Insert for wide opening vials, clear, flat bottom	0.3 mL	6 x 31 mm	100	**702825**
702709 Micro-vial, clear, with integrated 0.2 mL insert	0.2 mL	11.6 x 32 mm	100	**702709**
702134 PP / glass Micro-vial, polypropylene, transparent, with integrated 0.15 mL glass insert, conical	0.15 mL	11.6 x 32 mm	100	**702134**
702809 PP Micro-vial, polypropylene, transparent, with conical insert	0.3 mL	11.6 x 32 mm	100	**702809**

Snap ring vials, inserts, and closures N 11

Description	Dimensions (scale 1:2)	Pack of	REF

Ready assembled snap ring closures N 11

Cap description	Septa description	Hardness	Thickness		
N 11 PE snap ring cap, blue, center hole	Red Rubber / TEF colorless	65° shore A	1.0 mm	100	**702063**
as above, transparent cap	Red Rubber / TEF colorless	65° shore A	1.0 mm	100	**702731**
N 11 PE snap ring cap, blue, center hole	Silicone white / PTFE red	55° shore A	1.0 mm	100	**702710.1**
as above, transparent cap	Silicone white / PTFE red	55° shore A	1.0 mm	100	**702710**
N 11 PE snap ring cap, blue, center hole	Silicone white / PTFE blue, cross-slit	55° shore A	1.0 mm	100	**702717.2**
as above, transparent cap	Silicone white / PTFE blue, cross-slit	55° shore A	1.0 mm	100	**702064**
N 11 PE snap ring cap, blue, center hole	PTFE red / Silicone white / PTFE red	45° shore A	1.0 mm	100	**702718.1**
as above, transparent cap	PTFE red / Silicone white / PTFE red	45° shore A	1.0 mm	100	**702718**
N 11 PE cap, transparent, closed top, with thin piercing area				100	**702401**

Vial Kits snap ring N 11

Packs of 100 vials and 100 closures, each

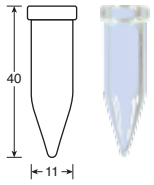
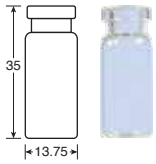
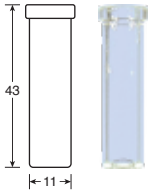
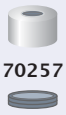
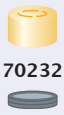
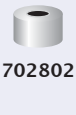
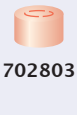
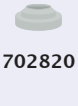
Closure → / Vial ↓	702710	702064	702731	702718
702714: 1.5 mL, clear, flat bottom	**702225**	**702228**	**702232**	**702235**
702713: 1.5 mL, clear, flat bottom, label and scale	**702719**	**702229**	**702233**	**702236**
702712: 1.5 mL, amber, flat bottom, label and scale	**702227**	**702231**	**702234**	**702237**

Other Vial Kits on request

Containers for screw neck vials N 8 / N 9 / N 10 as well as crimp neck and snap ring vials N 11

Description	Pack of	REF
81 position container blue for vials 11.6 x 32 mm, outer length 130 mm, outer width 130 mm, outer height 45 mm, coded, with transparent lid (suitable for freezers)	1	**702514**

Crimp neck vials and closures N 13

Description	Dimensions (scale 1:2)	Pack of	REF
Crimp neck vials N 13			
	 **70255**		
	 **70203**		
	 **70258**		
Type of vial	Usable volume	OD x height		
Clear, conical	1 mL	11 x 40 mm	100	**70255**
Clear, flat bottom	2 mL	13.75 x 35 mm	100	**70203**
Clear, flat bottom	2 mL	11 x 43 mm	100	**70258**
Ready assembled crimp closures N 13 and plain crimp caps N 13				
	 **70257**  **70232**  **702802**  **702803**  **702820**			
Cap description	Septa description	Hardness	Thickness		
N 13 aluminium crimp cap, silver, center hole	Butyl dark gray / PTFE gray (only centrically laminated, typically called Pharma-Fix)	50° shore A	2 mm	100	**70257**
N 13 aluminium center tear off cap, gold	Butyl dark gray / PTFE gray (only centrically laminated, typically called Pharma-Fix)	50° shore A	2 mm	100	**70232**
N 13 aluminium crimp cap, silver, center hole	no liner	–	–	100	**702802**
N 13 aluminium center tear off cap, coppery	no liner	–	–	100	**702803**
Stoppers N 13					
	N 13 Bromobutyl stopper, gray	45° shore A	–	100	**702820**

Crimping tools N 13		
Manual crimper, height adjustable, for 13 mm aluminium crimp caps	1	**735113**
Manual crimper, height adjustable, for 13 mm Flip Top/Flip Off caps	1	**735133**
Manual decapper for 13 mm aluminium crimp caps	1	**735913**

Containers for crimp and screw neck vials N 13

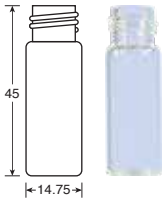
Description	Pack of	REF
49 position container blue for crimp and screw neck vials N 13, outer length 130 mm, outer width 130 mm, outer height 50 mm, with transparent lid (suitable for freezers)	1	**702515**

Screw neck vials, inserts, and closures N 13

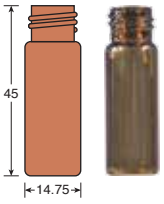
Screw neck vials and closures N 13

- Generally used for large volume samples in HPLC
- In combination with closed top screw closures suitable for sample storage (see page 92)
- Compatible insert requires metal spring for centrical alignment
- Range of ready assembled closures and plain caps with center hole or with closed top as well as separate septa (PTFE virginal, Red Rubber / FEP and Silicone / PTFE) are available.

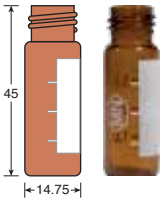
Screw neck vials N 13 (13-425 thread) and compatible insert



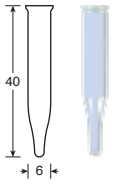
702962



702973



702089



702972

702974

Type of vial	Usable volume	OD x height		
Clear, flat bottom	4 mL	14.75 x 45 mm	100	**702962**
Amber, flat bottom	4 mL	14.75 x 45 mm	100	**702973**
Amber, flat bottom, label and scale	4 mL	14.75 x 45 mm	100	**702089**
Insert, clear, conical, metal spring required	0.3 mL	6 x 40 mm	100	**702972**
Metal spring for 702972	-	-	100	**702974**

Ready assembled screw closures and plain screw caps N 13

702103

702050

702051

702926

702052

702963

-

702966

-

Cap description	Septa description	Hardness	Thickness		
N 13 screw cap (13-425), green, closed top	F217 white / PTFE beige (firmly fixed)		1.5 mm	100	**702103**
N 13 PP screw cap, black, center hole	Red Rubber / FEP colorless	40° shore A	1.5 mm	100	**702050**
as above, but closed top	Red Rubber / FEP colorless	40° shore A	1.5 mm	100	**702051**
N 13 PP screw cap, black, center hole	Silicone white / PTFE red	40° shore A	1.3 mm	100	**702926**
as above, but closed top	Silicone white / PTFE red	40° shore A	1.3 mm	100	**702052**
N 13 PP screw cap, black, center hole	no liner	-	-	100	**702963**
as above, but closed top	no liner	-	-	100	**702966**

N 12 septa for screw caps N 13

Material	Illustration	Hardness	Thickness		
PTFE virginal, white		53° shore D	0.25 mm	100	**70260**
Red Rubber / FEP colorless		40° shore A	1.5 mm	100	**702053**
Silicone white / PTFE red		40° shore A	1.3 mm	100	**702292**

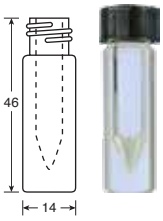
Micro reaction vials and closures

Description	Dimensions (scale 1:2)	Pack of	REF

Micro reaction vials with screw neck N 13 / N 20 and closures

N 13

702210

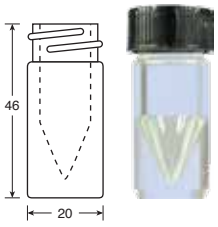


702220

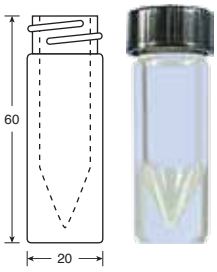
702926

702926

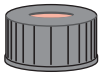
N 20



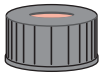
702230



702240



702280



702280

Micro reaction vials complete with screw caps and septa

Type of vial	Usable volume	OD x height		
Screw neck vials N 13 (13–425 thread), clear, with inner conical funnel in solid, flat glass bottom; complete with screw closure	0.25 mL	14 x 33 mm	1	**702210**
Screw neck vials N 13 (13–425 thread), clear, with inner conical funnel in solid, flat glass bottom; complete with screw closure	0.75 mL	14 x 46 mm	1	**702220**
Screw neck vials N 20 (20–400 thread), clear, with inner conical funnel in solid, flat glass bottom; complete with screw closure	3 mL	20 x 46 mm	1	**702230**
Screw neck vials N 20 (20–400 thread), clear, with inner conical funnel in solid, flat glass bottom; complete with screw closure	4.5 mL	20 x 60 mm	1	**702240**

Replacement screw caps with septa for micro reaction vials N 13 and N 20

Cap description	Septa description	Hardness	Thickness		
N 13 PP screw cap, black, center hole, assembled	Silicone white / PTFE red	40° shore A	1.3 mm	100	**702926**
N 20 phenolic screw cap, black, center hole (unassembled)	Butyl red / PTFE gray	55° shore A	1.4 mm	48	**702280**

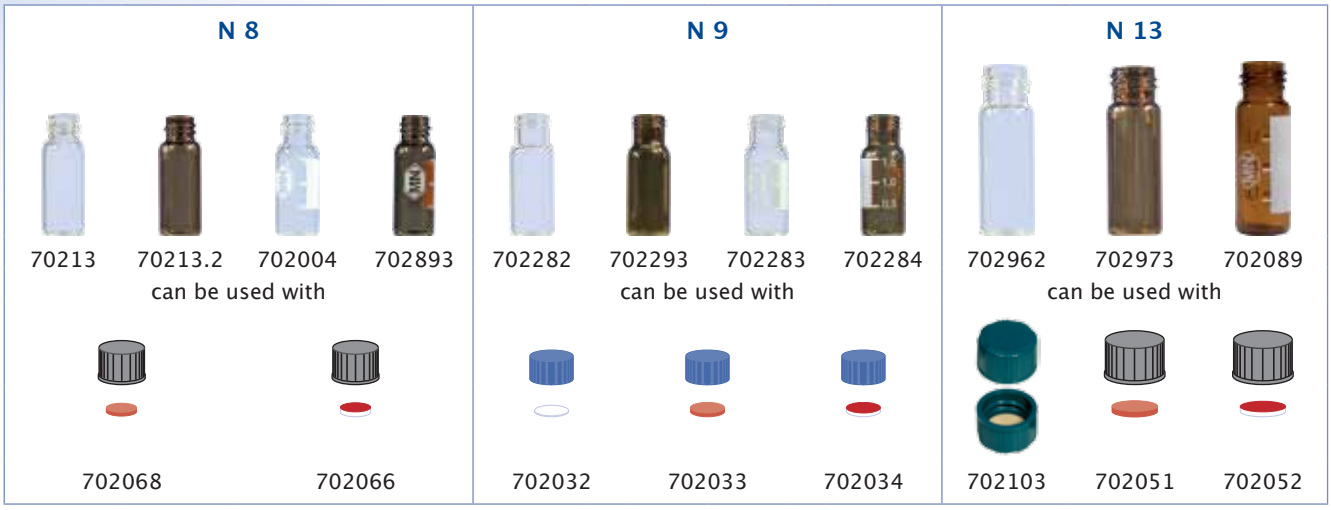
Replacement septa N 12 and N 18 for screw caps N 13 and N 20, respectively

Material	Illustration	Hardness	Thickness		
Silicone white / PTFE red		40° shore A	1.3 mm	100	**702292**
Butyl red / PTFE gray		55° shore A	1.4 mm	48	**702300**

Special vials and closures

Screw neck vials for storage of liquid samples

- Usable volumes of 1.5 up to 24 mL
- Available neck sizes N 8, N 9, N 13, N 15, N 18 and N 20
- Corresponding closed top screw closures with different septa materials



Description	Dimensions	Pack of	REF
Screw neck vials N 8, small opening (8-425 thread)			
Type of vial	Usable volume OD x height		
Clear, flat bottom	1.5 mL 11.6 x 32 mm	100	**70213**
Amber, flat bottom	1.5 mL 11.6 x 32 mm	100	**70213.2**
Clear, flat bottom, label and scale	1.5 mL 11.6 x 32 mm	100	**702004**
Amber, flat bottom, label and scale	1.5 mL 11.6 x 32 mm	100	**702893**
Closed top screw closures N 8			
Cap description	Septa description Hardness Thickness		
N 8 PP screw cap, black, closed top	Red Rubber / FEP colorless 40° shore A 1.0 mm	100	**702068**
N 8 PP screw cap, black, closed top	Silicone white / PTFE red 40° shore A 1.3 mm	100	**702066**
For drawings of vials see page 79			

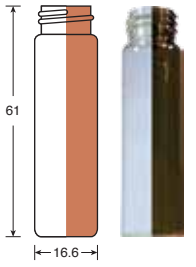
Description	Dimensions	Pack of	REF
Screw neck vials N 9, wide opening (short thread)			
Type of vial	Usable volume OD x height		
Clear, flat bottom	1.5 mL 11.6 x 32 mm	100	**702282**
Amber, flat bottom	1.5 mL 11.6 x 32 mm	100	**702293**
Clear, flat bottom, label and scale	1.5 mL 11.6 x 32 mm	100	**702283**
as above, silanized	1.5 mL 11.6 x 32 mm	100	**702078**
Amber, flat bottom, label and scale	1.5 mL 11.6 x 32 mm	100	**702284**
as above, silanized	1.5 mL 11.6 x 32 mm	100	**702079**
Closed top screw closures N 9			
Cap description	Septa description Hardness Thickness		
N 9 PP screw cap blue, closed top	PTFE virginal, white 53° shore D 0.25 mm	100	**702032**
N 9 PP screw cap blue, closed top	Red Rubber / FEP colorless 40° shore A 1.0 mm	100	**702033**
N 9 PP screw cap blue, closed top	Silicone white / PTFE red 40° shore A 1.0 mm	100	**702034**
For drawings of vials see page 80			

Description	Dimensions		Pack of	REF
Screw neck vials N 13 (13-425 thread)				
Type of vial	Usable volume	OD x height		
Clear, flat bottom	4 mL	14.75 x 45 mm	100	**702962**
Amber, flat bottom	4 mL	14.75 x 45 mm	100	**702973**
Amber, flat bottom, label and scale	4 mL	14.75 x 45 mm	100	**702089**
Closed top screw closures N 13				
Cap description	Septa description	Hardness / Thickness		
N 13 screw cap (13-425), green, closed top	F217 white / PTFE beige (firmly fixed)	1.5 mm	100	**702103**
N 13 PP screw cap, black, closed top	Red Rubber / FEP colorless	40° shore A / 1.5 mm	100	**702051**
N 13 PP screw cap, black, closed top	Silicone white / PTFE red	40° shore A / 1.3 mm	100	**702052**

For drawings of vials see page 90

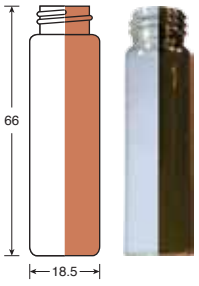
Description	Dimensions (scale 1:2)		Pack of	REF
Screw neck vials N 15, N 18, and N 20 for storage of liquid samples				

N 15



702096 / 702311

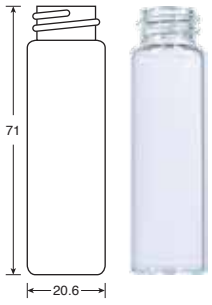
702104



70285 / 702097

702104

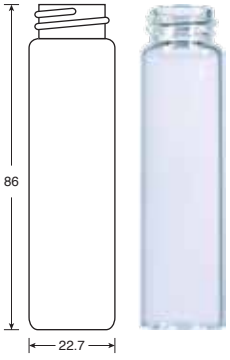
N 18



702098

702105

N 20



702099

702106

Type of vial	Usable volume	OD x height		
Screw neck vial N 15 (15-425 thread), clear, flat bottom	8 mL	16.6 x 61 mm	100	**702096**
Screw neck vial N 15 (15-425 thread), amber, flat bottom	8 mL	16.6 x 61 mm	100	**702311**
Screw neck vial N 15 (15-425 thread), clear, flat bottom	12 mL	18.5 x 66 mm	100	**70285**
Screw neck vial N 15 (15-425 thread), amber, flat bottom	12 mL	18.5 x 66 mm	100	**702097**
Screw neck vial N 18 (18-400 thread), clear, flat bottom	16 mL	20.6 x 71 mm	100	**702098**
Screw neck vial N 20 (20-400 thread), clear, flat bottom	24 mL	22.7 x 86 mm	100	**702099**
Closed top screw closures N 15, N 18, and N 20				
Cap description	Septa description	Thickness		
N 15 screw cap (15-425), green, closed top	F217 white / PTFE beige (firmly fixed)	1.5 mm	100	**702104**
N 18 screw cap (18-400), green, closed top	F217 white / PTFE beige (firmly fixed)	1.5 mm	100	**702105**
N 20 screw cap (20-400), green, closed top	F217 white / PTFE beige (firmly fixed)	1.5 mm	100	**702106**

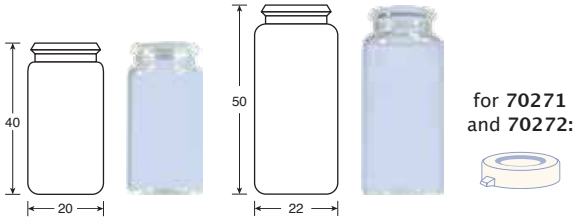
For screw neck vials with even larger volumes please see page 102.

Special vials and closures

Snap cap vials for storage of powdery samples

- Available sizes N 18 and N 22
- Usable volumes from 5 up to 25 mL
- Glass of 3rd hydrolytic class

Description	Dimensions (scale 1:2)	Pack of	REF
Snap cap vials N 18 and N 22 for storage of powdery samples			



70271 70272 70274 702019 70273 70275

Snap cap vials

Type of vial	Usable volume	OD x height	Pack of	REF
N 18, clear, flat bottom	5 mL	20 x 40 mm	100	**70271**
N 18, clear, flat bottom	10 mL	22 x 50 mm	100	**70272**
N 22, clear, flat bottom	15 mL	26 x 48 mm	100	**702019**
N 22, clear, flat bottom	25 mL	26 x 65 mm	100	**70273**

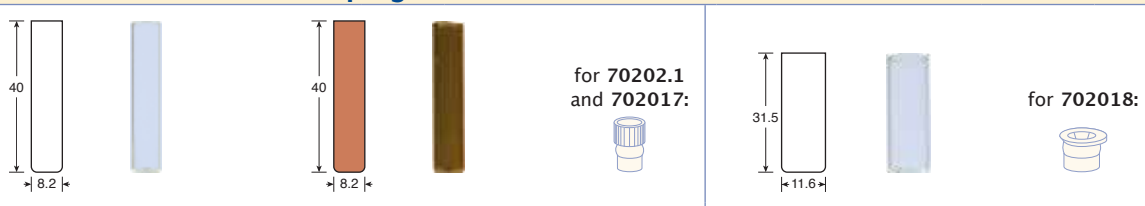
PE snap caps

N 18 PE snap cap, transparent, for 70271 and 70272			100	**70274**
N 22 PE snap cap, transparent, for 702019 and 70273			100	**70275**

Shell vials N 8 and N 12

- Economic combination of vials and closures for uncritical HPLC applications

Description	Dimensions (scale 1:2)	Pack of	REF
Shell vials N 8 and N 12 with PE plug			



70202.1 702017 702807 702018 702054

Shell vials

Type of vial	Usable volume	OD x height	Pack of	REF
N 8, clear, flat bottom	1 mL	8.2 x 40 mm	100	**70202.1**
N 8, amber, flat bottom	1 mL	8.2 x 40 mm	100	**702017**
N 12, clear, flat bottom	2 mL	11.6 x 31.5 mm	100	**702018**

PE plugs

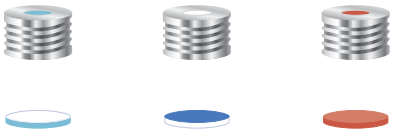
N 8 PE plug, transparent, for 70202.1 and 702017	100	**702807**
N 12 PE plug, transparent, for 702018	100	**702054**

Screw neck vials and magnetic screw closures N 18

- Headspace vials for convenient, safe and consistent handling
- High tightness and better reproducibility of the sealing process (as compared to crimping)
- Thinner septum (1.5 mm instead of 3 mm septum thickness in crimp caps), thus safe penetration of the needle and less fragmentation (especially important for SPME applications)
- Improved run in autosamplers with magnets (CTC Combi PAL and equivalent instruments), since a flat surface for the magnet is ensured, thus avoiding that the filled vial can drop from the magnet

Headspace screw neck vials N 18

702866 702826



702827 702055 702072

Type of vial	Usable volume	OD x height	Pack of	REF
Clear, rounded bottom	10 mL	22.5 x 46 mm	100	**702866**
Clear, rounded bottom	20 mL	22.5 x 75.5 mm	100	**702826**

Ready assembled, magnetic screw closures N 18

Cap description	Septa description	Hardness	Thickness	Pack of	REF
N 18 magnetic screw cap, silver, center hole	Silicone blue transparent / PTFE white	45° shore A	1.5 mm	100	**702827**
N 18 magnetic screw cap, silver, center hole	Silicone white / PTFE blue	55° shore A	1.5 mm	100	**702055**
N 18 magnetic screw cap, silver, center hole	Red Rubber / TEF colorless	65° shore A	1.5 mm	100	**702072**

N 17 septa for magnetic screw caps N 18

Material	Illustration	Hardness	Thickness	Pack of	REF
Silicone blue transparent / PTFE white		45° shore A	1.5 mm	100	**702981**
Silicone white / PTFE blue		55° shore A	1.5 mm	100	**702110**

Containers for screw neck vials N 18 and crimp neck vials N 20

Description	Pack of	REF
25 position container blue, with removable divider for headspace screw neck vials N 18 and crimp neck vials N 20; outer length 130 mm, outer width 130 mm, outer height 80 mm, with transparent lid (suitable for freezers)	1	**702516**

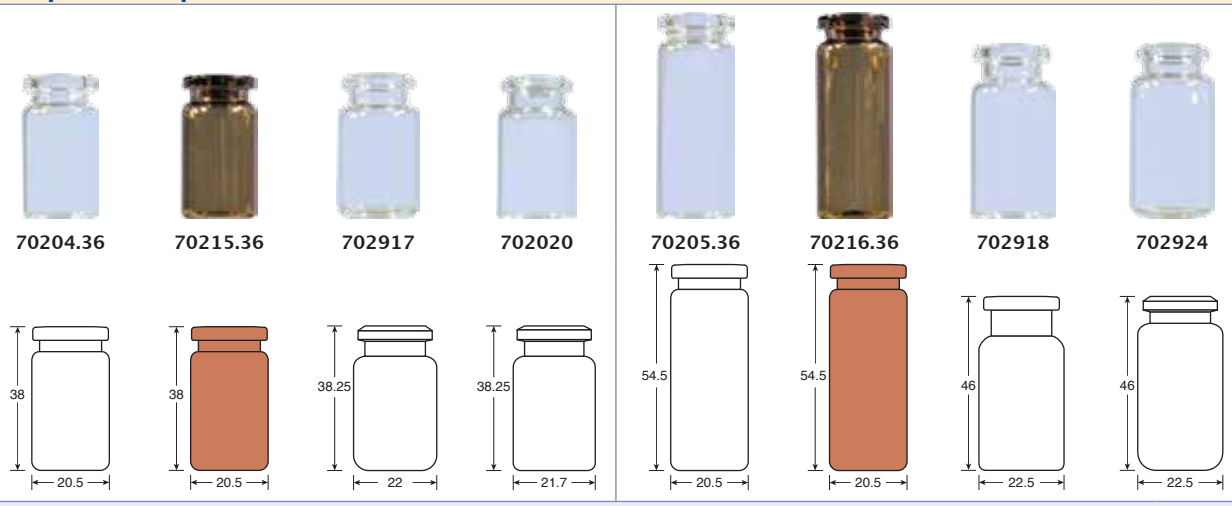
Crimp neck vials and closures N 20

Crimp neck vials and closures N 20

- Large range of Headspace crimp neck vials with different volumes and diameters
- Flat DIN crimp neck with stable bearing surface for the septum (especially suited for high vial pressures) as well as beveled HS crimp neck for instruments of certain manufacturers (PerkinElmer).
- Assignment to respective instrument manufacturers in parentheses
- Different types of crimp closures depending on instrument and application

Please consider our various crimping tools on page 100 and 101.

Headspace crimp neck vials N 20 (volume 5–10 mL)



Type of vial	Usable volume	OD x height	Pack of	REF
Clear, flat bottom, flat DIN crimp neck (Varian)	5 mL	20.5 x 38 mm	100	**70204.36**
Amber, flat bottom, flat DIN crimp neck (Varian)	5 mL	20.5 x 38 mm	100	**70215.36**
Clear, rounded bottom, beveled HS crimp neck (PerkinElmer)	6 mL	22.0 x 38.25 mm	100	**702917**
Clear, flat bottom, beveled HS crimp neck (Metrohm, Karl-Fischer titration)	5 mL	21.7 x 38.25 mm	100	**702020**
Clear, flat bottom, flat DIN crimp neck (Varian)	10 mL	20.5 x 54.5 mm	100	**70205.36**
Amber, flat bottom, flat DIN crimp neck (Varian)	10 mL	20.5 x 54.5 mm	100	**70216.36**
Clear, flat bottom, flat DIN crimp neck (Dani, Agilent)	10 mL	22.5 x 46 mm	100	**702918**
Clear, rounded bottom, beveled HS crimp neck (CTC)	10 mL	22.5 x 46 mm	100	**702924**

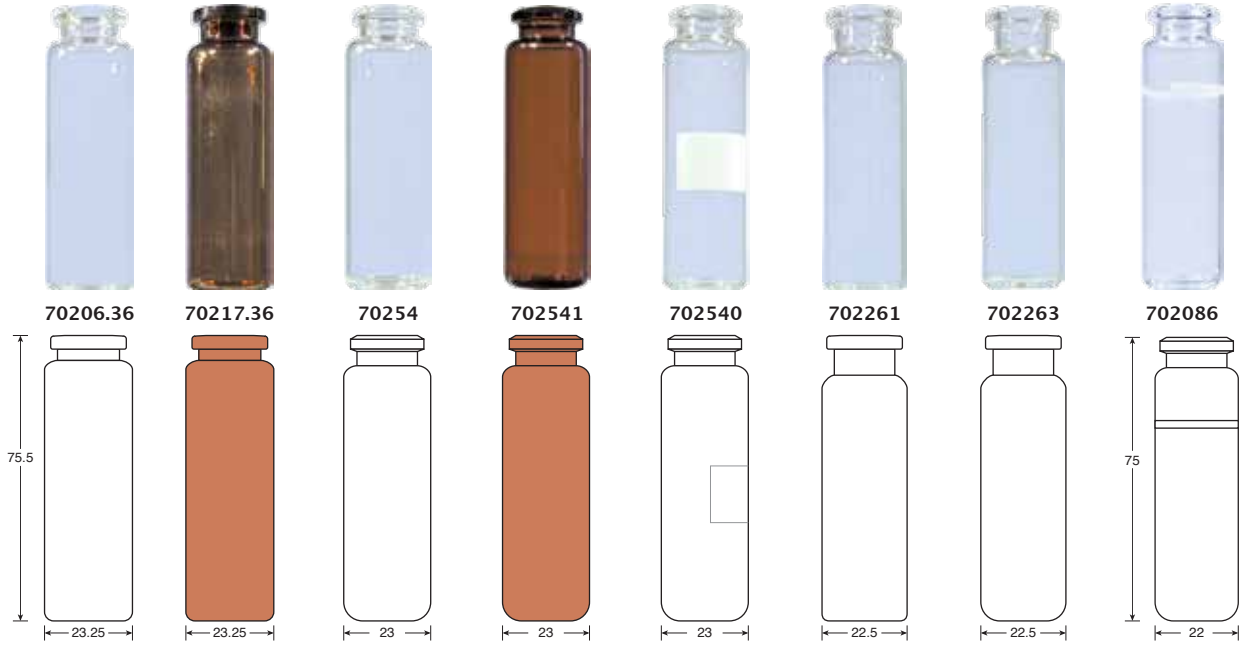
Crimping tools N 20

Manual ergonomic crimper for 20 mm aluminium crimp caps	1	**735220**
Manual ergonomic decapper for 20 mm aluminium crimp caps	1	**735320**
Manual crimper, height adjustable, for 20 mm aluminium crimp caps	1	**735120**
Manual crimper, height adjustable, for 20 mm Flip Top / Flip Off caps	1	**735132**
Manual decapper for 20 mm aluminium crimp caps	1	**735920**

For electronic crimping tools N 20 see page 101; pneumatic crimping tools are available on request.

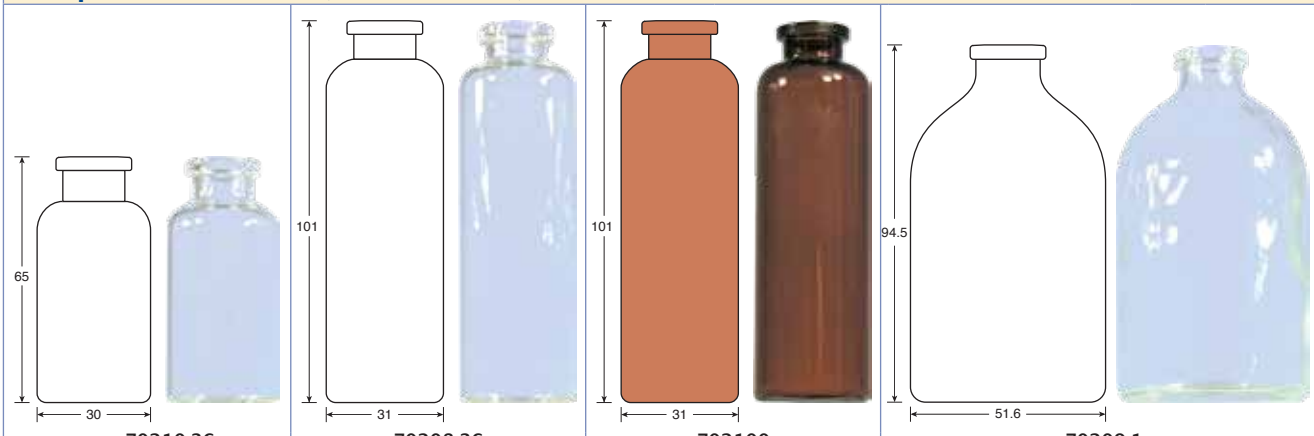
Description	Dimensions (scale 1:2)	Pack of	REF

Crimp neck vials N 20 (volume 20 mL)



Type of vial	Usable volume	OD x height		
Clear, flat bottom, flat DIN crimp neck	20 mL	23.25 x 75.5 mm	100	**70206.36**
Amber, flat bottom, flat DIN crimp neck	20 mL	23.25 x 75.5 mm	100	**70217.36**
Clear, rounded bottom, beveled HS crimp neck (PerkinElmer)	20 mL	23 x 75.5 mm	100	**70254**
Amber, rounded bottom, beveled HS crimp neck (PerkinElmer)	20 mL	23 x 75.5 mm	100	**702541**
Clear, rounded bottom, beveled HS crimp neck, label (PerkinElmer)	20 mL	23 x 75.5 mm	100	**702540**
Clear, flat bottom, flat DIN crimp neck (Dani, Agilent)	20 mL	22.5 x 75.5 mm	100	**702261**
Clear, rounded bottom, flat DIN crimp neck (CTC)	20 mL	22.5 x 75.5 mm	100	**702263**
Clear, rounded bottom, beveled HS crimp neck, graduation at 15 mL	20 mL	22 x 75 mm	100	**702086**

Crimp neck vials N 20 (volume > 20 mL)



Type of vial	Usable volume	OD x height		
Clear, flat bottom, flat DIN crimp neck	25 mL	30 x 65 mm	100	**70210.36**
Clear, flat bottom, flat DIN crimp neck	50 mL	31 x 101 mm	100	**70208.36**
Amber, flat bottom, flat DIN crimp neck	50 mL	31 x 101 mm	100	**702100**
Clear, flat bottom, flat DIN crimp neck (3rd hydrolytic class)	100 mL	51.6 x 94.5 mm	88	**70209.1**

Crimp neck vials and closures N 20

Center hole caps

Cap description	Septa description	Hardness	Thickness	Pack of	REF
N 20 aluminium crimp cap, silver, center hole	Butyl red / PTFE gray	50° shore A	3 mm	100	**702773**
as above	Butyl light gray / PTFE dark gray	50° shore A	3 mm	100	**702775**
as above	Molded septum Butyl / PTFE gray	50° shore A	3 mm	100	**70234.9**
as above	Butyl dark gray / PTFE gray*	50° shore A	3 mm	100	**70234**
N 20 aluminium crimp cap, **gold,** center hole	Butyl dark gray / PTFE gray*	50° shore A	3 mm	100	**702056**
N 20 aluminium crimp cap, silver, center hole	Butyl stopper gray, **unassembled** (separate parts)	37° shore A	–	100 each	**70237**
as above	Silicone blue transparent / PTFE colorless	40° shore A	3 mm	100	**702093**
as above	Silicone white / PTFE beige	40° shore A	3 mm	100	**702094**
as above	no liner	–	–	100	**702804**
N 20 aluminium crimp cap, **gold,** center hole	no liner	–	–	100	**702112**

Pressure release caps

with assembled septum	702836	702829	70234.8	702071	702927	702835	no liner 702799

N 20 aluminium pressure release cap, silver, center hole	Butyl red / PTFE gray	50° shore A	3 mm	100	**702836**
as above	Butyl light gray / PTFE dark gray	50° shore A	3 mm	100	**702829**
as above	Molded septum Butyl / PTFE gray	50° shore A	3 mm	100	**70234.8**
as above	Butyl dark gray / PTFE gray*	50° shore A	3 mm	100	**702071**
as above	Silicone blue transparent / PTFE colorless	40° shore A	3 mm	100	**702927**
as above	Silicone white / PTFE beige	40° shore A	3 mm	100	**702835**
as above	no liner	–	–	100	**702799**

Center tear off caps

70233	70236	70236.1	no liner

N 20 aluminium center tear off cap, gold	Butyl dark gray / PTFE gray*	50° shore A	3 mm	100	**70233**
N 20 aluminium center tear off cap, silver	Butyl stopper gray, **unassembled** (separate parts)	37° shore A	–	100 each	**70236**
N 20 aluminium center tear off cap, silver	no liner	–	–	100	**70236.1**

Complete tear off caps

70235	70238	702805	no liner

N 20 aluminium complete tear off cap, silver	Butyl dark gray / PTFE gray*	50° shore A	3 mm	100	**70235**
N 20 aluminium complete tear off cap, silver	Butyl stopper gray, **unassembled** (separate parts)	37° shore A	–	100 each	**70238**
N 20 aluminium complete tear off cap, silver	no liner	–	–	100	**702805**

* only centrically laminated, typically called Pharma-Fix

Crimp neck vials and closures N 20

Cap description	Septa description	Hardness	Thickness	Pack of	REF
Bi-metal crimp caps					
 with assembled septum	 702838	 702834	 702837	no liner 702833	
N 20 bi-metal crimp cap, blue / silver, center hole	Butyl light gray / PTFE dark gray	50° shore A	3 mm	100	**702838**
as above	Silicone blue transp. / PTFE colorless	40° shore A	3 mm	100	**702834**
as above	Silicone white / PTFE beige	40° shore A	3 mm	100	**702837**
as above	no liner	–	–	100	**702833**
Magnetic crimp caps					
 with assembled septum	 702774	 702928	 702928.9	 702929	no liner 702808
N 20 magnetic crimp cap, silver, 8 mm center hole	Butyl red / PTFE gray	50° shore A	3 mm	100	**702774**
as above	Butyl light gray / PTFE dark gray	50° shore A	3 mm	100	**702928**
as above	Butyl dark gray / PTFE gray*	50° shore A	3 mm	100	**702928.9**
as above	Silicone blue transp. / PTFE colorless	40° shore A	3 mm	100	**702929**
as above	no liner	–	–	100	**702808**

N 20 septa for crimp caps N 20					
Material	Illustration	Hardness	Thickness		
Butyl red / PTFE gray		50° shore A	3 mm	100	**70277**
Butyl light gray / PTFE dark gray		50° shore A	3 mm	100	**702057**
Molded septum Butyl / PTFE gray		50° shore A	3 mm	100	**702101**
Butyl dark gray / PTFE gray*		50° shore A	3 mm	100	**702D20TB**
Silicone blue transparent / PTFE colorless		40° shore A	3 mm	100	**702780**
Silicone white / PTFE beige		40° shore A	3 mm	100	**70278**
Silicone white / Aluminium foil silver		50° shore A	3 mm	100	**70279**

Stopper N 20					
Butyl gray		37° shore A	–	100	**702931**
Bromobutyl red		45° shore A	–	100	**702931.1**

* only centrically laminated, typically called Pharma-Fix

PE caps N 20

Description	Illustration	Hardness	Thickness	Pack of	REF
PE caps N 20					
height 8.4 mm	 **70266**  **702128**	height 9.1 mm	 **70267**  **702129**		
N 20 PE cap, transparent, for beveled HS crimp neck N 20, 4.3 mm center hole (no liner)				100	**70266**
as above, but with assembled septum natural rubber red-orange / TEF colorless, 45° shore A, 1.3 mm				100	**702128**
N 20 PE cap, transparent, for flat DIN crimp neck N 20, 4.3 mm center hole (no liner)				100	**70267**
as above, but with assembled septum natural rubber red-orange / TEF colorless, 45° shore A, 1.3 mm				100	**702129**

N 19 septa for PE caps N 20					
Butyl beige / PTFE gray		55° shore A	1.3 mm	100	**70269**
Natural rubber red-orange / TEF colorless		45° shore A	1.3 mm	100	**702904**

Manual crimping tools

Advanced ergonomic version

- **Available for 11 mm and 20 mm crimp caps**
  - More lightweighted than complete steel crimpers
  - Ergonomically designed handles
  - Adjustment by a knob on the crimping head that is easily accessible and visible
  - Activated by bottom handle motion only which allows a steadier and safer hold of the tool during crimping
  - Due to design and alignment of the crimping head better vertical clearance over the vial
- Advanced ergonomic decappers allow safe removal of caps; no adjustment required

Standard version

- **Available for 8, 11, 13, and 20 mm crimp caps**
  - Adjustable crimping height via hexagon key, which allows to move the inner part of the crimping head up and down (not possible for manual crimpers N 8)
  - Crimping pressure adjustable via screw in the handle
  - Manual crimpers for N 13 and N 20 Flip Top / Flip Off caps (pharmaceutical closures) available
  - Long life time and convenient handling
- Manual decappers (standard version) allow safe removal of caps; no adjustment required

Description	Pack of	REF
Manual crimpers (ergonomic) (crimping pressure adjustable by knob on the crimping head)		
Manual ergonomic crimper for 11 mm aluminium crimp caps	1	**735211**
Manual ergonomic crimper for 20 mm aluminium crimp caps	1	**735220**
Manual decappers (ergonomic)		
Manual ergonomic decapper for 11 mm aluminium crimp caps	1	**735311**
Manual ergonomic decapper for 20 mm aluminium crimp caps	1	**735320**

Manual crimpers (standard)		
Manual crimper for 8 mm aluminium crimp caps	1	**735126**
Manual crimper, height adjustable, for 11 mm aluminium crimp caps	1	**735111**
Manual crimper, height adjustable, for 13 mm aluminium crimp caps	1	**735113**
Manual crimper, height adjustable, for 13 mm Flip Top / Flip Off caps	1	**735133**
Manual crimper, height adjustable, for 20 mm aluminium crimp caps	1	**735120**
Manual crimper, height adjustable, for 20 mm Flip Top / Flip Off caps	1	**735132**
Manual decappers (standard)		
Manual decapper for 8 mm aluminium crimp caps	1	**735408**
Manual decapper for 11 mm aluminium crimp caps	1	**735911**
Manual decapper for 13 mm aluminium crimp caps	1	**735913**
Manual decapper for 20 mm aluminium crimp caps	1	**735920**

Electronic crimping tools

Battery-powered electronic crimping tools

for 11 mm and 20 mm aluminium crimp caps (not suitable for 20 mm magnetic / bi-metal crimp caps)

- Mobile tools for consistent and reproducible crimping results
  - Crimping pressure adjustable by pushing +/- buttons of the control unit on top of the tool
  - Long lasting lithium ion cell batteries (full battery charge for several hundred vials, life time of battery > 1500 charges)
  - CE certificate of conformity along with one year warranty
  - One tool each necessary for crimping and for decapping

Electronic high power crimping tool

for 11 mm and 20 mm crimp caps (also suitable for magnetic / bi-metal crimp caps)

- Due to a more powerful motor also suitable for magnetic and bi-metal crimp caps
  - Fixed power supply
  - Exchangeable crimping / decapping heads
  - Digital LED display of crimp settings; different jaw settings can be stored in separate programs
  - CE certificate of conformity along with one year warranty
  - For more convenient handling a stand is optionally available

Description	Pack of	REF
Electronic crimpers (battery-powered)		
Electronic crimper for 11 mm aluminium crimp caps	1	**735511**
Electronic crimper for 20 mm aluminium crimp caps (not suitable for magnetic / bi-metal crimp caps)	1	**735520**
Electronic decappers (battery-powered)		
Electronic decapper for 11 mm aluminium crimp caps	1	**735611**
Electronic decapper for 20 mm aluminium crimp caps (not suitable for magnetic / bi-metal crimp caps)	1	**735620**
Accessories for battery-powered electronic crimping/decapping tools		
Replacement battery 6.4 Volt, 8.6 Wh		**735500**

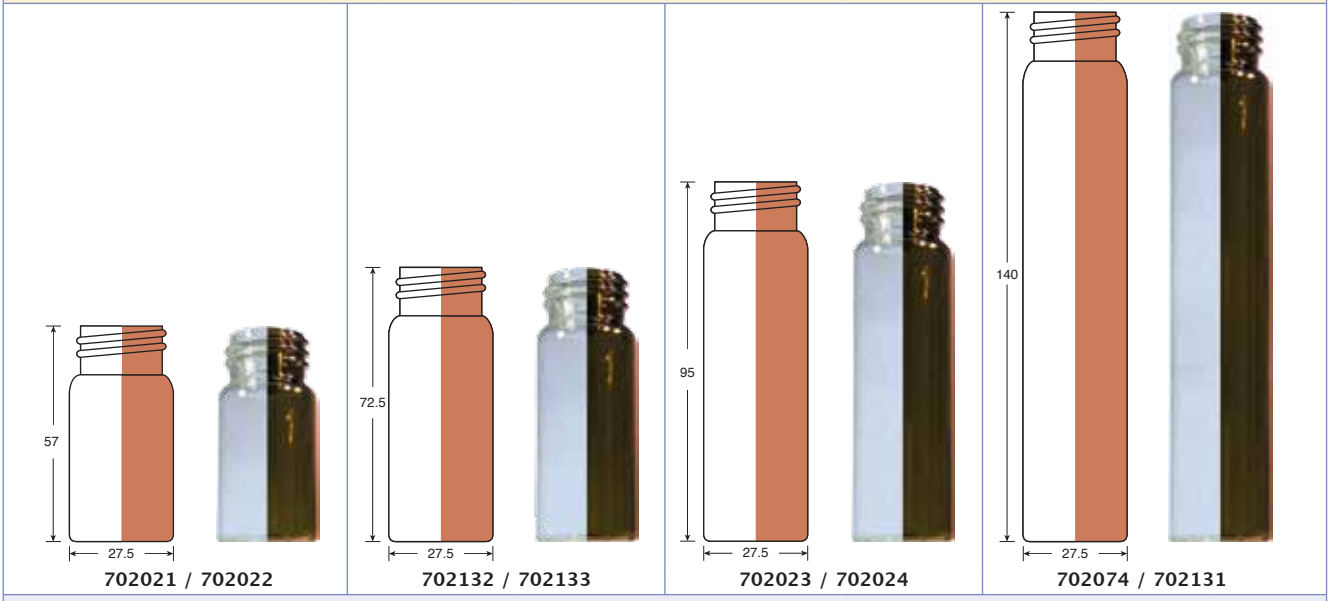
Electronic high power crimping tool		
Electronic high power crimping tool with power supply (exchangeable crimping / decapping heads separately available)	1	**735700**
Accessories for 735700		
Crimping head for 11 mm crimp caps (for electronic high power crimping tool 735700)	1	**735711**
Crimping head for 20 mm crimp caps (aluminium, magnetic, bi-metal) (for electronic high power crimping tool 735700)	1	**735720**
Decapping head for 11 mm crimp caps (for electronic high power crimping tool 735700)	1	**735811**
Decapping head for all 20 mm crimp caps (for electronic high power crimping tool 735700)	1	**735820**
Stand for electronic crimping tools	1	**735501**

Screw neck vials and closures N 24

Screw neck vials and closures N 24 (EPA)

- Recommended for VOC and TOC analyses
- Closed top screw closures for sample storage
- Most frequently used: 40 mL clear glass
- Often called EPA vials, since they are defined in the regulations of the US Environmental Protection Agency
- Due to their size mainly used as bonded closure for a firm fit of the septum
- Recommended for environmental analysis: screw closure with center hole and Silicone / PTFE septum

Description	Dimensions (scale 1:2)	Pack of	REF
Screw neck vials N 24 (EPA)			

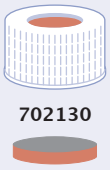


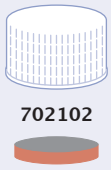
702021 / 702022 | **702132 / 702133** | **702023 / 702024** | **702074 / 702131**

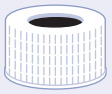
Type of vial	Usable volume	OD x height	Pack of	REF
Clear, flat bottom	20 mL	27.5 x 57 mm	100	**702021**
Amber, flat bottom	20 mL	27.5 x 57 mm	100	**702022**
Clear, flat bottom	30 mL	27.5 x 72.5 mm	100	**702132**
Amber, flat bottom	30 mL	27.5 x 72.5 mm	100	**702133**
Clear, flat bottom	40 mL	27.5 x 95 mm	100	**702023**
Amber, flat bottom	40 mL	27.5 x 95 mm	100	**702024**
Clear, flat bottom	60 mL	27.5 x 140 mm	100	**702074**
Amber, flat bottom	60 mL	27.5 x 140 mm	100	**702131**

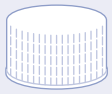
Description	Dimensions (scale 1:2)	Pack of	REF

Screw closures N 24, plain screw caps N 24 and single septa N 22









Cap description	Septum description	Hardness	Thickness		
N 24 PP bonded* screw cap, white, center hole	Silicone white / PTFE beige	45° shore A	3.2 mm	100	**702058**
as above, but closed top	Silicone white / PTFE beige	45° shore A	3.2 mm	100	**702059**
N 24 PP bonded* screw cap, white, center hole	Red Rubber / TEF colorless	65° shore A	2.5 mm	100	**702073**
* Septum firmly connected with the cap, cannot be removed					
N 24 PP screw cap, white, center hole	Butyl red / PTFE gray	50° shore A	2.4 mm	100	**702130**
as above, but closed top	Butyl red / PTFE gray	50° shore A	2.4 mm	100	**702102**
N 24 PP screw cap, white, center hole	no liner			100	**702060**
as above, but closed top	no liner			100	**702061**
N 22 septum, Silicone natural / PTFE beige		45° shore A	3.2 mm	100	**702062**
N 22 septum, Butyl red / PTFE gray		50° shore A	2.4 mm	100	**702791**

Autosampler compatibility

Agilent

Application / Type of vial	Most popular MN products fur use on Agilent instruments			Page
GC:	Vials:	Inserts:	Closures:	
N 8 crimp (microsampling)	**70282, 70286**		**70289**	78
N 9 screw (standard samples)	**702282, 702293, 702283, 702284, 702006, 702078, 702079, 702007, 702008, 702088**	**702813, 702818, 702825, 702077**	**702732, 702082, 702081, 702080, 702287.1, 702038, 702037, 702035, 702085, 702084, 702028, 702026**	80
N 11 crimp (standard samples)	**70201HP, 702885, 702892, 702888, 702075, 702076, 702891, 702014, 702015, 702016**	**702813, 702818, 702825, 702077**	**70256, 70231.3, 70231.1, 70231.2, 702001, 702730, 70288, 702995, 702879** (for GC PAL)	84
HPLC:				
N 9 screw (standard samples)	As indicated under GC, but additionally the following closures with slit septum: **702288.1, 702083, 702040, 702027**			80
N 11 crimp (standard samples)	As indicated under GC, but additionally the following closure with slit septum: **702823**			84
N 11 snap ring (standard samples)	**702714, 702713, 702712, 702709**	**702813, 702818, 702825, 702077**	**702063, 702731, 702710.1, 702064, 702718, 702401**	87
Headspace:	Vials:		Closures:	
N 18 screw (Combi PAL + G 1888A)	**702866, 702826**		**702055**	95
N 20 crimp	**702918, 702261, 702263**		**70234, 702094, 702093, 702071, 702835, 702927**	96

Autosampler compatibility

CTC

Application / Type of vial	Most popular MN products for use on CTC instruments			Page
GC:	Vials:	Inserts:	Closures:	
N 8 crimp (microsampling)	**70282, 70286, 70212, 70212.1, 702002, 702003**		**70289, 702878**	78
N 9 screw (standard samples)	**702282, 702293, 702283, 702284, 702006, 702078, 702079**	**702813, 702818, 702825, 702077**	**702287.1, 702035, 702026, 702027**	80
N 11 crimp (standard samples)	**70201HP, 702885, 702892, 702888, 702075, 702076**	**702813, 702818, 702825, 702077**	**702879 (for GC PAL), 70288, 702995**	84
HPLC:				
N 9 screw (standard samples)	As indicated under GC, but additionally the following closures with slit septum: **702288.1, 702027**			80
N 11 crimp (standard samples)	**70201HP, 702885, 702892, 702888, 702075, 702076**	**702813, 702818, 702825, 702077**	**70288, 702995, 702823**	84
N 11 snap ring (standard samples)	**702714, 702713, 702712**	**702813, 702818, 702825, 702077**	**702710.1, 702717.2, 702718.1**	87
Headspace:				
N 18 screw (Combi PAL)	**702866, 702826**		**702055, 702827**	95
N 20 crimp	**702924, 702263**		**702929, 702834**	96

Dionex

Application / Type of vial	Most popular MN products for use on Dionex instruments			Page
HPLC:	Vials:	Inserts:	Closures:	
N 8 screw (microsampling)	**702880, 70286, 70282**		**702025, 70289**	78
N 8 screw (standard samples)	**70213, 70213.2, 702004, 702893, 702860**	**702968, 702824, 702005**	**70245, 702437**	79
N 9 screw (standard samples)	**702282, 702293, 702283, 702284, 702006, 702078, 702079, 702007, 702008**	**702813, 702818, 702825, 702077**	**702287.1, 702288.1, 702026, 702027**	80
N 11 crimp (standard samples)	**70201HP, 702885, 702892, 702888, 702075, 702076, 702891, 702014**	**702813, 702818, 702825, 702077**	**70288, 702823, 70256**	84
N 11 snap ring (standard samples)	**702714, 702713, 702712, 702709**	**702813, 702818, 702825, 702077**	**702710.1, 702717.2**	87
IC:				
N 9 screw	**702009**		**702288.1, 702027**	80

PerkinElmer

Application / Type of vial	Most popular MN products for use on PerkinElmer instruments			Page
GC:	Vials:	Inserts:	Closures:	
N 8 crimp (microsampling)	**70251, 70286**		**70252.1, 70283, 702025**	78
N 9 screw (standard samples)	**702282, 702293, 702283, 702284, 702078, 702079**	**702818, 702825**	**702732, 702287.1, 702026, 702028**	80
N 10 screw (standard samples)	**702012, 702013**	**702818, 702825**	**702045, 702046**	83
N 11 crimp (standard samples)	**70201CG***, **70214CG***	**702824*, 702005***	**70256, 702730, 70231.1, 70231.2, 70231.3, 70288, 702995**	84
(* small opening; ** wide opening)	**70201HP**, 702885**, 702892**, 702888**, 702075**, 702076****	**702818**, 702825****		84
HPLC:				
N 8 crimp (microsampling)	**70286**		**70252.1, 702025**	78
N 9 screw (standard samples)	As indicated under GC, but additionally the following closures with slit septum: **702288.1, 702027**			80
N 10 screw (standard samples)	As indicated under GC, but additionally the following closure with slit septum: **702047**			83
N 11 crimp (standard samples)	As indicated under GC, but additionally the following closure with slit septum: **702823**			84
N 11 snap ring (standard samples)	**702714, 702713, 702712**	**702818, 702825**	**702064, 702718, 702710, 702401**	87
Headspace:				
N 18 screw (CTC Combi PAL + TurboMatrix™ HS 16 + 40)	**702866, 702826**		**702055, 702827, 702072**	95
N 20 crimp (CTC Combi PAL)	**702924, 702263**		**702929, 702834, 702928.9, 702928, 702774**	96
N 20 crimp (TurboMatrix™ HS 16, 40 + 110) *** not suited for TurboMatrix™ 110	**702917***, 70254, 702540, 702541**		**702829, 702836, 702071, 70234.8, 702835, 702927, 702775, 702773, 70234, 70234.9, 702093, 702094, 70237, 702931**	96

Autosampler compatibility

Shimadzu

Application / Type of vial	Most popular MN products for use on Shimadzu instruments			Page
GC:	Vials:	Inserts:	Closures:	
N 8 crimp (microsampling)	**70282, 70286, 70212, 70212.1, 702002, 702003**		**70289, 702878**	78
N 9 screw (standard samples)	**702282, 702293, 702283, 702284, 702006, 702078, 702079, 702007, 702008**	**702813, 702818, 702825, 702077**	**702287.1, 702035, 702026**	80
N 10 screw (standard samples)	**702011, 702012, 702013**	**702813, 702818, 702825, 702077**	**702045, 702046, 702048**	83
N 11 crimp (standard samples)	**70201HP, 702885, 702892, 702888, 702075, 702076, 702891, 702014**	**702813, 702818, 702825, 702077**	**702879** (for AOC5000), **70288, 702995**	84
N 13 screw (large volume samples)	**702962, 702973, 702089**	**702972** + spring **702974**	**702926**	90
HPLC:				
N 8 crimp (microsampling)	**70282, 70286**		**702025, 70289, 702878**	78
N 9 screw (standard samples)	**702282, 702293, 702283, 702284, 702006, 702078, 702079, 702009, 702007, 702008**	**702813, 702818, 702825, 702077**	**702287.1, 702037, 702038, 702036, 702026, 702288.1, 702040, 702083, 702039, 702027, 702031**	80
N 10 screw (standard samples)	**702011, 702012, 702013**	**702813, 702818, 702825, 702077**	**702045, 702046, 702047**	83
N 11 crimp (standard samples)	**70201HP, 702885, 702892, 702888, 702141, 702075, 702076, 702891, 702014**	**702813, 702818, 702825, 702077**	**702730, 70288, 702823**	84
N 11 snap ring (standard samples)	**702714, 702713, 702712, 702809**	**702813, 702818, 702825, 702077**	**702064, 702717.2, 702710, 702710.1**	87
N 8 + N 11 shell vials (standard samples)		Vials + closures:	**70202.1** + **702807**, **702017** + **702807**, **702018** + **702054**	94
Headspace:				
N 18 screw (AOC 5000)	**702866, 702826**		**702055, 702827**	95
N 20 crimp (AOC 5000)	**702924, 702263**		**702929, 702834, 702928, 702774**	96
N 20 crimp (HT200H)	**702918, 702263**		**702094, 702093**	96

Thermo Scientific

Application / Type of vial	Most popular MN products for use on Thermo Scientific instruments			Page
GC:	Vials:	Inserts:	Closures:	
N 8 crimp (microsampling)	**70251, 70282, 70286, 702880, 70212, 70212.1, 702002, 702003**		**70252.1, 702025, 70289, 702878**	78

Autosampler compatibility

Application / Type of vial	Most popular MN products for use on Thermo Scientific instruments			Page
N 8 screw (standard samples)	70213, 70213.2, 702004, 702893, 702860	702968, 702968.1, 702824, 702005	702067, 70245, 702069	79
N 9 screw (standard samples)	702282, 702293, 702283, 702284, 702006, 702078, 702079, 702007, 702008	702813, 702818, 702716, 702825, 702077	702732, 702287.1, 702035, 702026	80
N 11 crimp (standard samples)	70201HP, 702885, 702892, 702888, 702141, 702075, 702076, 702891, 702014	702813, 702818, 702716, 702825, 702077	702879 (GC PAL), 702001, 70256, 702730, 70288, 702995	84
HPLC:				
N 8 crimp (microsampling)	70282, 70286, 702880, 70212, 70212.1, 702002, 702003		70252.1, 702025, 70289, 702878	78
N 8 screw (standard samples)	As indicated under GC			79
N 9 screw (standard samples)	As indicated under GC			80
N 11 crimp (standard samples)	As indicated under GC, however, not closure 702879			84
N 11 snap ring (standard samples)	702714, 702713, 702712, 702809	702813, 702818, 702716, 702825, 702077	702064, 702717.2, 702710, 702710.1, 702731, 702063	87
Headspace:				
N 18 screw (Combi PAL)	702866, 702826		702055, 702827	95
N 20 crimp (Combi PAL)	702924, 702263		702929, 702834	96
N 20 crimp (HS850/HS200)	702924, 702263		702094, 702093, 702773 / 702775 / 70234.9	96

Varian (now Agilent)

Application / Type of vial	Most popular MN products for use on Varian instruments			Page
GC:	Vials:	Inserts:	Closures:	
N 8 crimp (microsampling)	70282, 70286, 702880, 70212, 70212.1, 702002, 702003		70289, 702878	78
N 8 screw (standard samples)	70213, 70213.2, 702004, 702893, 702860	702968, 702824	702067, 70245, 702069	79
N 9 screw (standard samples)	702282, 702293, 702283, 702284, 702006, 702078, 702079	702813, 702818, 702716, 702825, 702077	702732, 702287.1, 702037, 702035, 702026	80
N 11 crimp (standard samples)	70201HP, 702885, 702892, 702888, 702075, 702076	702813, 702818, 702716, 702825, 702077	702879 (GC PAL), 70256, 70288, 702995	84
HPLC:	Vials:	Inserts:	Closures:	
N 8 crimp (microsampling)	As indicated under GC, but additionally closures 70252.1, 702025			78
N 8 screw (standard samples)	As indicated under GC, but additionally closure 702437			79
N 9 screw (standard samples)	As indicated under GC, but additionally closure 702040			80

Autosampler compatibility

Varian (now Agilent)

Application / Type of vial	Most popular MN products for use on Varian instruments			Page
N 10 screw (standard samples)	702011, 702012, 702013	702813, 702818, 702716, 702825, 702077	702045 / 702046, 702048, 702044	83
N 11 crimp (standard samples)	As indicated under GC, however, not closure 702879			84
N 11 snap ring (standard samples)	702714, 702713, 702712, 702809	702813, 702818, 702716, 702825, 702077	702064, 702717.2, 702710, 702710.1, 702731, 702063, 702718	87
Headspace:				
N 18 screw (Combi PAL)	702866, 702826		702055, 702827, 702073	95
N 20 crimp (Combi PAL)	702924, 702263		702929, 702834	96
N 20 crimp (CP-9020/9025, CP-9060, Genesis)	702924, 702918, 702261		702093, 70234, 702773 / 702775	96

VWR (Merck® / Hitachi)

Application / Type of vial	Most popular MN products for use on VWR instruments			Page
HPLC:	Vials:	Inserts:	Closures:	
N 8 crimp (microsampling)	70286, 70282		70289, 702878	78
N 8 screw (standard samples)	70213, 70213.2, 702004, 702893, 702860	702968, 702968.1, 702824, 702005	702067, 70245, 702437	79
N 9 screw (standard samples)	702282, 702293, 702283, 702284, 702078, 702079	702813, 702716, 702818, 702077	702287.1, 702288.1, 702026, 702027, 702031	80
N 11 snap ring (standard samples)	702714, 702713, 702712	702813, 702716, 702818, 702077	702063, 702710.1, 702717.2	87
N 13 screw (large volume samples)	702962, 702973	702972 + spring 702974	702926, 702963 + 70260	90

Waters®

Application / Type of vial	Most popular MN products for use on Waters® instruments			Page
HPLC:	Vials:	Inserts:	Closures:	
N 9 screw (standard samples)	702282, 702293, 702283, 702284, 702006, 702007, 702008, 702078, 702079, 702009	702818	702026, 702027, 702287.1, 702288.1, 702037, 702040, 702038, 702083, 702287, 702288	80
N 10 screw (standard samples)	702011, 702012, 702013	702818	702045, 702046, 702047	83
N 11 snap ring (standard samples)	702714, 702713, 702712, 702809, 702709	702818	702710.1, 702717.2	87
N 8 shell vials (standard samples)		Vials + closures:	70202.1 + 702807, 702017 + 702807	94
N 13 screw (large volume samples)	702962, 702973, 702089	702972 + spring 702974	702926, 702963 + 70260	90

Columns for HPLC

Adsorbents for liquid chromatography

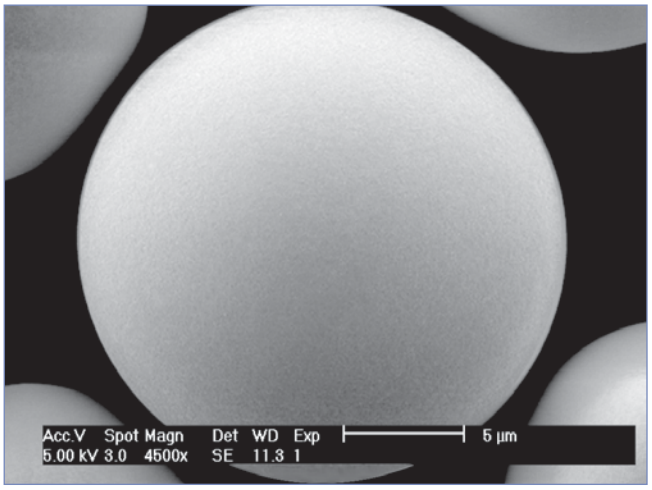
NUCLEODUR® high purity silica for HPLC

NUCLEODUR® is a fully synthetical type B silica (silica of 3rd generation) offering highly advanced physical properties like **totally spherical** particle shape, outstanding **surface microstructure,** high **pressure stability** and **low metal content.**

NUCLEODUR® as a state-of-the-art silica is the ideal base material for modern HPLC phases. It is the result of MACHEREY-NAGEL's pioneering research in chromatography for more than 40 years.

In RP liquid chromatography the efficiency of the packing is strongly affected by the quality of the base silica itself. Shortcomings in the surface geometry of the particles or metal contaminants are the main reasons for inadequate coverage with the covalently bonded alkylsilanes in the subsequent derivatization steps. It is well known, that poor surface coverage and, in consequence, high activity of residual free silanols often results in peak tailing or adsorption, particularly with basic compounds.

Particle shape and surface symmetry



NUCLEODUR® silicas are synthesized in a unique and carefully controlled manufacturing process which provides silica particles, which are totally spherical. The picture shows the outstanding smoothness of the NUCLEODUR® surface.

Purity

As already mentioned above, a highly pure silica is required for achieving symmetric peak shapes and maximum resolution. Inclusions of, e.g., iron or alkaline earth metal ions on the silica surface are largely responsible for the unwanted interactions with ionizable analytes, e.g. amines or phenolic compounds.

NUCLEODUR® is virtually free of metal impurities and low acidic surface silanols. Elemental analysis data of NUCLEODUR® 5 µm measured by AAS are listed below.

Elementary analysis (metal ions) of NUCLEODUR® 100-5

Aluminium	<	5	ppm
Iron	<	5	ppm
Sodium	<	5	ppm
Calcium	<	10	ppm
Titanium	<	1	ppm
Zirconium	<	1	ppm
Arsenic	<	0.5	ppm
Mercury	<	0.05	ppm

Pressure stability

The totally spherical and 100% synthetic silica gel exhibits an outstanding mechanical stability, even at high pressures up to 800 bar and elevated eluent flow rates.

In addition, after several cycles of repeated packing, no significant drop in pressure can be observed. The latter is of prime importance for preparative and process-scale applications.

Physical data of NUCLEODUR®

Surface area (BET)	340 m^2/g
Pore size	110 Å
Pore volume	0.9 mL/g

NUCLEODUR® modifications

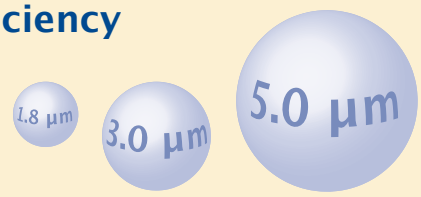
Several different surface modifications based on NUCLEODUR® silica have been developed over the last years providing a full range of specified HPLC phases and an ideal tool for every separation:

- NUCLEODUR® C_{18} Gravity and C_8 Gravity
- NUCLEODUR® C_{18} Isis
- NUCLEODUR® C_{18} Pyramid
- NUCLEODUR® PolarTec *NEW!*
- NUCLEODUR® PFP *NEW!*
- NUCLEODUR® Sphinx RP
- NUCLEODUR® C_{18} HTec
- NUCLEODUR® C_{18} ec and C_8 ec
- NUCLEODUR® HILIC
- NUCLEODUR® CN and CN-RP
- NUCLEODUR® NH_2 and NH_2-RP

For a summary of important properties of our NUCLEODUR® phases please see page 112.

1.8 µm particles for increased separation efficiency

- **Key features**
  - Decrease of analysis time (ultra fast HPLC)
  - Shorter columns with high separation efficiency and significant improvement of resolution and detection sensitivity
  - Suitable for **LC/MS** due to low bleeding characteristics



- NUCLEODUR® 1.8 µm particles are fractionated to limit the increase in back pressure.
- Available in 1.8 µm: C_{18} Gravity, C_8 Gravity, C_{18} Isis, C_{18} Pyramid, PolarTec, PFP, Sphinx RP, C_{18} HTec, HILIC

Advantages of 1.8 µm particle size

Miniaturization started in the early stage of HPLC with the reduction of particle size from 10 µm via 7 µm to standard 5 µm – still the most used particle diameter in analytical HPLC – to 3 µm spherical particles. With the introduction of 1.8 µm NUCLEODUR® particles researchers have turned over a new leaf in HPLC column technology, featuring extraordinary improvements in terms of plate numbers, column efficiency and resolution compared with 3 µm particles.

- **Increased separation efficiency by higher number of theoretical plates (N):**
  50 x 4.6 mm NUCLEODUR® C_{18} Gravity
  3 µm: N ≥ 100 000 plates/m (h value ≤ 10)
  1.8 µm: N ≥ 166 667 plates/m (h value ≤ 6)

Increase of the plate number by ~67% offers the possibility of using shorter columns with equal plate number resulting in a decrease of analysis time.

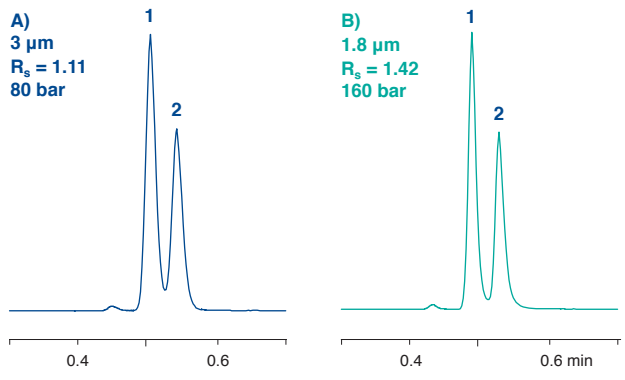
- **Significant improvement in resolution**

$$R_s = \frac{\sqrt{N}}{4}\left(\frac{\alpha-1}{\alpha}\right)\left(\frac{k_i'}{k_i'+1}\right)$$

R_s = resolution, α = selectivity (separation factor), k_i' = retention
N = plate number with $N \propto 1/d_P$, d_P = particle diameter

Resolution as a function of particle size

Column: 50 x 4 mm NUCLEODUR® C_{18} Gravity
A) 3 µm, B) 1.8 µm
Eluent: acetonitrile – water (80:20, v/v)
Flow rate: 2 mL/min
Detection: UV, 254 nm
Peaks: 1. naphthalene, 2. ethylbenzene



Use of 1.8 µm instead of 3 µm particles leads to an increase of resolution by a factor of 1.29 (29%) since the resolution is inversely proportional to the square root of the particle size.

- **Column back pressure**

Due to the smaller particles the back pressure will increase according to

$$\Delta_P = \frac{\Phi \cdot L_C \cdot \eta \cdot u}{{d_P}^2}$$

Δ_P = pressure drop; Φ = flow resistance (nondimensional)
L_C = column length; u = linear velocity
η = viscosity; d_P = particle diameter

The high sphericity of the NUCLEODUR® particles and the very narrow particle size distribution allow to keep the back pressure on a moderate level.

Comparison of back pressures:
100% methanol, 1.5 mL/min, 22 °C, column 50 x 4.6 mm

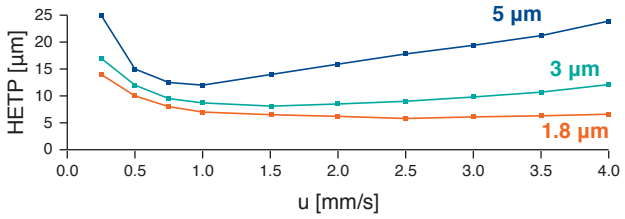
	NUCLEODUR® C_{18} Gravity	Competitor A
3 µm	70 bar	–
1.8 µm	130 bar	170 bar

- **Higher flow rates and shorter run times**

The optimal flow rate for 1.8 µm particles is higher than for 3 and 5 µm particles (see figure – the flow rate should be at the van Deemter minimum).

Van Deemter curves

Column 50 x 4.6 mm, CH_3CN – H_2O (50:50, v/v), analyte toluene



- **Technical requirements**

To gain best results with 1.8 µm particles certain technical demands must be met including pumps for flow rates of 2–3 mL with pressures of 250–1000 bar, minimized dead volume, and fast data recording

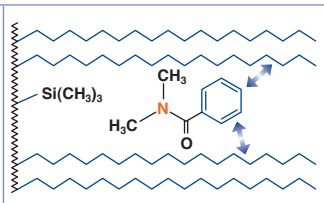
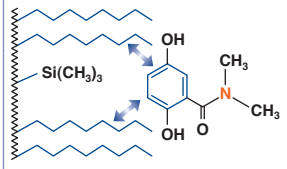
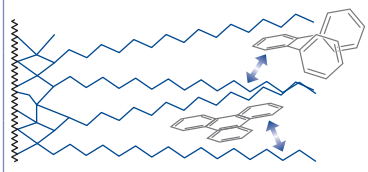
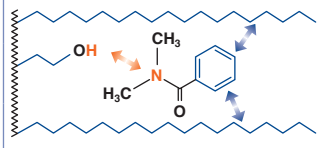
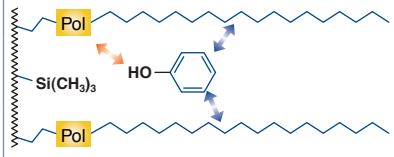
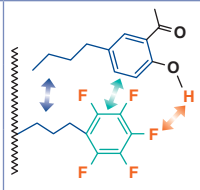
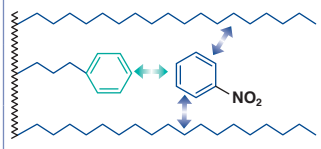
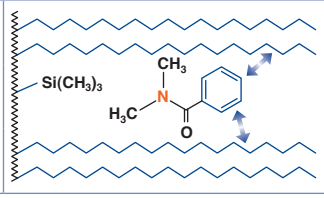
NUCLEODUR® high purity silica for HPLC

Overview of NUCLEODUR® HPLC phases

NUCLEODUR® phase	Specification	Characteristics*	Stability	Structure
C_{18} Gravity	Octadecyl phase, high density coating, multi-endcapping, 18 % C · **USP L1**	A ⬢⬢⬢⬢⬢ B ◖ C ⬢⬢◖	pH 1–11, suitable for LC/MS	NUCLEODUR® $(Si–O_2)_n$
C_8 Gravity	Octyl phase high density coating multi-endcapping 11 % C · **USP L7**	A ⬢⬢◖ B ⬢ C ⬢◖	pH 1–11, suitable for LC/MS	NUCLEODUR® $(Si–O_2)_n$
C_{18} Isis	Octadecyl phase with specially crosslinked surface modification endcapping 20 % C · **USP L1**	A ⬢⬢⬢⬢◖ B ⬢⬢ C ⬢⬢⬢⬢⬢	pH 1–10, suitable for LC/MS	NUCLEODUR® $(Si–O_2)_n$
C_{18} Pyramid	Octadecyl phase with polar endcapping 14 % C · **USP L1**	A ⬢⬢⬢⬢ B ⬢⬢◖ C ⬢⬢	Stable against 100 % aqueous eluents, pH 1–9, suitable for LC/MS	NUCLEODUR® $(Si–O_2)_n$ OH OH
PolarTec	Octadecyl phase with embedded polar group, endcapping 17 % C · **USP L1** and **L60**	A ⬢⬢⬢⬢ B ⬢⬢◖ C ⬢⬢⬢⬢	Stable against 100 % aqueous eluents, pH 1–9, suitable for LC/MS	NUCLEODUR® $(Si–O_2)_n$ Pol Si–OH Pol Si–O–Si$(CH_3)_3$
PFP	Pentafluorophenyl-propyl modification with multi-endcapping 8 % C · **USP L43**	A ⬢⬢ B ⬢⬢⬢⬢ C ⬢⬢⬢⬢	pH 1–9, suitable for LC/MS	NUCLEODUR® $(Si–O_2)_n$ Si–OH F F F F F Si–O–Si$(CH_3)_3$
Sphinx RP	Bifunctional RP phase, phenylpropyl and C_{18} ligands; endcapping 15 % C · **USP L1** and **L11**	A ⬢⬢⬢ B ⬢⬢◖ C ⬢	pH 1–10, suitable for LC/MS	NUCLEODUR® $(Si–O_2)_n$
C_{18} HTec	Octadecyl phase with high capacity, high density coating, multi-endcapping 18 % C · **USP L1**	A ⬢⬢⬢⬢⬢ B ◖ B ⬢⬢◖	pH 1–11, suitable for LC/MS	NUCLEODUR® $(Si–O_2)_n$

* A = ⬢ hydrophobic selectivity, B = ⬢ polar / ionic selectivity, C = ⬢ steric selectivity

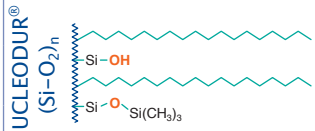
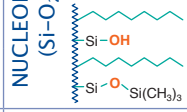
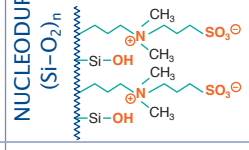
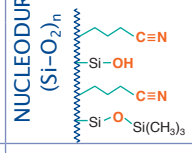
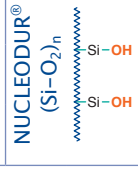
Columns for HPLC

	Application	Similar phases**	Interactions · retention mechanism		Page
	In general compounds with ionizable functional groups such as basic pharmaceuticals and pesticides	**NUCLEOSIL® C_{18} HD** Xterra® RP18 / MS C_{18}; Luna® C18(2), Gemini®, Synergi® Max RP; Zorbax® Extend-C18; Inertsil® ODS III; Purospher® STAR RP-18; Hypersil™ BDS	**Hydrophobic** (van der Waals interactions)		116
	Like C_{18} Gravity, however, generally shorter retention times for nonpolar compounds	**NUCLEOSIL® C_8 HD** Xterra® RP8 / MS C_8; Luna® C8; Zorbax® Eclipse XDB-C8			
	High steric selectivity, thus suited for separation of positional and structural isomers, planar / non-planar molecules	**NUCLEOSIL® C_{18} AB** Inertsil® ODS-P; Pro C18 RS; Zorbax® SB	**Steric** and **hydrophobic**		120
	Basic pharmaceuticals, very polar compounds, organic acids	Aqua, Synergi® Hydro-RP; AQ; Atlantis® dC_{18}	**Hydrophobic** and **polar** (H bonds)		122
	Basic pharmaceuticals, organic acids, pesticides, amino acids, water-soluble vitamins	**NUCLEOSIL® C_{18} Nautilus** ProntoSIL® C18, Zorbax® Bonus-RP, Polaris® Amide-C18; Ascentis® RP Amide, SymmetryShield™ RP18; SUPELCOSIL™ LC-ABZ+; HyPURITY™ ADVANCE	**Hydrophobic** and **polar** (H bonds)		124
	Aromatic and unsaturated compounds, halogen compounds, phenols, isomers, polar pharmaceuticals, antibiotics	ACQUITY® CSH Fluoro-Phenyl; Hypersil™ GOLD PFP; Luna® PFP(2); Discovery® HS F5; Allure® PFP Propyl; Ultra II PFP Propyl	**Polar** (H bonds), **dipole-dipole, π-π** and **hydrophobic**		126
	Compounds with aromatic and multiple bond systems	no similar phases	**π-π** and **hydrophobic**		128
	Robust and well base deactivated C_{18} phase; all separation tasks with preparative potential	Xterra® RP18 / MS C_{18} / SunFire™ C_{18}; Luna® C18(2), Gemini®, Synergi® Max RP; Zorbax® Extend-C18; Inertsil® ODS III; Purospher® STAR RP-18; Hypersil™ BDS	**Hydrophobic** (van der Waals interactions)		130

** Phases which provide a similar selectivity based on chemical and physical properties

NUCLEODUR® high purity silica for HPLC

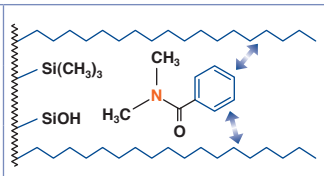
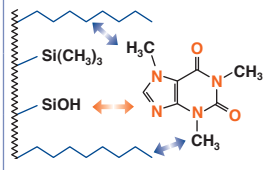
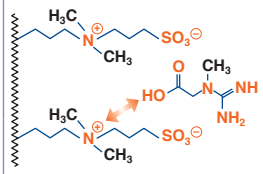
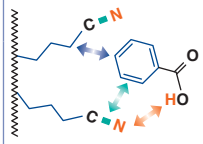
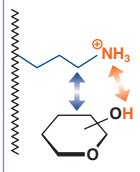
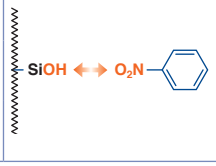
Columns for HPLC

NUCLEODUR® phase	Specification	Characteristics*	Stability	Structure
C_{18} ec	Octadecyl phase, medium density coating endcapping 17.5 % C · **USP L1**	A ⬢⬢⬢⬢ B ⬢ C ⬢⬢⬢◗	pH 1–9	
C_8 ec	Octyl phase, medium density coating endcapping 10.5 % C · **USP L7**	A ⬢⬢ B ⬢◖ C ⬢⬢◖	pH 1–9	
HILIC	Zwitterionic ammonium – sulfonic acid phase 7 % C	A ⬢ B ⬢⬢⬢⬢⬢ C –	pH 2–8.5, suitable for LC/MS	
CN / CN–RP	Cyano (nitrile) phase for NP and RP separations 7 % C · **USP L10**	A ⬢ B ⬢⬢⬢⬢ C –	pH 1–8, stable towards highly aqueous mobile phases	
NH_2 / NH_2–RP	Amino phase for NP and RP separations 2.5 % C · **USP L8**	A ⬢ B ⬢⬢⬢⬢ C –	pH 2–8, stable towards highly aqueous mobile phases	
SiOH	Unmodified high purity silica **USP L3**	A – B – C –	pH 2–8	

* A = ⬢ hydrophobic selectivity, B = ⬢ polar / ionic selectivity, C = ⬢ steric selectivity

High purity NUCLEODUR® silica

NUCLEODUR® high purity silica for HPLC

	Application	Similar phases**	Interactions · retention mechanism		Page
	Robust C_{18} phase for routine analyses	**NUCLEOSIL® C_{18}** Spherisorb® ODS II; Symmetry® C_{18}; Hypersil™ ODS; Inertsil® ODS II; Kromasil C_{18}; LiChrospher® RP-18	**Hydrophobic** (van der Waals interactions) some residual silanol interactions		133
	Robust C_8 phase for routine analyses	**NUCLEOSIL® C_8 ec / C_8** Spherisorb® C_8; Symmetry® C_8; Hypersil™ MOS; Kromasil C_8; LiChrospher® RP-8			
	Hydrophilic compounds such as polar organic acids and bases, polar natural compounds	Sequant™ ZIC®-HILIC; Obelisc™	**Ionic / hydrophilic** and **electrostatic**		136
	Polar organic compounds (basic drugs), molecules containing π-electron systems	**NUCLEOSIL® CN / CN-RP**	**π-π** and **polar** (H bonds), **hydrophobic**		138
	Sugars, sugar alcohols and other hydroxy compounds, DNA bases, polar compounds in general	**NUCLEOSIL® NH_2 / NH_2-RP**	**Polar / ionic** and **hydrophobic**		140
	Polar compounds in general	NUCLEOSIL® SiOH	**Polar / ionic**		142
	** Phases which provide a similar selectivity based on chemical and physical properties				

Columns for HPLC

An optimized phase for every separation

NUCLEODUR® high purity silica for HPLC

NUCLEODUR® C_{18} Gravity · C_8 Gravity — nonpolar high density phases

Key features:
- Suitable for **LC/MS** and HPLC at pH extremes (pH 1–11)
- Superior base deactivation
- Ideal for method development

Technical characteristics:
Available as octadecyl (C_{18}) and octyl (C_8), multi-endcapped

Pore size 110 Å; particle sizes 1.8 µm, 3 µm and 5 µm for C_{18}, 1.8 and 5 µm for C_8; 7, 10, 12 and 16 µm particles for preparative purposes on request

Carbon content 18% for C_{18}, 11% for C_8

Recommended application:
Overall sophisticated analytical separations

Compound classes separated include pharmaceuticals, e.g., analgesics, anti-inflammatory drugs, antidepressants; herbicides; phytopharmaceuticals; immunosuppressants

USP L1 (C_{18}) / **USP L7** (C_8)

Base deactivation

NUCLEODUR® C_{18} Gravity and NUCLEODUR® C_8 Gravity are based on the ultrapure NUCLEODUR® silica. Derivatization generates a homogeneous surface with a high density of bonded silanes (~18% C for C_{18}, ~11% C for C_8). Thorough endcapping suppresses any unwanted polar interactions between the silica surface and the sample, which makes "Gravity" particularly suitable for the separation of basic and other ionizable analytes. Even strongly basic pharmaceuticals like amitriptyline are eluted without tailing under isocratic conditions. For a discussion of the different retention behavior of C_{18} phases compared to C_8 phases see page 134.

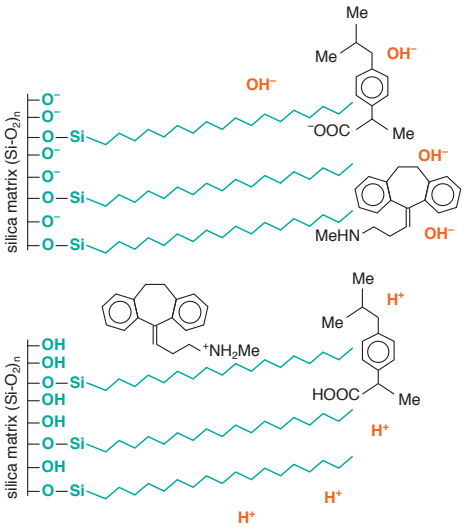
Enhanced pH stability

One major disadvantage of silica stationary phases is limited stability at strongly acidic or basic pH. Cleavage of the siloxane bonding by hydrolysis, or dissolution of the silica will rapidly lead to a considerable loss in column performance. Conventional RP phases are usually not recommended to be run with mobile phases at pH > 8 or pH < 2 for extended periods of time. The special surface bonding technology and the low concentration of trace elements of NUCLEODUR® C_{18} and C_8 Gravity allow for use at an expanded pH range from pH 1 to 11.

Benefits of enhanced pH stability

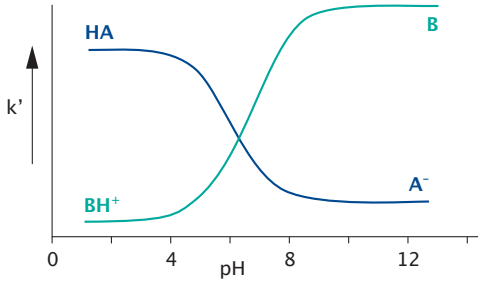
An expanded pH range is often required in method development. Many nitrogen containing compounds like basic drugs are protonated at acidic or neutral pH and exhibit poor retention on a standard C_{18} phase. The retention behavior can be improved by working at a higher pH, where the analyte is no longer protonated, but formally neutrally charged, as a rule between pH 9–10. For acidic analytes it is exactly in inverse proportion, maximum retention can be attained at low pH.

Surface silanols at different pH values



The figure above shows the extent of protonation of surface silanols and of two exemplary analytes at acidic and alkaline pH. The following graph explains the general correlation between retention and pH.

Correlation between retention and pH for basic and acidic compounds

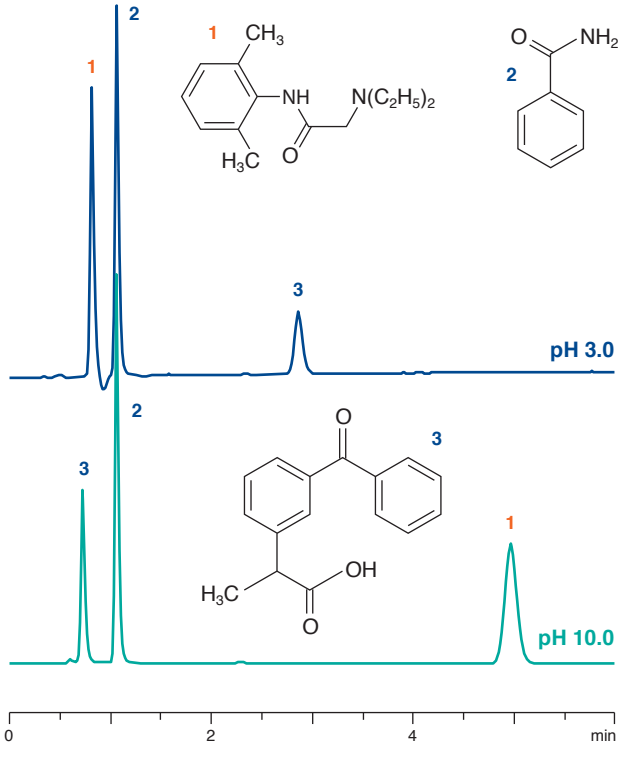


An example how selectivity can be controlled by pH is the separation of the acid ketoprofen, the base lidocaine and benzamide. Under acidic conditions the protonated lidocaine is eluted very fast due to lack of sufficiently strong hydrophobic interactions between analyte and C_{18} chains, while the formally neutral ketoprofen is eluted after about 3 min. However, at pH 10 a reversal of the elution order, with a visibly longer retention time for the basic lidocaine, is observed.

Influence of the pH value on selectivity

Column: 125 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluent: A) acetonitrile – 10 mmol/L ammonium formate, pH 3.0 (50:50, v/v); B) acetonitrile – 10 mmol/L ammonium bicarbonate, pH 10.0 (50:50, v/v)
Flow rate: 1.0 mL/min
Temperature: 30 °C
Detection: UV, 230 nm
Injection: 2 µL

Peaks:
1. Lidocaine
2. Benzamide
3. Ketoprofen



MN Appl. No. 120860

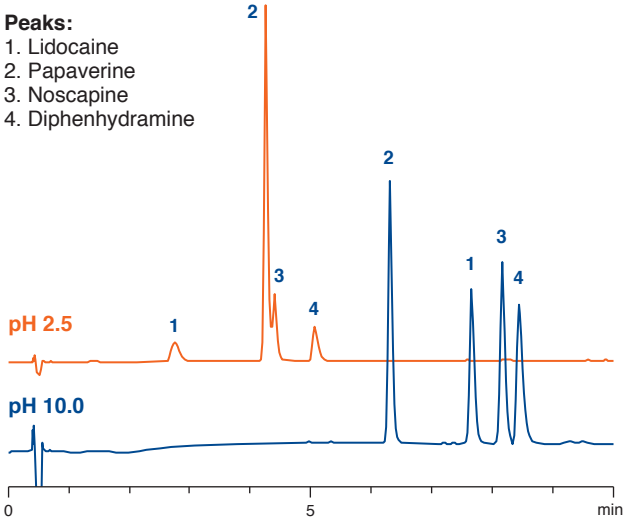
As mentioned above, pH stability of the stationary phase can be helpful for improving selectivity in method development. The following figure shows the separation of 4 basic drugs under acidic and basic conditions.

At pH 2.5 the protonated analytes exhibit poor retention (early elution) and in addition an inadequate resolution for papaverine and noscapine, whilst the formally non ionized molecules can be baseline separated due to the better retention pattern at alkaline pH.

Separation of basic alkaloids

Column: 125 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluent: A) acetonitrile
B) 20 mmol/L $(NH_4)_2HPO_4$, pH 2.5 / 10.0
10 % A (1 min) → 75 % A in 10 min
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection: 2 µL

Peaks:
1. Lidocaine
2. Papaverine
3. Noscapine
4. Diphenhydramine



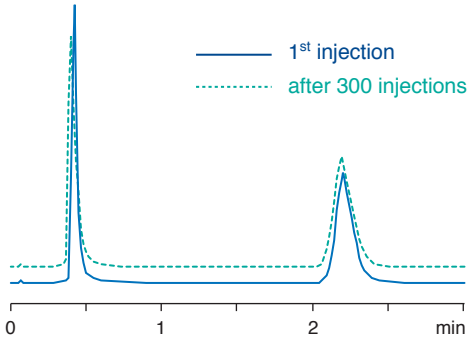
MN Appl. No. 118010

The following chromatogram demonstrates the stability of NUCLEODUR® C_{18} Gravity under alkaline conditions. The ultrapure Gravity with its unique high density surface bonding technology withstands strong alkaline mobile phase conditions.

Stability of NUCLEODUR® C_{18} Gravity at pH 11

Column: 50 x 4.6 mm NUCLEODUR® Gravity, 5 µm
Eluent: methanol – water – ammonia (20:80:0.5, v/v/v), pH 11
Flow rate: 1.3 mL/min
Temperature: 30 °C
Detection: UV, 254 nm
Injection: 2.0 µL

Peaks: 1. Theophylline, 2. Caffeine



MN Appl. No. 120850

NUCLEODUR® high purity silica for HPLC

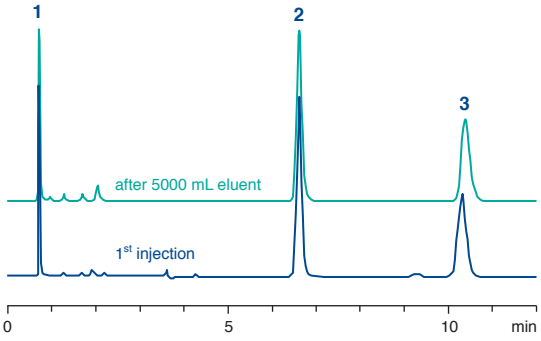
Even after 300 injections no loss of column efficiency – identified, e.g., by peak broadening or decrease in retention times – could be observed.

Under alkaline conditions dissolution of the silica support is possible, resulting in dead volume and thus peak broadening. It is worth mentioning, that this phenomenon also depends on type and concentration of buffers, as well as on the temperature. It is well known that the use of phosphate buffers, particularly at elevated temperatures, can reduce column lifetime even at moderate pH. If possible, phosphate buffers should be replaced by less harmful alternatives.

The following chromatograms show the excellent column stability of NUCLEODUR® C_{18} Gravity in acidic conditions. Retention times of all three compounds in the column performance test remain consistent and virtually unchanged, even after the column is run with 5000 mL eluent. Due to the extremely stable surface modification, no cleavage of the Si-O-Si bonding occurs, column deterioration is therefore successfully prevented.

Stability of NUCLEODUR® C_{18} Gravity at pH 1.5

Column: 125 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluent: acetonitrile – 1 % TFA in water (50:50, v/v), pH 1.5
Flow rate: 1.0 mL/min
Temperature: 30 °C,
Detection: UV, 230 nm
Injection: 5 µL
Peaks: 1. Pyridine, 2. Toluene, 3. Ethylbenzene



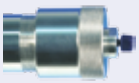
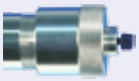
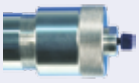
MN Appl. No. 120840

Ordering information

Eluent in column acetonitrile – water

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® C_{18} Gravity, 1.8 µm				octadecyl phase, particle size 1.8 µm, 18 % C			
Analytical EC columns							
2 mm ID	**760078.20**	**760079.20**	**760071.20**	**760076.20**		**760075.20**	
3 mm ID	**760078.30**	**760079.30**		**760076.30**			
4 mm ID	**760078.40**	**760079.40**		**760076.40**			
4.6 mm ID	**760078.46**	**760079.46**		**760076.46**			
EC guard columns*		4 x 2 mm: **761901.20**		4 x 3 mm: **761901.30**			
NUCLEODUR® C_{18} Gravity, 3 µm				octadecyl phase, particle size 3 µm, 18 % C			
Analytical EC columns							
2 mm ID		**760080.20**		**760084.20**	**760081.20**	**760083.20**	**760082.20**
3 mm ID		**760080.30**		**760084.30**	**760081.30**	**760083.30**	**760082.30**
4 mm ID		**760080.40**		**760084.40**	**760081.40**	**760083.40**	**760082.40**
4.6 mm ID		**760080.46**	**760086.46**	**760084.46**	**760081.46**	**760083.46**	**760082.46**
EC guard columns*		4 x 2 mm: **761902.20**		4 x 3 mm: **761902.30**			
CC guard columns**		8 x 3 mm: **761124.30**		8 x 4 mm: **761124.40**			
NUCLEODUR® C_{18} Gravity, 5 µm				octadecyl phase, particle size 5 µm, 18 % C			
Analytical EC columns							
2 mm ID		**760102.20**		**760104.20**	**760100.20**	**760103.20**	**760101.20**
3 mm ID		**760102.30**		**760104.30**	**760100.30**	**760103.30**	**760101.30**
4 mm ID		**760102.40**		**760104.40**	**760100.40**	**760103.40**	**760101.40**
4.6 mm ID		**760102.46**	**760106.46**	**760104.46**	**760100.46**	**760103.46**	**760101.46**
EC guard columns*		4 x 2 mm: **761903.20**		4 x 3 mm: **761903.30**			
CC guard columns**		8 x 3 mm: **761125.30**		8 x 4 mm: **761125.40**			

NUCLEODUR® high purity silica for HPLC

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm
VarioPrep columns							
 10 mm ID		**762103.100**			**762109.100**		**762113.100**
21 mm ID		**762103.210**			**762109.210**		**762113.210**
32 mm ID							**762113.320**
40 mm ID						**762100.400**	**762113.400**
VP guard columns***		10 x 8 mm: **762160.80**		10 x 16 mm: **762160.160**		15 x 32 mm: **762163.320**	
NUCLEODUR® C_{18} Gravity, 10 µm				octadecyl phase, particle size 10 µm, 18% C			
VarioPrep columns							
 21 mm ID							**762250.210**
40 mm ID							**762250.400**
VP guard columns***				10 x 16 mm: **762160.160**		15 x 32 mm: **762163.320**	
NUCLEODUR® C_8 Gravity, 1.8 µm				octyl phase, particle size 1.8 µm, 11% C			
Analytical EC columns							
 2 mm ID	**760756.20**	**760755.20**	**760760.20**	**760757.20**		**760759.20**	
3 mm ID	**760756.30**	**760755.30**		**760757.30**			
4 mm ID	**760756.40**	**760755.40**		**760757.40**			
4.6 mm ID	**760756.46**	**760755.46**		**760757.46**			
EC guard columns*		4 x 2 mm: **761905.20**		4 x 3 mm: **761905.30**			
NUCLEODUR® C_8 Gravity, 5 µm				octyl phase, particle size 5 µm, 11% C			
Analytical EC columns							
 2 mm ID		**760750.20**		**760754.20**	**760751.20**	**760752.20**	**760753.20**
3 mm ID		**760750.30**		**760754.30**	**760751.30**	**760752.30**	**760753.30**
4 mm ID		**760750.40**		**760754.40**	**760751.40**	**760752.40**	**760753.40**
4.6 mm ID		**760750.46**	**760749.46**	**760754.46**	**760751.46**	**760752.46**	**760753.46**
EC guard columns*		4 x 2 mm: **761907.20**		4 x 3 mm: **761907.30**			
CC guard columns**		8 x 3 mm: **761754.30**		8 x 4 mm: **761754.40**			
VarioPrep columns							
 10 mm ID		**762081.100**			**762071.100**		**762070.100**
21 mm ID		**762081.210**			**762071.210**	**762082.210**	**762070.210**
VP guard columns***		10 x 8 mm: **762097.80**		10 x 16 mm: **762097.160**			
EC and VarioPrep columns in packs of 1 column, guard columns see below							

Guard column systems						
Guard columns for EC columns with ID		**2 mm**	**3 mm**	**4 mm**	**4.6 mm**	Guard column holder
* Column Protection System (pack of)	EC	4/2 (3)	4/3 (3)	4/3 (3)	4/3 (3)	718966
** ChromCart® guard columns (pack of)	CC	8/3 (3)	8/3 (3)	8/4 (3)	8/4 (3)	721359
Guard columns for VarioPrep columns with ID		**8, 10 mm**	**16, 21 mm**	**32, 40 mm**	**≥ 50 mm**	
*** VP guard columns (pack of)	VP	10/8 (2)	10/16 (2)	15/32 (1)	15/50 (1)	
VP guard column holder		718251	718256	718253	718255	

For details of our column systems see pages 189–196

NUCLEODUR® high purity silica for HPLC

NUCLEODUR® C_{18} Isis — phase with high steric selectivity

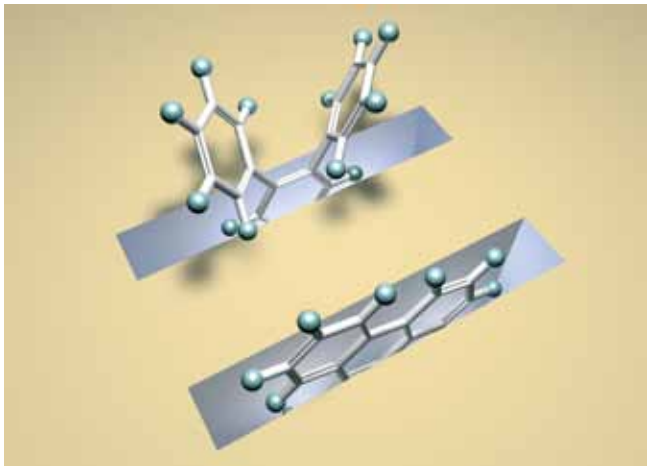
- **Key features:**
  - Exceptional steric selectivity
  - Outstanding surface deactivation
  - Suitable for **LC/MS** and HPLC at pH 1–10
- **Technical characteristics:**
  C_{18} phase with special polymeric, crosslinked surface modification; pore size 110 Å; particle sizes 1.8 µm, 3 µm and 5 µm; carbon content 20%
- **Recommended application:**
  Steroids, (*o,p,m*–) substituted aromatics, fat-soluble vitamins
  USP L1

Surface modification

By use of specific C_{18} silanes and polymeric bonding technologies a dense shield of alkyl chains protects the subjacent silica matrix. Elemental analysis of NUCLEODUR® C_{18} Isis shows a carbon load of 20%. The target crosslinking of the C_{18} chains on the surface enables the separation of compounds with similar molecular structure but different stereochemical properties. The technical term for this feature is steric selectivity.

Slot model

Sander and Wise [LCGC **8** (1990) 378–390] proposed a model for the retention of aromatic compounds based on molecular shape, which is referred to as "Slot Model". This model pictures the bonded C_{18} phase on the silica surface with slots which the analytes have to penetrate during retention. Planar molecules are able to penetrate these slots deeper than non-planar molecules of similar molecular weight and length-to-breadth ratio. Thus triphenylene is longer retained than *o*-terphenyl.

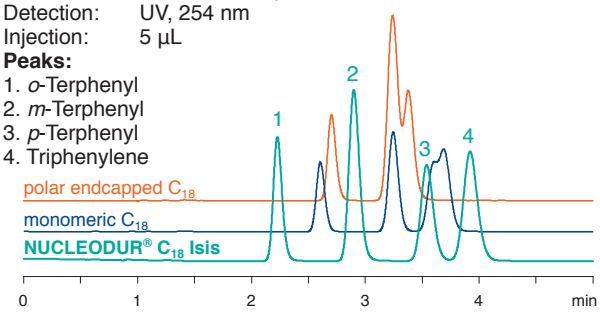


Steric selectivity

The following chromatograms reveal the improved resolution for positional isomers in a test mixture of aromatic compounds on NUCLEODUR® C_{18} Isis (green) in direct comparison with monomerically coated (blue) and polar endcapped (red) C_{18} columns.

Steric selectivity of NUCLEODUR® C_{18} Isis

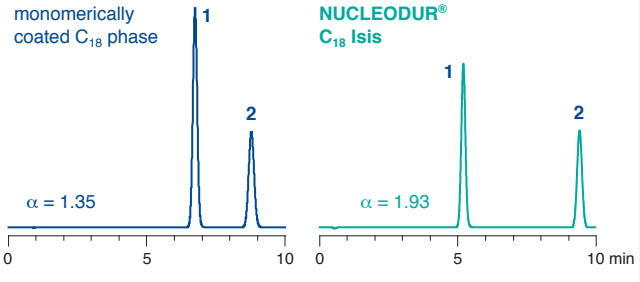
Columns: 125 x 4 mm; **NUCLEODUR® C_{18} Isis**, **monomerically coated C_{18} phase**, **polar endcapped phase**
Eluent: methanol – water (90:10, v/v)
Flow rate: 1 mL/min, temperature 35 °C
Detection: UV, 254 nm
Injection: 5 µL
Peaks:
1. *o*-Terphenyl
2. *m*-Terphenyl
3. *p*-Terphenyl
4. Triphenylene



The separation of *o*-terphenyl and triphenylene is a good example to evaluate the selectivity of a RP column in terms of the shape of two molecules. The phenyl rings of *o*-terphenyl are twisted out of plane while triphenylene has a planar geometry. The separation factor α is a measure for the steric selectivity. As is shown below the α value is considerable larger on NUCLEODUR® C_{18} Isis compared to a conventional C_{18} column.

Steric selectivity of NUCLEODUR® C_{18} Isis

Columns: 125 x 4 mm
Eluent: methanol – water (80:20, v/v)
Flow rate: 1 mL/min, temperature 40 °C
Detection: UV, 254 nm, injection 1 µL
Peaks: 1. *o*-Terphenyl, 2. Triphenylene



The surface bonding technology also provides improved stability features for the NUCLEODUR® C_{18} Isis phase.

Surface deactivation

The chromatography of basic analytes requires a high density of surface-bonded C_{18} silanes combined with a thorough endcapping procedure to keep silanol activity at a minimum. This ensures tailing-free elution of even strongly basic amino-containing compounds (see Appl. 121210 at ***www.mn-net.com/apps***).

Ordering information

Eluent in column acetonitrile – water

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® C_{18} Isis, 1.8 µm						particle size 1.8 µm	
Analytical EC columns							
2 mm ID	**760406.20**	**760405.20**	**760396.20**	**760407.20**		**760409.20**	
3 mm ID	**760406.30**	**760405.30**		**760407.30**			
4 mm ID	**760406.40**	**760405.40**		**760407.40**			
4.6 mm ID	**760406.46**	**760405.46**		**760407.46**			
EC guard columns*		4 x 2 mm: **761910.20**		4 x 3 mm: **761910.30**			
NUCLEODUR® C_{18} Isis, 3 µm						particle size 3 µm	
Analytical EC columns							
2 mm ID		**760400.20**		**760401.20**	**760402.20**	**760403.20**	**760404.20**
3 mm ID		**760400.30**		**760401.30**	**760402.30**	**760403.30**	**760404.30**
4 mm ID		**760400.40**		**760401.40**	**760402.40**	**760403.40**	**760404.40**
4.6 mm ID		**760400.46**	**760397.46**	**760401.46**	**760402.46**	**760403.46**	**760404.46**
EC guard columns*		4 x 2 mm: **761911.20**		4 x 3 mm: **761911.30**			
CC guard columns**		8 x 3 mm: **761300.30**		8 x 4 mm: **761300.40**			
NUCLEODUR® C_{18} Isis, 5 µm						particle size 5 µm	
Analytical EC columns							
2 mm ID		**760410.20**		**760415.20**	**760412.20**	**760413.20**	**760414.20**
3 mm ID		**760410.30**		**760415.30**	**760412.30**	**760413.30**	**760414.30**
4 mm ID		**760410.40**		**760415.40**	**760412.40**	**760413.40**	**760414.40**
4.6 mm ID		**760410.46**	**760416.46**	**760415.46**	**760412.46**	**760413.46**	**760414.46**
EC guard columns*		4 x 2 mm: **761912.20**		4 x 3 mm: **761912.30**			
CC guard columns**		8 x 3 mm: **761310.30**		8 x 4 mm: **761310.40**			
VarioPrep columns							
10 mm ID		**762404.100**			**762405.100**		**762403.100**
21 mm ID		**762404.210**			**762405.210**		**762403.210**
32 mm ID							**762403.320**
40 mm ID						**762406.400**	**762403.400**
VP guard columns***		10 x 8 mm: **762420.80**		10 x 16 mm: **762420.160**		15 x 32 mm: **762422.320**	
EC and VarioPrep columns in packs of 1 column, guard columns see below							

Guard column systems						Guard column holder
Guard columns for EC columns with ID		**2 mm**	**3 mm**	**4 mm**	**4.6 mm**	
* Column Protection System (pack of)	EC	4/2 (3)	4/3 (3)	4/3 (3)	4/3 (3)	718966
** ChromCart® guard columns (pack of)	CC	8/3 (3)	8/3 (3)	8/4 (3)	8/4 (3)	721359
Guard columns for VarioPrep columns with ID		**8, 10 mm**	**16, 21 mm**	**32, 40 mm**	**≥ 50 mm**	
*** VP guard columns (pack of)	VP	10/8 (2)	10/16 (2)	15/32 (1)	15/50 (1)	
VP guard column holder		718251	718256	718253	718255	

For details of our column systems see pages 189–196

NUCLEODUR® high purity silica for HPLC

NUCLEODUR® C_{18} Pyramid — phase for highly aqueous eluents

- **Key features:**
  - Stable in 100 % aqueous mobile phase systems
  - Interesting polar selectivity features
  - Excellent base deactivation; suitable for **LC/MS** due to low bleeding characteristics
- **Technical characteristics:**
  Special phase with polar endcapping; pore size 110 Å; particle sizes 1.8 µm, 3 µm and 5 µm (7 and 10 µm particles for preparative purposes on request); carbon content 14 %; pH stability 1–9
- **Recommended application:**
  Analgesics, penicillin antibiotics, nucleic acid bases, water-soluble vitamins, complexing agents, organic acids

  USP L1

Columns for HPLC

RP-HPLC with highly aqueous mobile phases

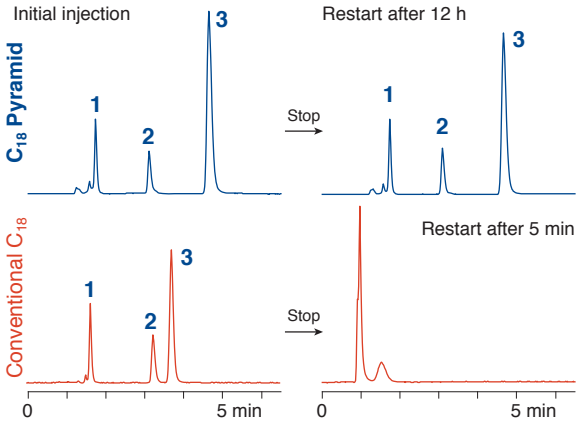
The efforts to neutralize unwanted silanol activity often results in well base-deactivated RP phases with high carbon load, but a limited scope of selectivity beyond non-polar interactions. Polar compounds like carboxylic acids or drug metabolites show only weak retention on densely bonded RP columns due to distinct hydrophobic properties but low polar interactions. Very polar analytes require highly aqueous mobile phases for solubility and retention. Conventional reversed phase columns often display stability problems in eluent systems with high percentage of water (> 95 %) as evidenced by a sudden decrease of retention time and overall poor reproducibility. This phenomenon is described as phase collapse caused by the mobile phase expelled from the pores due to the fact, that hydrophobic RP phases are incompletely wetted with the mobile phase [U. D. Neue et al., Chromatographia **54** (2001) 169–177].

Different approaches can be used to increase column stability with highly aqueous mobile phase systems. The most promising concepts are incorporating a polar group in the hydrophobic alkyl chain, or using hydrophilic endcapping procedures to improve the wettability of the reversed phase modification. NUCLEODUR® PolarTec may be taken as an example for the embedded polar group strategy, in which a C_{18} silane with a polar function is successfully linked to the silica surface.

Stability features

NUCLEODUR® C_{18} Pyramid is a silica phase with hydrophilic endcapping, designed especially for use in eluent systems of up to 100 % water. The upper figure shows the retention behavior of tartaric, acetic and maleic acid under purely aqueous conditions on NUCLEODUR® C_{18} Pyramid in comparison with a conventionally bonded C_{18} phase. It can be shown that the retention times for NUCLEODUR® C_{18} Pyramid remain nearly unchanged between initial injection and restart after the flow has been stopped for 12 h, whilst the performance of the conventional RP column already collapsed totally 5 min.

Stability test



Both columns: 125 x 4 mm
Eluent: 50 mmol/L KH_2PO_4 pH 2.5
Flow rate: 0.7 mL/min, temperature 25 °C
Detection: UV, 210 nm
Injection: 1 µL
Peaks: 1. Tartaric acid, 2. Acetic acid, 3. Maleic acid

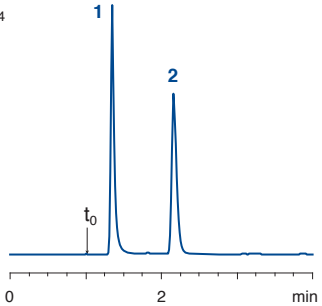
MN Appl. No. 120870

Retention characteristics

Separation of very polar compounds

Column: 125 x 4 mm NUCLEODUR® C_{18} Pyramid, 5 µm
Eluent: 0.2 % H_3PO_4
Flow rate: 1.0 mL/min
Temperature: 22 °C
Detection: UV, 202 nm
Injection: 2 µL

Peaks:
1. Formic acid
2. Acetic acid



MN Appl. No. 119170

The polar surface exhibits retention characteristics different from conventional C_{18} phases. Application 119170 shows the improved retention behavior of the very polar short chain organic acids, which are insufficiently retained on RP columns with predominantly hydrophobic surface properties. In addition to the exceptional polar selectivity NUCLEODUR® C_{18} Pyramid also provides adequate hydrophobic retention (see application No. 119190 at ***www.mn-net.com***). The perceptible increase in polarity has no impact on the retention behavior of ionizable analytes. Even with the strongly basic compounds of the tricyclic antidepressant drug test mixture, no unwanted interactions or a so-called lack in base deactivation are observed (see application 119200 at ***www.mn-net.com/apps***).

Ordering information

Eluent in column acetonitrile – water

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® C_{18} Pyramid, 1.8 µm						particle size 1.8 µm	
Analytical EC columns							
2 mm ID	**760271.20**	**760272.20**	**760275.20**	**760273.20**		**760274.20**	
3 mm ID	**760271.30**	**760272.30**		**760273.30**			
4 mm ID	**760271.40**	**760272.40**		**760273.40**			
4.6 mm ID	**760271.46**	**760272.46**		**760273.46**			
EC guard columns*		4 x 2 mm: **761915.20**		4 x 3 mm: **761915.30**			
NUCLEODUR® C_{18} Pyramid, 3 µm						particle size 3 µm	
Analytical EC columns							
2 mm ID		**760263.20**		**760264.20**	**760260.20**	**760261.20**	**760262.20**
3 mm ID		**760263.30**		**760264.30**	**760260.30**	**760261.30**	**760262.30**
4 mm ID		**760263.40**		**760264.40**	**760260.40**	**760261.40**	**760262.40**
4.6 mm ID		**760263.46**	**760259.46**	**760264.46**	**760260.46**	**760261.46**	**760262.46**
EC guard columns*		4 x 2 mm: **761916.20**		4 x 3 mm: **761916.30**			
CC guard columns**		8 x 3 mm: **761854.30**		8 x 4 mm: **761854.40**			
NUCLEODUR® C_{18} Pyramid, 5 µm						particle size 5 µm	
Analytical EC columns							
2 mm ID		**760200.20**		**760204.20**	**760201.20**	**760203.20**	**760202.20**
3 mm ID		**760200.30**		**760204.30**	**760201.30**	**760203.30**	**760202.30**
4 mm ID		**760200.40**		**760204.40**	**760201.40**	**760203.40**	**760202.40**
4.6 mm ID		**760200.46**	**760205.46**	**760204.46**	**760201.46**	**760203.46**	**760202.46**
EC guard columns*		4 x 2 mm: **761917.20**		4 x 3 mm: **761917.30**			
CC guard columns**		8 x 3 mm: **761800.30**		8 x 4 mm: **761800.40**			
VarioPrep columns							
10 mm ID		**762271.100**			**762273.100**		**762272.100**
21 mm ID		**762271.210**			**762273.210**		**762272.210**
32 mm ID							**762272.320**
40 mm ID						**762269.400**	**762272.400**
VP guard columns***		10 x 8 mm: **762291.80**		10 x 16 mm: **762291.160**		15 x 32 mm: **762293.320**	

EC and VarioPrep columns in packs of 1, guard columns see below; details of our column systems see pages 189–196

Guard column systems						
Guard columns for EC columns with ID		**2 mm**	**3 mm**	**4 mm**	**4.6 mm**	Guard column holder
* Column Protection System (pack of)	EC	4/2 (3)	4/3 (3)	4/3 (3)	4/3 (3)	718966
** ChromCart® guard columns (pack of)	CC	8/3 (3)	8/3 (3)	8/4 (3)	8/4 (3)	721359
Guard columns for VarioPrep columns with ID		**8, 10 mm**	**16, 21 mm**	**32, 40 mm**	**≥ 50 mm**	
*** VP guard columns (pack of)	VP	10/8 (2)	10/16 (2)	15/32 (1)	15/50 (1)	
VP guard column holder		718251	718256	718253	718255	

NUCLEODUR® high purity silica for HPLC

NUCLEODUR® PolarTec

RP phase with embedded polar group

- **Key features:**
  - Excellent base deactivation
  - Suitable for **LC/MS** and 100% aqueous eluents
  - Pronounced steric selectivity
- **Technical characteristics:**
  Phase with embedded polar group; pore size 110 Å; particle sizes 1.8 µm, 3 µm and 5 µm; carbon content 17%; pH stability 1–9
- **Recommended application:**
  Exceptional selectivity for phenols and nitrogen containing compounds, polar compounds like basic pharmaceuticals, organic acids, pesticides, amino acids, water-soluble vitamins, etc.

  USP L1 and **L60**

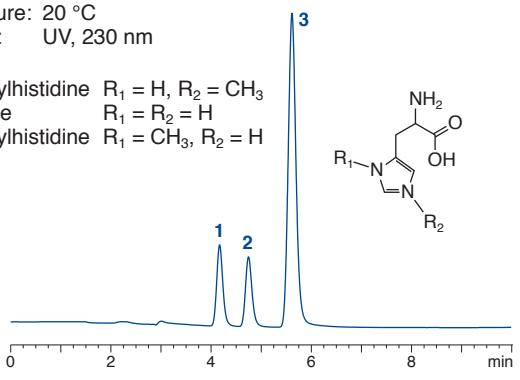
RP-HPLC under 100% aqueous conditions

The dominant form of interactions of conventional C_{18} phases are nonpolar London dispersion forces. Besides nonpolar interactions phases with embedded polar groups possess the ability to show polar interactions (dipole-dipole, hydrogen bonds, π-π, etc.) These interactions enhance retention and selectivity for polar compounds like carboxylic acids, phenols and nitrogen containing compounds.

Separation of histidines

Column: 150 x 3 mm NUCLEODUR® PolarTec, 3 µm
Eluent: 1.0 mmol/L perfluoropentanoic acid in water – 0.5 mmol/L perfluoropentanoic acid in acetonitrile (99.5:0.5, v/v)
Flow rate: 0.4 mL/min
Temperature: 20 °C
Detection: UV, 230 nm

Peaks:
1. 3-Methylhistidine $R_1 = H, R_2 = CH_3$
2. Histidine $R_1 = R_2 = H$
3. 1-Methylhistidine $R_1 = CH_3, R_2 = H$



MN Appl. No. 125140

In order to increase retention for polar compounds it is often necessary to decrease the organic ratio of the mobile phase to zero. Under these conditions many conventional C_{18} phases display the so-called dewetting effect which means that the mobile phase is expelled from the pores. This phenomenon leads to a dramatic loss in retention. NUCLEODUR® PolarTec is stable in 100% aqueous mobile phases and therefore especially suited for the separation of polar compounds like organic acids.

Due to the shielding effect of the embedded group NUCLEODUR® PolarTec shows an excellent base deactivation, which is at the top-notch of embedded polar group phases on the market. The pronounced steric selectivity (see Tanaka plot) is an additional tool for the separation of complex mixtures.

Due to low bleeding characteristics NUCLEODUR® PolarTec is also suitable for LC/MS.

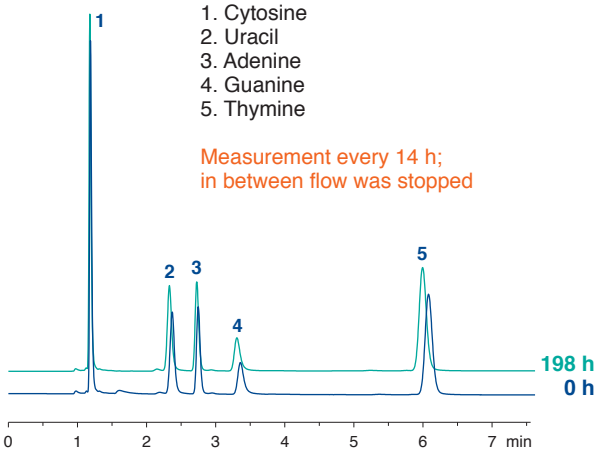
Even after days or weeks of operation in purely aqueous eluents the C_{18} chains of NUCLEODUR® PolarTec are neither folded nor show any collapsing. A significant reduction of retention time cannot be observed.

Stability of NUCLEODUR® PolarTec

Column: 150 x 3 mm NUCLEODUR® PolarTec, 3 µm
Eluent: 30 mmol/L KH_2PO_4, pH 3.0
Flow rate: 0.5 mL/min
Temperature: 30 °C
Detection: UV, 220 nm

Peaks:
1. Cytosine
2. Uracil
3. Adenine
4. Guanine
5. Thymine

Measurement every 14 h; in between flow was stopped



MN Appl. No. 124610

NUCLEODUR® high purity silica for HPLC

In spite of the polar character of the embedded functional group NUCLEODUR® PolarTec exhibits sufficient hydrophobic properties and is very well suited for analyzing basic compounds.

Ordering information

Eluent in column acetonitrile – water

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® PolarTec, 1.8 µm						particle size 1.8 µm	
Analytical EC columns							
2 mm ID	**760461.20**	**760463.20**	**760465.20**	**760466.20**		**760468.20**	
3 mm ID	**760461.30**	**760463.30**		**760466.30**			
4 mm ID	**760461.40**	**760463.40**		**760466.40**			
4.6 mm ID	**760461.46**	**760463.46**		**760466.46**			
EC guard columns*		4 x 2 mm: **761980.20**		4 x 3 mm: **761980.30**			
NUCLEODUR® PolarTec, 3 µm						particle size 3 µm	
Analytical EC columns							
2 mm ID		**760473.20**		**760476.20**	**760477.20**	**760478.20**	**760479.20**
3 mm ID		**760473.30**		**760476.30**	**760477.30**	**760478.30**	**760479.30**
4 mm ID		**760473.40**		**760476.40**	**760477.40**	**760478.40**	**760479.40**
4.6 mm ID		**760473.46**	**760475.46**	**760476.46**	**760477.46**	**760478.46**	**760479.46**
EC guard columns*		4 x 2 mm: **761981.20**		4 x 3 mm: **761981.30**			
CC guard columns**		8 x 3 mm: **761160.30**		8 x 4 mm: **761160.40**			
NUCLEODUR® PolarTec, 5 µm						particle size 5 µm	
Analytical EC columns							
2 mm ID		**760483.20**		**760486.20**	**760487.20**	**760488.20**	**760489.20**
3 mm ID		**760483.30**		**760486.30**	**760487.30**	**760488.30**	**760489.30**
4 mm ID		**760483.40**		**760486.40**	**760487.40**	**760488.40**	**760489.40**
4.6 mm ID		**760483.46**	**760485.46**	**760486.46**	**760487.46**	**760488.46**	**760489.46**
EC guard columns*		4 x 2 mm: **761982.20**		4 x 3 mm: **761982.30**			
CC guard columns**		8 x 3 mm: **761161.30**		8 x 4 mm: **761161.40**			
VarioPrep columns							
10 mm ID		**762220.100**			**762221.100**		**762223.100**
21 mm ID		**762220.210**			**762221.210**		**762223.210**
32 mm ID							**762223.320**
40 mm ID						**762222.400**	**762223.400**
VP guard columns***		10 x 8 mm: **762224.80**		10 x 16 mm: **762224.160**		15 x 32 mm: **762226.320**	
EC and VarioPrep columns in packs of 1, guard columns see below							

Guard column systems						
Guard columns for EC columns with ID		**2 mm**	**3 mm**	**4 mm**	**4.6 mm**	Guard column holder
* Column Protection System (pack of)	EC	4/2 (3)	4/3 (3)	4/3 (3)	4/3 (3)	718966
** ChromCart® guard columns (pack of)	CC	8/3 (3)	8/3 (3)	8/4 (3)	8/4 (3)	721359
Guard columns for VarioPrep columns with ID		**8, 10 mm**	**16, 21 mm**	**32, 40 mm**	**≥ 50 mm**	
*** VP guard columns (pack of)	VP	10/8 (2)	10/16 (2)	15/32 (1)	15/50 (1)	
VP guard column holder		718251	718256	718253	718255	

For details of our column systems see pages 189–196

NUCLEODUR® high purity silica for HPLC

NUCLEODUR® PFP — hydrophobic pentafluorophenyl phase

Key features:
- Hydrophobic phase with alternative selectivity in comparison to classical C_{18} modifications
- Separation principle based on 4 retention mechanisms (polar interactions (H bonds), dipole-dipole, π-π, and hydrophobic interactions)
- Suitable for **LC/MS** due to low bleeding characteristics

Technical characteristics:
Phase with pentafluorophenyl-propyl modification and multi-endcapping; pore size 110 Å; particle sizes 1.8 µm, 3 µm and 5 µm; carbon content 8%; pH stability 1-9

Recommended application:
Aromatic and unsaturated compounds, phenols, halogen compounds, isomers, polar compounds like pharmaceuticals, antibiotics; strong retention of basic compounds

USP L43

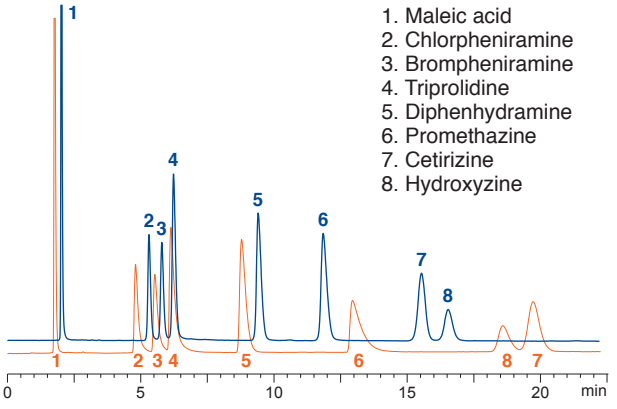
Orthogonality in selectivity

Fluorinated stationary phases in HPLC have gained increasing interest over the last years. Most common representative of fluorinated silica phases is the pentafluorophenyl modification (PFP or F5). Especially the orthogonal selectivity compared to traditional alkyl phases widens the scope in analytical HPLC. Thus NUCLEODUR® PFP offers an excellent selectivity especially for highly polar analytes like aromatic and unsaturated compounds, phenols or halogenated hydrocarbons.

Separation of antihistamines

Columns: **250 x 3 mm NUCLEODUR® PFP, 5 µm**
250 x 3 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluent: acetonitrile – 20 mmol/L KH_2PO_4 (30:70, v/v)
Flow rate: 0.563 mL/min
Temperature: 30 °C
Detection: UV, 210 nm

Peaks:
1. Maleic acid
2. Chlorpheniramine
3. Brompheniramine
4. Triprolidine
5. Diphenhydramine
6. Promethazine
7. Cetirizine
8. Hydroxyzine



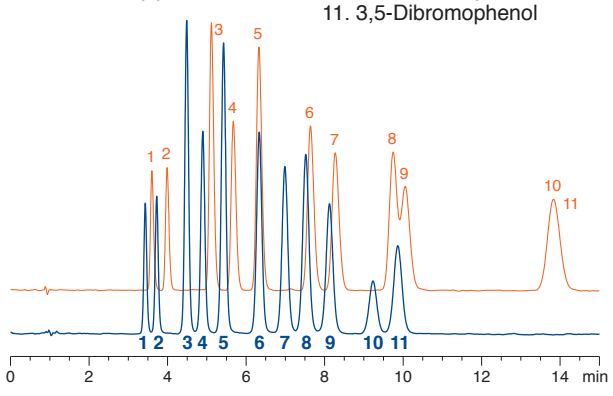
MN Appl. No. 124861

While a typical C_{18} phase just provides hydrophobic interactions between stationary phase and analyte NUCLEODUR® PFP offers four different retention mechanisms: polar interactions (H bonds), dipole-dipole, π-π, and hydrophobic interactions. Especially the pronounced ion exchange capacity and distinct steric selectivity are typical for fluorinated phases. Due to low bleeding characteristics NUCLEODUR® PFP is also suitable for LC/MS. Based on a special surface modification procedure NUCLEODUR® PFP offers highest stability also at low pH values.

Separation of phenol isomers

Columns: **125 x 4 mm NUCLEODUR® PFP, 5 µm**
125 x 4 mm NUCLEODUR® C_{18} HTec, 5 µm
Eluent: acetonitrile, 0.1 % formic acid – water, 0.1 % formic acid (35:65, v/v)
Flow rate: 1 mL/min, temperature 35 °C
Detection: UV, 280 nm

Peaks:
1. *o*-Cresol
2. *m*-Cresol
3. 3,4-Dimethylphenol
4. 3,5-Dimethylphenol
5. 2,5-Dimethylphenol
6. 2,6-Dichlorophenol
7. 2,3-Dichlorophenol
8. 2,4-Dichlorophenol
9. 3,4-Dichlorophenol
10. 2,4-Dibromophenol
11. 3,5-Dibromophenol



MN Appl. No. 124531

NUCLEODUR® high purity silica for HPLC

NUCLEODUR® PFP offers a completely different retention behavior compared to alkyl modified silica and is often used for separations which provide insufficient results on traditional C_{18} phases. Applications in the areas of (bio-) pharma, natural compounds and environment show the broad applicability of this phase.

Ordering information

Eluent in column acetonitrile – water

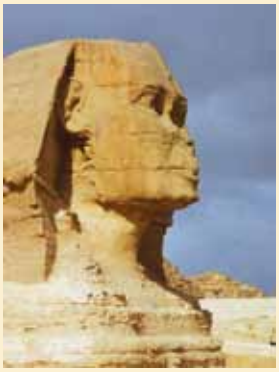
Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® PFP, 1.8 µm						particle size 1.8 µm	
Analytical EC columns							
2 mm ID	**760431.20**	**760433.20**	**760435.20**	**760436.20**		**760438.20**	
3 mm ID	**760431.30**	**760433.30**		**760436.30**			
4 mm ID	**760431.40**	**760433.40**		**760436.40**			
4.6 mm ID	**760431.46**	**760433.46**		**760436.46**			
EC guard columns*		4 x 2 mm: **761975.20**		4 x 3 mm: **761975.30**			
NUCLEODUR® PFP, 3 µm						particle size 3 µm	
Analytical EC columns							
2 mm ID		**760443.20**		**760446.20**	**760447.20**	**760448.20**	**760449.20**
3 mm ID		**760443.30**		**760446.30**	**760447.30**	**760448.30**	**760449.30**
4 mm ID		**760443.40**		**760446.40**	**760447.40**	**760448.40**	**760449.40**
4.6 mm ID		**760443.46**	**760445.46**	**760446.46**	**760447.46**	**760448.46**	**760449.46**
EC guard columns*		4 x 2 mm: **761976.20**		4 x 3 mm: **761976.30**			
CC guard columns**		8 x 3 mm: **761145.30**		8 x 4 mm: **761145.40**			
NUCLEODUR® PFP, 5 µm						particle size 5 µm	
Analytical EC columns							
2 mm ID		**760453.20**		**760456.20**	**760457.20**	**760458.20**	**760459.20**
3 mm ID		**760453.30**		**760456.30**	**760457.30**	**760458.30**	**760459.30**
4 mm ID		**760453.40**		**760456.40**	**760457.40**	**760458.40**	**760459.40**
4.6 mm ID		**760453.46**	**760455.46**	**760456.46**	**760457.46**	**760458.46**	**760459.46**
EC guard columns*		4 x 2 mm: **761977.20**		4 x 3 mm: **761977.30**			
CC guard columns**		8 x 3 mm: **761146.30**		8 x 4 mm: **761146.40**			
VarioPrep columns							
10 mm ID		**762210.100**			**762211.100**		**762213.100**
21 mm ID		**762210.210**			**762211.210**		**762213.210**
32 mm ID							**762213.320**
40 mm ID						**762212.400**	**762213.400**
VP guard columns***		10 x 8 mm: **762214.80**		10 x 16 mm: **762214.160**		15 x 32 mm: **762216.320**	
EC and VarioPrep columns in packs of 1, guard columns see below							

Guard column systems						
Guard columns for EC columns with ID		**2 mm**	**3 mm**	**4 mm**	**4.6 mm**	Guard column holder
* Column Protection System (pack of)	EC	4/2 (3)	4/3 (3)	4/3 (3)	4/3 (3)	718966
** ChromCart® guard columns (pack of)	CC	8/3 (3)	8/3 (3)	8/4 (3)	8/4 (3)	721359
Guard columns for VarioPrep columns with ID		**8, 10 mm**	**16, 21 mm**	**32, 40 mm**	**≥ 50 mm**	
*** VP guard columns (pack of)	VP	10/8 (2)	10/16 (2)	15/32 (1)	15/50 (1)	
VP guard column holder		718251	718256	718253	718255	

For details of our column systems see pages 189–196

NUCLEODUR® high purity silica for HPLC

NUCLEODUR® Sphinx RP — bifunctional RP phase



- **Key features:**
  - Distinct selectivity based on well-balanced bifunctional surface coverage
  - Widens the scope for method development based on additional π–π interactions
  - Suitable for **LC/MS** due to low bleeding characteristics
- **Technical characteristics:**
  Octadecyl and propylphenyl modified silica; pore size 110 Å; particle sizes 1.8 µm, 3 µm and 5 µm; carbon content 15 %;
  pH stability 1–10; high reproducibility and consistent quality
- **Recommended application:**
  Quinolone antibiotics, sulfonamides, xanthines, substituted aromatics
  USP L1 and **L11**

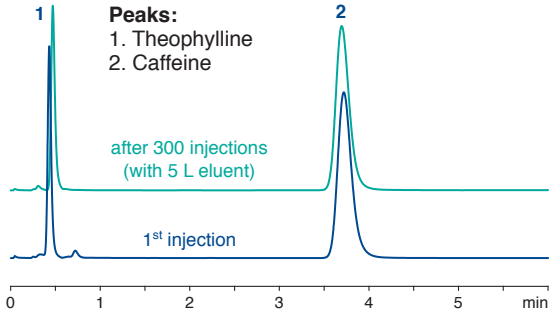
Alternative RP selectivity

NUCLEODUR® Sphinx RP is characterized by exceptional selectivity features generated by a **well-balanced ratio of covalently bonded octadecyl and phenyl groups**. The combination of classical hydrophobic with π–π interactions (aromatic ring system) expands the scope of selectivity in comparison with conventional reversed phase packings. NUCLEODUR® Sphinx RP is particularly suited for the separation of molecules containing aromatic and multiple bonds. For the separation of polar compounds NUCLEODUR® Sphinx RP can be especially recommended and can also outperform many customary C_{18} phases. In addition, exhaustive endcapping steps minimize unwanted surface silanol activity and guarantee excellent peak shapes even for strong basic analytes.

Stability of NUCLEODUR® Sphinx RP at pH 10

Column: 50 x 4.6 mm NUCLEODUR® Sphinx RP, 5 µm
Eluent: methanol – dil. NH_3, pH 10 (20:80, v/v)
Flow rate: 1.0 mL/min, temperature 30 °C
Detection: UV, 275 nm, injection 3 µL

Peaks:
1. Theophylline
2. Caffeine



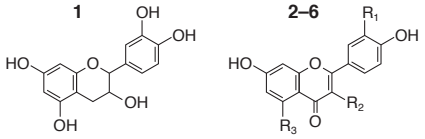
MN Appl. No. 120900

Different from standard phenyl phases, NUCLEODUR® Sphinx RP is far more stable towards hydrolysis and is also suggested for LC/MS applications. Due to the additional intermolecular interactions NUCLEODUR® Sphinx RP is an interesting replenishment to the high density bonded phases NUCLEODUR® C_8/C_{18} Gravity and the polar endcapped NUCLEODUR® C_{18} Pyramid.

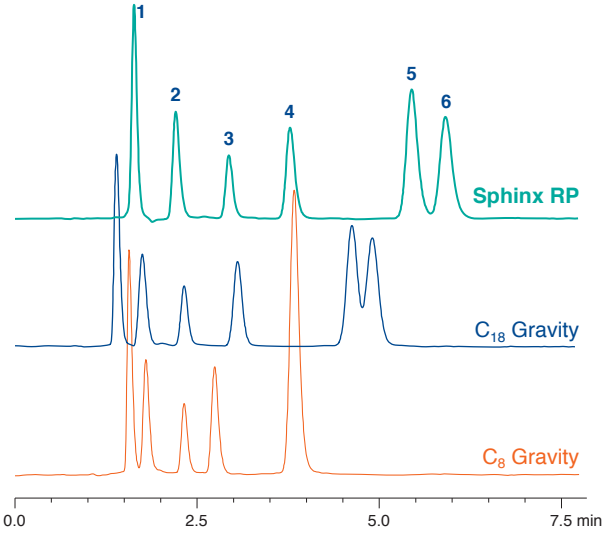
Separation of flavonoids on 3 different NUCLEODUR® phases

Columns: 150 x 4.6 mm
NUCLEODUR® Sphinx RP, 5 µm
NUCLEODUR® C_{18} Gravity, 5 µm
NUCLEODUR® C_8 Gravity, 5 µm
Eluent: water – methanol (40:60, v/v)
Flow rate: 1 mL/min
Temperature: 30 °C
Detection: UV, 270 nm
Injection: 3 µL

Peaks:



1. Catechin
2. Rutin — $R_1 = R_3 = OH$, R_2 = O-Rutinose
3. Fisetin — $R_1 = R_2 = OH$, $R_3 = H$
4. Quercetin — $R_1 = R_2 = R_3 = OH$
5. Kaempferol — $R_1 = H$, $R_2 = R_3 = OH$
6. Isorhamnetin — $R_1 = OCH_3$, $R_2 = R_3 = OH$



MN Appl. No. 119830

Ordering information

Eluent in column acetonitrile – water

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® Sphinx RP, 1.8 µm						particle size 1.8 µm	
Analytical EC columns							
2 mm ID	760821.20	760822.20	760825.20	760823.20		760824.20	
3 mm ID	760821.30	760822.30		760823.30			
4 mm ID	760821.40	760822.40		760823.40			
4.6 mm ID	760821.46	760822.46		760823.46			
EC guard columns*		4 x 2 mm: 761920.20		4 x 3 mm: 761920.30			
NUCLEODUR® Sphinx RP, 3 µm						particle size 3 µm	
Analytical EC columns							
2 mm ID		760806.20		760812.20	760807.20	760805.20	760808.20
3 mm ID		760806.30		760812.30	760807.30	760805.30	760808.30
4 mm ID		760806.40		760812.40	760807.40	760805.40	760808.40
4.6 mm ID		760806.46	760813.46	760812.46	760807.46	760805.46	760808.46
EC guard columns*		4 x 2 mm: 761921.20		4 x 3 mm: 761921.30			
CC guard columns**		8 x 3 mm: 761557.30		8 x 4 mm: 761557.40			
NUCLEODUR® Sphinx RP, 5 µm						particle size 5 µm	
Analytical EC columns							
2 mm ID		760800.20		760809.20	760801.20	760802.20	760803.20
3 mm ID		760800.30		760809.30	760801.30	760802.30	760803.30
4 mm ID		760800.40		760809.40	760801.40	760802.40	760803.40
4.6 mm ID		760800.46	760815.46	760809.46	760801.46	760802.46	760803.46
EC guard columns*		4 x 2 mm: 761922.20		4 x 3 mm: 761922.30			
CC guard columns**		8 x 3 mm: 761550.30		8 x 4 mm: 761550.40			
VarioPrep columns							
10 mm ID		762372.100			762375.100		762373.100
21 mm ID		762372.210			762375.210		762373.210
32 mm ID							762373.320
40 mm ID						762371.400	762373.400
VP guard columns***		10 x 8 mm: 762390.80		10 x 16 mm: 762390.160		15 x 32 mm: 762392.320	
EC and VarioPrep columns in packs of 1, guard columns see below							

Guard column systems						
Guard columns for EC columns with ID		**2 mm**	**3 mm**	**4 mm**	**4.6 mm**	Guard column holder
* Column Protection System (pack of)	EC	4/2 (3)	4/3 (3)	4/3 (3)	4/3 (3)	718966
** ChromCart® guard columns (pack of)	CC	8/3 (3)	8/3 (3)	8/4 (3)	8/4 (3)	721359
Guard columns for VarioPrep columns with ID		**8, 10 mm**	**16, 21 mm**	**32, 40 mm**	**≥ 50 mm**	
*** VP guard columns (pack of)	VP	10/8 (2)	10/16 (2)	15/32 (1)	15/50 (1)	
VP guard column holder		718251	718256	718253	718255	

For details of our column systems see pages 189–196

NUCLEODUR® high purity silica for HPLC

NUCLEODUR® C_{18} HTec — base-deactivated preparative octadecyl phase

Key features:
- Reliable and durable standard RP phase for up-scaling to preparative scale, suited for **LC/MS**
- High loading capacity and excellent stability
- Outstanding base deactivation

Technical characteristics:
High density octadecyl modification (C_{18}); pore size 110 Å; particle sizes 1.8 µm, 3 µm, 5 µm, 7 µm and 10 µm for analytical and preparative separations; carbon content 18%, pH stability 1–11

Recommended application:
Sophisticated analytical and preparative separations of basic, neutral and acidic pharmaceuticals, derivatized amino acids, pesticides, fat-soluble vitamins, aldehydes, ketones and phenolic compounds

USP L1

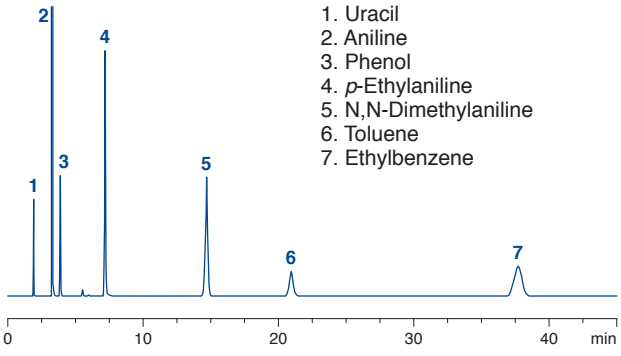
Preparative separations place high demands on silica based HPLC materials. Apart from excellent selectivity and base deactivation, robustness (pH, pressure stability, ...) and capacity are vital criteria for optimal and efficient separation at the preparative scale.

Selectivity and base deactivation

The innovative endcapping procedure leads to exceptionally good base deactivation – the Engelhardt test demonstrates superb selectivity, peak symmetry and peak shape over the entire polarity range. In addition NUCLEODUR® C_{18} HTec scores in low bleed characteristics and is therefore highly suitable for LC/MS.

Engelhardt test

Column: 250 x 4 mm NUCLEODUR® C_{18} HTec, 5 µm
Eluent: methanol – water (49:51, v/v)
Flow rate: 1 mL/min
Temperature: 40 °C
Detection: UV, 254 nm
Injection: 5 µL



Peaks:
1. Uracil
2. Aniline
3. Phenol
4. *p*-Ethylaniline
5. N,N-Dimethylaniline
6. Toluene
7. Ethylbenzene

MN Appl. No. 123580

Stability and lifetime

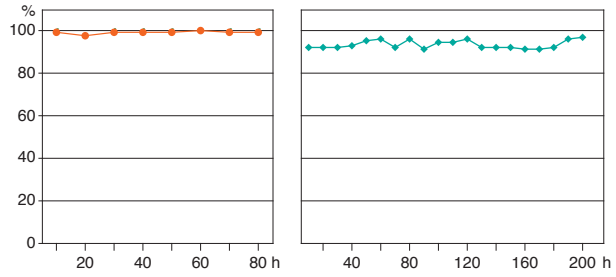
Based on fully synthetic and extremely robust totally spherical NUCLEODUR® silica, NUCLEODUR® C_{18} HTec offers outstanding mechanical rigidity and is thus the perfect choice also for self-packing of prep-columns. The special surface modification and endcapping procedure result in high chemical stability even at extreme chromatographic conditions like high flow rates, temperature or critical solvents (DMSO). Furthermore, NUCLEODUR® C_{18} HTec columns show a remarkably long lifetime in acidic (pH 1) as well as basic (pH 10) mobile phases.

pH stability test

Column: 150 x 4 mm NUCLEODUR® C_{18} HTec, 5 µm
Flow rate: 1 mL/min
Detection: UV, 254 nm
Injection: 5 µL

pH 1:
Eluent: acetonitrile – 1 % TFA in water (50:50, v/v); 80 °C
● % initial retention of ethylbenzene
693 injections

pH 10:
Eluent: methanol – 50 mmol/L triethylamine (25:85, v/v); 50 °C
◆ % initial N of theophylline
1034 injections



Due to innovative surface coating procedures NUCLEODUR® C_{18} HTec offers excellent analytical separation properties and is the first choice for up-scaling to preparative column dimensions.

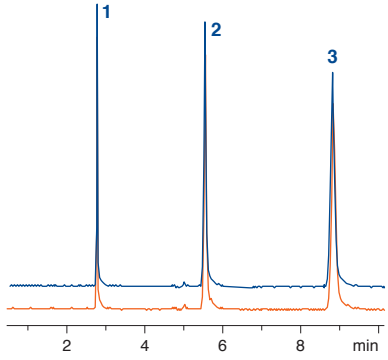
Up-scaling

Due to highest quality standards in silica production and phase chemistry combined with optimized packing technology, NUCLEODUR® C_{18} HTec allows exceptional transferability from analytical to preparative scale with respect to different particle sizes (e.g., 5, 7 or 10 µm) as well as column dimensions (e.g., ID 4.6 to 21 mm).

Up-scaling with NUCLEODUR® C_{18} HTec

Columns: **EC 250 x 4.6 mm NUCLEODUR® C_{18} HTec, 5 µm**
VP 250 x 21 mm NUCLEODUR® C_{18} HTec, 5 µm
Eluent: acetonitrile – water (80:20, v/v)
Flow rate: 1.3 mL/min / 27 mL/min
Temperature: 22 °C
Pressure: 84 bar / 109 bar
Detection: UV, 254 nm
Injection: 3 µL / 60 µL

Peaks: (1 mg/mL each)
1. Phenol
2. Naphthalene
3. Anthracene



MN Appl. No. 123780

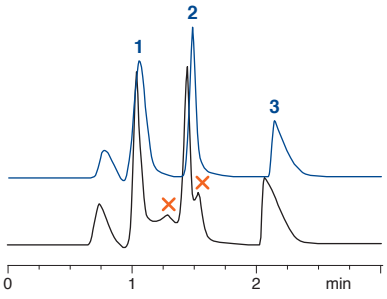
Capacity

A vital criterion for efficiency in preparative HPLC is the capacity of the separation medium. NUCLEODUR® C_{18} HTec is characterized by a notably high loading capacity under both basic and acidic conditions, while competitor columns show overload effects even at lower loads (x).

Loading capacity under acidic conditions

Columns: **VP 100 x 21 mm NUCLEODUR® C_{18} HTec, 5 µm**
100 x 21.2 mm AXIA™ Gemini® 5 µm C_{18} 110 Å
Eluent: acetonitrile – formic acid in H_2O pH 3.0 (30:70, v/v)
Flow rate: 28 mL/min
Temperature: 22 °C
Pressure: 124 bar
Detection: UV, 254 nm

Peaks:
total load 40 mg
(sample dissolved in DMSO)
1. 4-Acetamidophenol (5 mg)
2. 2-Acetamidophenol (10 mg)
3. Acetylsalicylic acid (25 mg)



MN Appl. No. 123890

Ordering information

Eluent in column acetonitrile – water

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® C_{18} HTec, 1.8 µm						particle size 1.8 µm	
Analytical EC columns							
2 mm ID	**760301.20**	**760305.20**	**760304.20**	**760306.20**		**760308.20**	
3 mm ID	**760301.30**	**760305.30**		**760306.30**			
4 mm ID	**760301.40**	**760305.40**		**760306.40**			
4.6 mm ID	**760301.46**	**760305.46**		**760306.46**			
EC guard columns*		4 x 2 mm: **761925.20**		4 x 3 mm: **761925.30**			
NUCLEODUR® C_{18} HTec, 3 µm						particle size 3 µm	
Analytical EC columns							
2 mm ID		**760321.20**		**760323.20**	**760324.20**	**760325.20**	**760326.20**
3 mm ID		**760321.30**		**760323.30**	**760324.30**	**760325.30**	**760326.30**
4 mm ID		**760321.40**		**760323.40**	**760324.40**	**760325.40**	**760326.40**
4.6 mm ID		**760321.46**	**760322.46**	**760323.46**	**760324.46**	**760325.46**	**760326.46**
EC guard columns*		4 x 2 mm: **761926.20**		4 x 3 mm: **761926.30**			
CC guard columns**		8 x 3 mm: **761120.30**		8 x 4 mm: **761120.40**			

NUCLEODUR® high purity silica for HPLC

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® C_{18} HTec, 5 µm							particle size 5 µm
Analytical EC columns							
2 mm ID		760311.20		760313.20	760314.20	760315.20	760316.20
3 mm ID		760311.30		760313.30	760314.30	760315.30	760316.30
4 mm ID		760311.40		760313.40	760314.40	760315.40	760316.40
4.6 mm ID		760311.46	760312.46	760313.46	760314.46	760315.46	760316.46
EC guard columns*		4 x 2 mm: 761927.20		4 x 3 mm: 761927.30			
CC guard columns**		8 x 3 mm: 761110.30		8 x 4 mm: 761110.40			
Preparative VarioPrep columns							
10 mm ID		762551.100			762554.100		762556.100
21 mm ID		762551.210		762553.210	762554.210		762556.210
32 mm ID				762553.320		762555.320	762556.320
40 mm ID						762555.400	762556.400
50 mm ID				762553.500		762555.500	762556.500
VP guard columns***		10 x 8 mm: 762591.80		10 x 16 mm: 762591.160			
		15 x 32 mm: 762592.320		15 x 50 mm: 762592.500			
NUCLEODUR® C_{18} HTec, 7 µm							particle size 7 µm
Preparative VarioPrep columns							
10 mm ID		762561.100			762564.100		762566.100
21 mm ID		762561.210		762563.210	762564.210		762566.210
32 mm ID				762563.320		762565.320	762566.320
40 mm ID						762565.400	762566.400
50 mm ID				762563.500		762565.500	762566.500
VP guard columns***		10 x 8 mm: 762591.80		10 x 16 mm: 762591.160			
		15 x 32 mm: 762592.320		15 x 50 mm: 762592.500			
NUCLEODUR® C_{18} HTec, 10 µm							particle size 10 µm
Preparative VarioPrep columns							
10 mm ID		762571.100			762574.100		762576.100
21 mm ID		762571.210		762573.210	762574.210		762576.210
32 mm ID				762573.320		762575.320	762576.320
40 mm ID						762575.400	762576.400
50 mm ID				762573.500		762575.500	762576.500
VP guard columns***		10 x 8 mm: 762591.80		10 x 16 mm: 762591.160			
		15 x 32 mm: 762592.320		15 x 50 mm: 762592.500			
EC and VarioPrep columns in packs of 1, guard columns see below							

Guard column systems						
Guard columns for EC columns with ID		**2 mm**	**3 mm**	**4 mm**	**4.6 mm**	Guard column holder
* Column Protection System (pack of)	EC	4/2 (3)	4/3 (3)	4/3 (3)	4/3 (3)	718966
** ChromCart® guard columns (pack of)	CC	8/3 (3)	8/3 (3)	8/4 (3)	8/4 (3)	721359
Guard columns for VarioPrep columns with ID		**8, 10 mm**	**16, 21 mm**	**32, 40 mm**	**≥ 50 mm**	
*** VP guard columns (pack of)	VP	10/8 (2)	10/16 (2)	15/32 (1)	15/50 (1)	
VP guard column holder		718251	718256	718253	718255	

For details of our column systems see pages 189–196

NUCLEODUR® C_{18} HTec bulk material in 5, 7 and 10 µm for self-packing of preparative columns see page 198

NUCLEODUR® C_{18} ec · C_8 ec — nonpolar phases for routine analysis

Key features:
- Ideal and reliable standard RP phase for daily routine analysis and up-scaling for preparative HPLC
- Medium density octadecyl (C_{18}) and octyl (C_8) modification with exhaustive end-capping
- Wide range of application areas

Technical characteristics:
Pore size 110 Å; particle sizes 3 µm and 5 µm; 7 µm, 10 µm, 12 µm, 16 µm, 20 µm, 30 µm and 50 µm for preparative separations; carbon content 17.5 % for C_{18}, 10.5 % for C_8

pH stability 1–9, high reproducibility from lot to lot

Recommended application:
Basic, neutral or acidic drugs, derivatized amino acids, pesticides
fat-soluble vitamins, aldehydes and ketones, phenolic compounds

USP L1 (C_{18}) / **L7** (C_8)

NUCLEODUR® C_{18} ec for daily routine analysis and up-scaling for preparative HPLC

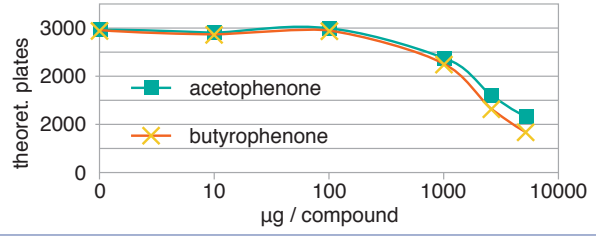
The efficiency of a separation is controlled by particle size and selectivity of the stationary phase. The exceptional surface coverage of monomeric bonded alkylsilanes, combined with an exhaustive endcapping, results in a surface with lowest silanol activity. This allows the tailing-free elution of polar compounds such as basic drugs. NUCLEODUR® C_{18} ec is available in 9 different particle sizes (3, 5, 7, 10, 12, 16, 20, 30 and 50 µm) which cover the whole range from high speed analytical HPLC up to medium and low pressure prep LC. NUCLEODUR® C_{18} ec is also an ideal tool for scale-up purposes.

Loading capacity

Loading capacity, probably the most important feature for preparative LC applications, is determined by pore size, pore volume and surface area of the packing. However, it can also be influenced by the molecular weight of the analytes. In the figure below the mass loading curve for acetophenone and butyrophenone on a NUCLEODUR® 100-20 C_{18} ec column describes the correlation between the increase of column loading and the decrease of separation efficiency.

Loading curve

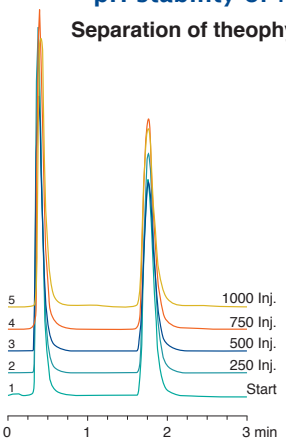
Column: 250 x 4.6 mm NUCLEODUR® 100-20 C_{18} ec, eluent: acetonitrile – H_2O 80:20 (v/v), flow rate: 1.0 mL/min, temperature: 25 °C, detection: UV, 280–370 nm



pH stability of NUCLEODUR® C_{18} ec

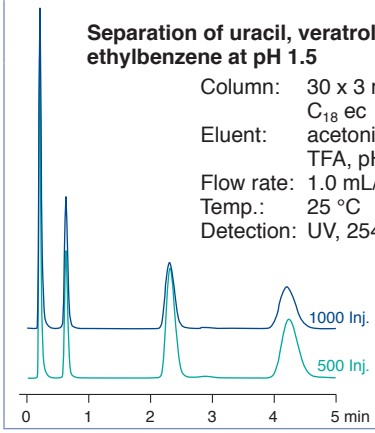
Separation of theophylline and caffeine at pH 10

Columns: 30 x 3 mm
NUCLEODUR® 100-5 C_{18} ec
Eluent: methanol – aq. NH_3 (20:80, v/v), pH 10
Flow rate: 0.5 mL/min
Temperature: 25 °C
Detection: UV, 254 nm



Separation of uracil, veratrol, toluene and ethylbenzene at pH 1.5

Column: 30 x 3 mm NUCLEODUR® 100-5 C_{18} ec
Eluent: acetonitrile – H_2O (65:35, v/v), TFA, pH 1.5
Flow rate: 1.0 mL/min
Temp.: 25 °C
Detection: UV, 254 nm



Chemical stability

The utmost purity of the base silica and the exceptional silane bonding chemistry minimize the risk of dissolution, or hydrolysis at pH extremes. The chromatograms show the retention behavior at pH values of 1.5 and 10.0 for NUCLEODUR® 100-5 C_{18} ec.

NUCLEODUR® high purity silica for HPLC

NUCLEODUR® octyl phases

In addition to NUCLEODUR® C_{18} phases MACHEREY-NAGEL offers octyl modified NUCLEODUR® C_8 Gravity and NUCLEODUR® C_8 ec columns to expand the RP tool box. Based on the same spherical high purity silica the C_8 phases exhibit the same chemical and mechanical stability as the C_{18} counterparts. Indeed NUCLEODUR® C_8 Gravity can also be run at pH extremes (pH 1–11) by choosing appropriate elution parameters. Due to the shorter chain and less hydrophobic properties of the stationary phase the retention of non-polar compounds is decreased, and in consequence a reduction in time of analysis can be achieved. Moreover a stronger polar selectivity, particularly with the separation of ionizable analytes is frequently observed (as distinct from the C_{18} phases). NUCLEODUR® C_8 ec and NUCLEODUR® C_8 Gravity are most suitable for the development of new methods but also for robust routine analyses.

There are no general guidelines which could make the choice between C_8 and C_{18} phases easier but it will always be beneficial to add both phases to the existing pool of RP columns in the laboratory.

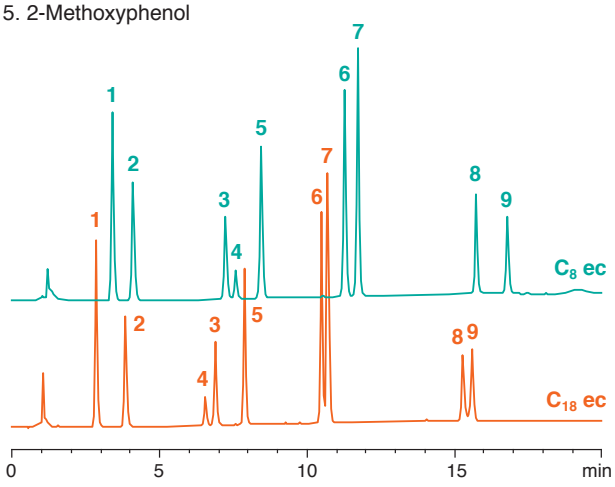
Comparative studies reveal some different selectivity patterns of NUCLEODUR® C_8 ec and C_{18} ec. The separation of phenols at right shows baseline separation for 2-ethoxyphenol and dimethoxybenzene (veratrol) and in addition a reversal of the elution order of phenol and 4-methoxyphenol can be shown on the octyl phase.

Separation of phenols

Column: 250 x 4 mm NUCLEODUR® 100-5 C_8 ec / C_{18} ec
Eluent: A) water, B) methanol
C_8: 20 % B (2 min) → 60 % B in 12 min
C_{18}: 25 % B (2 min) → 65 % B in 12 min
Flow rate: 1.0 mL/min, temperature 25 °C
Detection: UV, 275 nm, injection 10 µL

Peaks:

1. Resorcinol
2. Pyrocatechol
3. 4-Methoxyphenol
4. Phenol
5. 2-Methoxyphenol
6. 2-Ethoxyphenol
7. Veratrol
8. Biphenyl-2-ol
9. Phenetole



MN Appl. No. 120890/120891

C_{18} or C_8 · the best of both worlds

- High density C_8 and C_{18} phases allow tailing-free elution, also for very polar compounds.
- Octyl phases (C_8) show superior polar selectivity.
- Octadecyl phases (C_{18}) show superior hydrophobic selectivity.
- Hydrophobic compounds show shorter retention times on C_8 phases.

Ordering information

Eluent in column acetonitrile – water

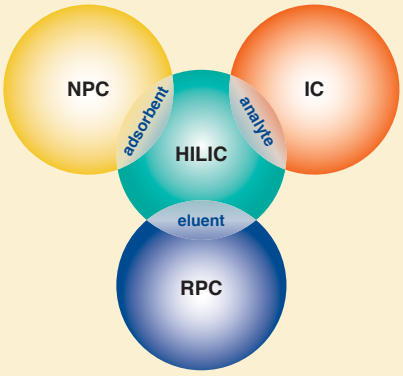
Length →	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® 100-3 C_{18} ec			octadecyl phase, 17.5 % C, particle size 3 µm			
Analytical EC columns						
2 mm ID	**760050.20**		**760054.20**	**760051.20**	**760053.20**	**760052.20**
3 mm ID	**760050.30**		**760054.30**	**760051.30**	**760053.30**	**760052.30**
4 mm ID	**760050.40**		**760054.40**	**760051.40**	**760053.40**	**760052.40**
4.6 mm ID	**760050.46**	**760046.46**	**760054.46**	**760051.46**	**760053.46**	**760052.46**
EC guard columns*		4 x 2 mm: **761931.20**		4 x 3 mm: **761931.30**		
CC guard columns**		8 x 3 mm: **761005.30**		8 x 4 mm: **761005.40**		

Guard column systems see previous NUCLEODUR® phases
For details of our column systems see pages 189–196
NUCLEODUR® C_{18} ec bulk material with 10–50 µm for self-packing of preparative columns see page 198

Length →	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® 100-5 C_{18} ec				octadecyl phase, 17.5 % C, particle size 5 µm		
Analytical EC columns						
2 mm ID	760004.20		760013.20	760001.20	760008.20	760002.20
3 mm ID	760004.30		760013.30	760001.30	760008.30	760002.30
4 mm ID	760004.40		760013.40	760001.40	760008.40	760002.40
4.6 mm ID	760004.46	760035.46	760013.46	760001.46	760008.46	760002.46
EC guard columns*		4 x 2 mm: **761932.20**		4 x 3 mm: **761932.30**		
CC guard columns**		8 x 3 mm: **761100.30**		8 x 4 mm: **761100.40**		
VarioPrep columns						
10 mm ID	762003.100			762029.100		762022.100
21 mm ID	762003.210			762029.210		762022.210
32 mm ID						762022.320
40 mm ID					762027.400	762022.400
VP guard columns***		10 x 8 mm: **762090.80**		10 x 16 mm: **762090.160**		
		15 x 32 mm: **762311.320**		15 x 50 mm: **762311.500**		
NUCLEODUR® 100-10 C_{18} ec				octadecyl phase, 17.5 % C, particle size 10 µm		
VarioPrep columns						
10 mm ID	762011.100			762302.100		762010.100
21 mm ID	762011.210			762302.210		762010.210
32 mm ID						762010.320
40 mm ID					762303.400	762010.400
50 mm ID						762010.500
VP guard columns***		10 x 8 mm: **762090.80**		10 x 16 mm: **762090.160**		
		15 x 32 mm: **762311.320**		15 x 50 mm: **762311.500**		
NUCLEODUR® 100-3 C_8 ec				octyl phase, 10.5 % C, particle size 3 µm		
Analytical EC columns						
2 mm ID	760063.20		760059.20	760060.20		760062.20
3 mm ID	760063.30		760059.30	760060.30		760062.30
4 mm ID	760063.40		760059.40	760060.40		760062.40
4.6 mm ID	760063.46	760064.46	760059.46	760060.46	760061.46	760062.46
EC guard columns*		4 x 2 mm: **761936.20**		4 x 3 mm: **761936.30**		
CC guard columns**		8 x 3 mm: **761012.30**		8 x 4 mm: **761012.40**		
NUCLEODUR® 100-5 C_8 ec				octyl phase, 10.5 % C, particle size 5 µm		
Analytical EC columns						
2 mm ID	760700.20		760704.20	760701.20		760703.20
3 mm ID	760700.30		760704.30	760701.30		760703.30
4 mm ID	760700.40		760704.40	760701.40		760703.40
4.6 mm ID	760700.46	760706.46	760704.46	760701.46	760702.46	760703.46
EC guard columns*		4 x 2 mm: **761937.20**		4 x 3 mm: **761937.30**		
CC guard columns**		8 x 3 mm: **761704.30**		8 x 4 mm: **761704.40**		
VarioPrep columns						
10 mm ID	762072.100			762061.100		762062.100
21 mm ID	762072.210			762061.210		762062.210
32 mm ID						762062.320
40 mm ID					762079.400	762062.400
VP guard columns***	10 x 8 mm: **762092.80**		10 x 16 mm: **762092.160**		15 x 32 mm: **762321.320**	
EC and VarioPrep columns in packs of 1, guard columns see previous NUCLEODUR® phases						

NUCLEODUR® high purity silica for HPLC

NUCLEODUR® HILIC — zwitterionic phase



- **Key features:**
  - Ideal for reproducible and stable chromatography of highly polar analytes
  - Suitable for analytical and preparative applications as well as **LC/MS**
  - Very short column conditioning period
- **Technical characteristics:**
  Ammonium – sulfonic acid modified silica; pore size 110 Å; particle sizes 1.8, 3 and 5 µm; carbon content 7%; pH stability 2–8.5
- **Recommended application:**
  Hydrophilic compounds such as organic polar acids and bases, polar natural compounds, nucleosides, oligonucleotides, amino acids, peptides, water soluble vitamins

Columns for HPLC

NUCLEODUR® HILIC

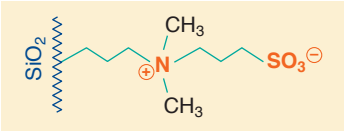
Separation science is always looking for new and effective strategies to accomplish the tasks of modern analytics. Especially for polar compounds reversed phase HPLC – the most common analytical method – is often limited. Here, hydrophilic stationary phases provide an additional tool for the separation of polar analytes in HPLC.

The expression HILIC (Hydrophilic Interaction Chromatography) was firstly published by Andrew Alpert in 1990 – since then it took quite some efforts to develop robust and reproducible hydrophilic HPLC phases for HILIC chromatography [A. Alpert, J. Chromatography **499** (1990), 177–196].

HILIC combines the characteristics of the 3 major methods in liquid chromatography – reversed phase (RPC), normal phase (NPC) and ion chromatography (IC):

- Stationary phases (adsorbents) are mostly polar modifications of silica or polymers (SiOH, NH_2, Diol, (zwitter) ions, ...) – like in NPC
- Mobile phases (eluents) are mixtures of aqueous buffer systems and organic modifier like acetonitrile or methanol – like in RPC
- Fields of application include quite polar compounds as well as organic and inorganic ions – like in IC

"HILIC is NP chromatography of polar and ionic compounds under RP conditions."



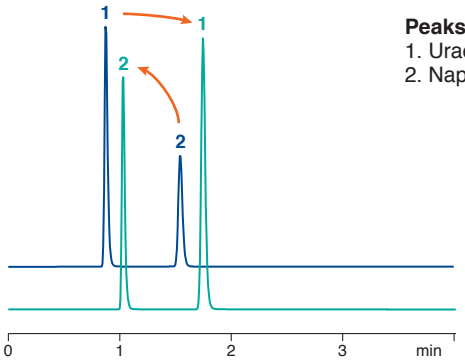
NUCLEODUR® HILIC is a special zwitterionic modified stationary phase based on ultra spherical NUCLEODUR® particles. The betaine character of the ammonium-sulfonic acid ligands results in total charge equalization and in an overall neutrally charged but highly polar surface.

Retention characteristic

Commonly HILIC is described as partition chromatography or liquid-liquid extraction system between mobile and stationary phases. Versus a water-poor mobile phase a water-rich layer on the surface of the polar stationary phase is formed. Thus, a distribution of the analytes between these two layers will occur. Furthermore HILIC includes weak electrostatic mechanisms as well as hydrogen donor interactions between neutral polar molecules under high organic elution conditions. This distinguishes HILIC from ion exchange chromatography – main principle for HILIC separation is based on compound's polarity and degree of solvation.

Separation of uracil and naphthalene

Columns: 125 x 4 mm NUCLEODUR® C_{18} Pyramid, 3 µm
125 x 4 mm NUCLEODUR® HILIC, 3 µm
Eluent: acetonitrile – water (90:10, v/v)
Flow rate: 1.0 mL/min, temperature 25 °C
Detection: UV, 254 nm



Peaks:
1. Uracil
2. Naphthalene

MN Appl. No. 122911/122912

More polar compounds will have stronger interaction with the stationary aqueous layer than less polar compounds – resulting in a stronger retention. Nonpolar compounds exhibit faster elution profiles due to minor hydrophobic interactions. In the separation of uracil and naphthalene the elution order is quite often inverse on HILIC columns compared to RP columns.

Stability features

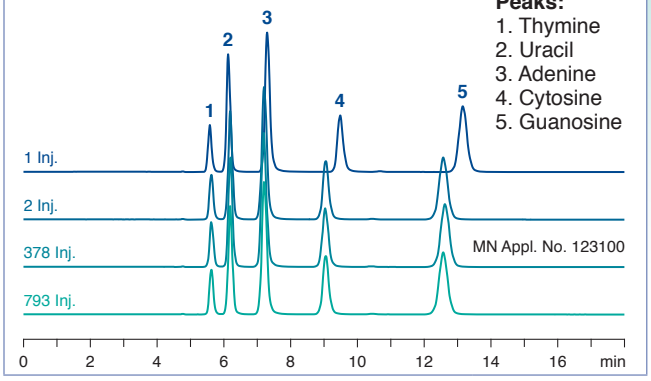
Due to an advanced and unique surface modification procedure (pat. pend.) NUCLEODUR® HILIC columns provide short equilibration times – after just 20 min equilibration already the 2nd injection shows stable and reproducible results. Beyond this, NUCLEODUR® HILIC columns are characterized by an outstanding column life time – even after nearly 800 runs the columns show no loss of pristine performance – peak shape and retention are still immaculate.

Due to its high loading capacity NUCLEODUR® HILIC is absolutely suitable for preparative and semi-preparative applications.

Overall NUCLEODUR® HILIC provides excellent chromatographic features and is hereby the perfect choice for separation of polar or charged compounds.

Stability and equilibration

Column: 250 x 4 mm NUCLEODUR® HILIC, 5 µm
Eluent: CH_3CN – 5 mmol/L ammonium acetate (80:20, v/v)
Flow rate: 0.6 mL/min, temperature 25 °C
Detection: UV, 254 nm



Ordering information

Eluent in column acetonitrile – water (80:20, v/v)

Length →	30 mm	50 mm	75 mm	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® HILIC, 1.8 µm						particle size 1.8 µm	
EC columns							
2 mm ID	**760521.20**	**760523.20**	**760525.20**	**760526.20**		**760528.20**	
3 mm ID	**760521.30**	**760523.30**		**760526.30**			
4 mm ID	**760521.40**	**760523.40**		**760526.40**			
4.6 mm ID	**760521.46**	**760523.46**		**760526.46**			
EC guard columns*		4 x 2 mm: **761960.20**		4 x 3 mm: **761960.30**			
NUCLEODUR® HILIC, 3 µm						particle size 3 µm	
EC columns							
2 mm ID		**760532.20**		**760534.20**	**760531.20**	**760533.20**	**760530.20**
3 mm ID		**760532.30**		**760534.30**	**760531.30**	**760533.30**	**760530.30**
4 mm ID		**760532.40**		**760534.40**	**760531.40**	**760533.40**	**760530.40**
4.6 mm ID		**760532.46**		**760534.46**	**760531.46**	**760533.46**	**760530.46**
EC guard columns*		4 x 2 mm: **761961.20**		4 x 3 mm: **761961.30**			
CC guard columns**		8 x 3 mm: **761580.30**		8 x 4 mm: **761580.40**			
NUCLEODUR® HILIC, 5 µm						particle size 5 µm	
EC columns							
2 mm ID		**760552.20**		**760554.20**	**760551.20**	**760553.20**	**760550.20**
3 mm ID		**760552.30**		**760554.30**	**760551.30**	**760553.30**	**760550.30**
4 mm ID		**760552.40**		**760554.40**	**760551.40**	**760553.40**	**760550.40**
4.6 mm ID		**760552.46**		**760554.46**	**760551.46**	**760553.46**	**760550.46**
EC guard columns*		4 x 2 mm: **761962.20**		4 x 3 mm: **761962.30**			
CC guard columns**		8 x 3 mm: **761590.30**		8 x 4 mm: **761590.40**			

EC columns in packs of 1, guard columns in packs of 3; for details see page 189

Guard column systems

Guard columns for EC columns with ID		2 mm	3 mm	4 mm	4.6 mm	Guard column holder
* Column Protection System	EC	4/2	4/3	4/3	4/3	718966
** ChromCart® guard columns	CC	8/3	8/3	8/4	8/4	721359

NUCLEODUR® high purity silica for HPLC

NUCLEODUR® CN / CN-RP — cyano-modified high purity silica phase

Key features:
- High retention capacity especially for very polar and unsaturated compounds
- Multi-mode column (RP and NP) widens scope of selectivity
- Stable against hydrolysis at low pH (working range pH 1–8)

Technical characteristics:
Cyanopropyl-modified high purity silica; pore size 110 Å; particle sizes 3 µm and 5 µm; carbon content 7%; special endcapping, high reproducibility from lot to lot; different retention characteristics in comparison to C_8 and C_{18}

Recommended application:
Tricyclic antidepressants
steroids
organic acids
USP L10

Alternative bonded-phase functionality

In reversed phase HPLC it is fairly common to start with C_{18} or C_8 columns, if new methods have to be developed. However, superior polarity and selectivity properties often required for more sophisticated separations, are not always sufficiently provided by classical RP phases, which are usually characterized by a hydrophobic layer of monomeric or polymeric bonded alkylsilanes.

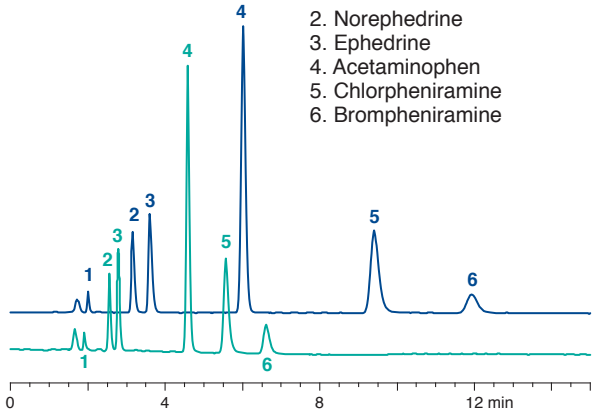
One approach to improve the resolution of compounds poorly separated on nonpolar stationary phases, is to change bonded-phase functionality. The fully endcapped and highly reproducible NUCLEODUR® 100-5 CN-RP phase has cyanopropyl groups on the surface able to generate a clearly recognizable different retention behavior compared to purely alkyl-functionalized surface modifications (see figure below).

The polarity of NUCLEODUR® 100-5 CN-RP can be classified as intermediate based on multiple retention mechanisms such as dipole-dipole, π-π, and also hydrophobic interactions [C. S. Young and R. J. Weigand, LCGC **20** (2002) 464–473]. Therefore, this phase shows a distinct selectivity for polar organic compounds as well as for molecules containing π electron systems (e.g. analytes with double bonds, tricyclic antidepressants) [V. R. Meyer, Practical High Performance Liquid Chromatography (John Wiley & Sons, New York, 3rd ed., 1999)]. Short-chain bonded phases are sometimes suspected of revealing shortcomings in stability towards hydrolysis at low pH [J. J. Kirkland, LCGC **14** (1996) 486–500]. The following chromatograms show that even after 100 sample injections and four weeks storage at pH 1 (blue curve), neither a considerable shift in retention, nor a visible change in peak symmetry could be noticed (green curve = new column).

Separation of cold medicine ingredients on two different NUCLEODUR® phases

Columns: A) 250 x 4 mm NUCLEODUR® 100-5 C_{18} ec
B) 250 x 4 mm NUCLEODUR® 100-5 CN-RP
Eluent: acetonitrile – 100 mmol/L sodium citrate pH 2.5 (15:85, v/v)
Flow rate: 1.0 mL/min, temperature 25 °C
Detection: UV, 270 nm, injection 10 µL

Peaks:
1. Maleic acid
2. Norephedrine
3. Ephedrine
4. Acetaminophen
5. Chlorpheniramine
6. Brompheniramine

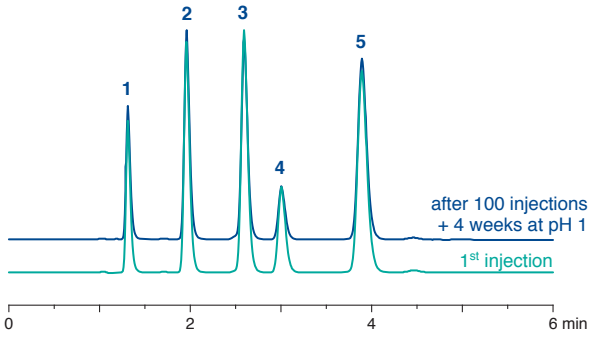


MN Appl. No. 119340

Stability of NUCLEODUR® CN-RP at pH 1

Column: 125 x 4 mm NUCLEODUR® 100-5 CN-RP
Eluent: acetonitrile – water, 2% TFA pH 1 (50:50, v/v)
Flow rate: 1.0 mL/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection: 5 µL

Peaks:
1. Benzamide
2. Dimethyl phthalate
3. Phenetole
4. *o*-Xylene
5. Biphenyl



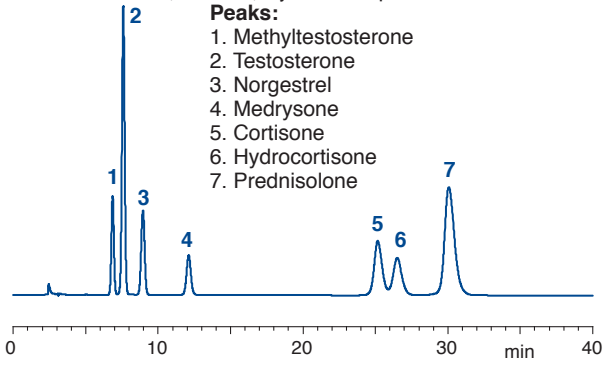
MN Appl. No. 119350

Due to its polarity the cyano phase can also be run in normal phase mode. NUCLEODUR® CN columns for NP applications are shipped in *n*-heptane. The change in selectivity and order of elution for a mixture of various steroids in NP and RP mode is displayed below. The high coverage combined with a thorough endcapping makes NUCLEODUR® 100-5 CN-RP suitable for separation of ionizable compounds such as basic drugs.

Separation of steroids in normal phase and reversed phase mode

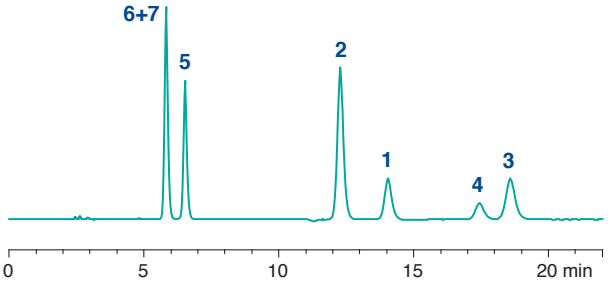
Normal phase mode
Column: 250 x 4 mm NUCLEODUR® 100-5 CN
Eluent: *n*-heptane – 2-propanol (90:10, v/v)
Flow rate: 1.0 mL/min, temperature 25 °C
Detection: UV, 254 nm, injection 10 µL

Peaks:
1. Methyltestosterone
2. Testosterone
3. Norgestrel
4. Medrysone
5. Cortisone
6. Hydrocortisone
7. Prednisolone



Reversed phase mode
Column: 250 x 4 mm NUCLEODUR® 100-5 CN-RP
Eluent: acetonitrile – water (25:75, v/v)
other conditions as for normal phase mode

MN Appl. Nos. 119271/119272



Ordering information

Length →	50 mm	125 mm	150 mm	250 mm
NUCLEODUR® 100-3 CN-RP		particle size 3 µm; eluent in column acetonitrile – water		
EC columns				
2 mm ID	**760159.20**	**760157.20**		
3 mm ID		**760157.30**		
4 mm ID			**760156.40**	
4.6 mm ID			**760156.46**	
EC guard columns*	4 x 2 mm: **761941.20**		4 x 3 mm: **761941.30**	
CC guard columns**	8 x 3 mm: **761430.30**		8 x 4 mm: **761430.40**	
NUCLEODUR® 100-5 CN-RP		particle size 5 µm; eluent in column acetonitrile – water		
EC columns				
4 mm ID		**760153.40**		**760152.40**
4.6 mm ID		**760153.46**	**760154.46**	**760152.46**
EC guard columns*			4 x 3 mm: **761944.30**	
CC guard columns**			8 x 4 mm: **761420.40**	
NUCLEODUR® 100-5 CN		particle size 5 µm; eluent in column *n*-heptane		
EC columns				
4 mm ID		**760151.40**	**760149.40**	**760150.40**
4.6 mm ID		**760151.46**	**760149.46**	**760150.46**
EC guard columns*			4 x 3 mm: **761943.30**	
CC guard columns**			8 x 4 mm: **761419.40**	

EC columns in packs of 1, guard columns in packs of 3; for details see page 189

Guard column systems

Guard columns for EC columns with ID		2 mm	3 mm	4 mm	4.6 mm	Guard column holder
* Column Protection System	EC	4/2	4/3	4/3	4/3	718966
** ChromCart® guard columns	CC	8/3	8/3	8/4	8/4	721359

NUCLEODUR® high purity silica for HPLC

NUCLEODUR® NH_2 / NH_2-RP — amino-modified high purity silica

- **Key features:**
  - Multi-mode columns (for RP, NP and IC)
  - Stable against hydrolysis at low pH (working range pH 2–8), 100 % stable in water; suitable for **LC/MS**
  - Widens scope of analytical HPLC into the polar range
- **Technical characteristics:**
  Aminopropyl modified high purity silica; pore size 110 Å; particle sizes 3, 5 and 7 µm; carbon content 2.5 %; not endcapped
- **Recommended application:**
  Polar compounds under RP conditions (sugars, DNA bases), hydrocarbons under NP conditions
  USP L8

- **Normal phase chromatography (NP)** with hexane, dichloromethane or 2-propanol as mobile phase for polar compounds such as substituted anilines, esters, chlorinated pesticides
- **Reversed phase chromatography (RP)** of polar compounds in aqueous-organic eluent systems
- **Ion exchange chromatography** of anions and organic acids using conventional buffers and organic modifiers

Some compounds, especially polar substances, cannot be sufficiently resolved on C_{18} phases. Polar-modified silica phases offer alternative selectivities thus expanding the spectrum of analytical HPLC into the polar range.

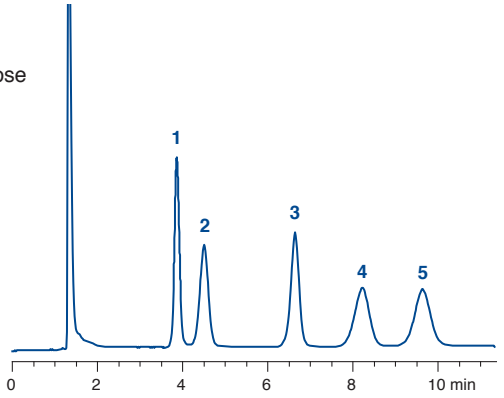
Multi-mode columns

Besides cyano modifications, amino modifications belong to the most frequently used polar silica phases – both feature the important advantage, that they can be run in the RP mode using aqueous-organic eluent mixtures as well as in the NP mode, e.g., with hexane as mobile phase.

Reversed phase separation of sugars

Column: 250 x 4 mm NUCLEODUR® 100-5 NH_2-RP
Eluent: acetonitrile – water (79:21, v/v)
Flow rate: 2 mL/min
Detection: RI

Peaks:
1. Fructose
2. Glucose
3. Saccharose
4. Maltose
5. Lactose



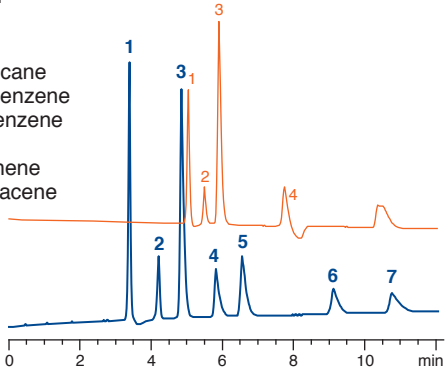
MN Appl. No. 122160

NUCLEODUR® NH_2, too, belongs to the so-called multi-mode columns. It can be used for RP chromatography of polar compounds such as sugars in aqueous-organic eluent systems, for NP chromatography of substituted aromatics or chlorinated pesticides with organic mobile phases such as hexane, dichloromethane or 2-propanol, but also for ion exchange chromatography of anions and organic acids using conventional buffers and organic modifiers. Main field of application of NUCLEODUR® NH_2 is the separation of simple and complex sugars, sugar alcohols and other hydroxy compounds under RP conditions as well as hydrocarbons under NP conditions.

Normal phase separation of middle distillates in accordance with DIN EN 12916

Columns: **A) 250 x 4 mm NUCLEODUR® 100-5 NH_2**
B) conventional aminopropyl phase
Eluent: heptane
Flow rate: 1 mL/min
Detection: RI

Peaks:
1. Cyclohexane
2. 1-Phenyldodecane
3. 1,2-Dimethylbenzene
4. Hexamethylbenzene
5. Naphthalene
6. Dibenzothiophene
7. 9-Methylanthracene



MN Appl. No. 122180

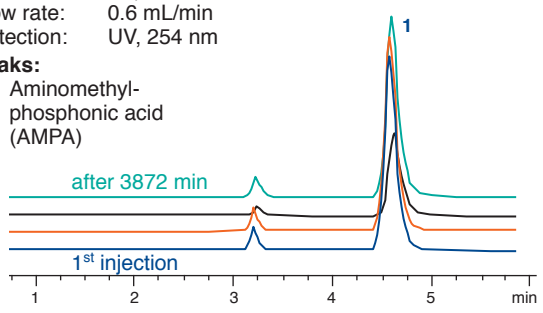
Due to the special method of surface modification NUCLEODUR® NH_2 features a pronounced stability at higher as well as at lower pH values. The following figure shows, that even after several days of exposure of the column material at pH 1.75 good separation efficiency and peak symmetry are maintained. The resulting high column life allows cost reduction due to lower column consumption. This example shows the enhanced pH stability of NUCLEODUR® NH_2 and the outstanding

suitability for the separation of total herbicides (AMPA, glyphosate, glufonisate, ...) – see application 122190 in our online data base at ***www.mn-net.com/apps***.

Hydrolytical resistance of NUCLEODUR® NH_2-RP

Column: 250 x 4 mm NUCLEODUR® 100-5 NH_2-RP
Eluent: acetonitrile – 50 mmol/L KH_2PO_4, pH 1.75 (50:50, v/v)
Flow rate: 0.6 mL/min
Detection: UV, 254 nm

Peaks:
1. Aminomethyl-phosphonic acid (AMPA)

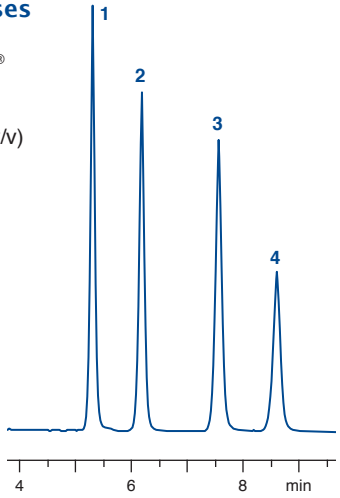


Separation of DNA bases

Column: 250 x 4 mm NUCLEODUR® 100-5 NH_2-RP
Eluent: acetonitrile – water (80:20, v/v)
Flow rate: 0.6 mL/min
Temperature: 35 °C
Pressure: 30 bar
Detection: UV, 254 nm

Peaks:
1. Thymine
2. Uracil
3. Cytosine
4. Adenine

MN Appl. No. 122170



Based on superspherical NUCLEODUR® this phase features a high pressure stability, which makes it the perfect choice for preparative separations as well as for LC/MS. Additionally, the high batch-to-batch reproducibility of NUCLEODUR® NH_2 enables reliable analyses especially for routine work.

Ordering information

Length →	100 mm	125 mm	150 mm	250 mm
NUCLEODUR® 100-3 NH_2-RP		particle size 3 µm; eluent in column acetonitrile – water		
EC columns				
2 mm ID	**760740.20**	**760741.20**		
4.6 mm ID			**760742.46**	**760739.46**
EC guard columns*	4 x 2 mm: **761951.20**		4 x 3 mm: **761951.30**	
CC guard columns**	8 x 3 mm: **761035.30**		8 x 4 mm: **761035.40**	
NUCLEODUR® 100-5 NH_2-RP		particle size 5 µm; eluent in column acetonitrile – water		
EC columns				
2 mm ID		**760730.20**		**760732.20**
3 mm ID		**760730.30**		**760732.30**
4 mm ID		**760730.40**		**760732.40**
4.6 mm ID		**760730.46**	**760731.46**	**760732.46**
EC guard columns*	4 x 2 mm: **761953.20**		4 x 3 mm: **761953.30**	
CC guard columns**	8 x 3 mm: **761137.30**		8 x 4 mm: **761137.40**	
NUCLEODUR® 100-5 NH_2		particle size 5 µm; eluent in column *n*-heptane		
EC columns				
4 mm ID		**760720.40**		**760722.40**
4.6 mm ID		**760720.46**	**760721.46**	**760722.46**
EC guard columns*			4 x 3 mm: **761952.30**	
CC guard columns**			8 x 4 mm: **761130.40**	

EC columns in packs of 1, guard columns in packs of 3; for details see page 189

Guard column systems

Guard columns for EC columns with ID		2 mm	3 mm	4 mm	4.6 mm	Guard column holder
* Column Protection System	EC	4/2	4/3	4/3	4/3	718966
** ChromCart® guard columns	CC	8/3	8/3	8/4	8/4	721359

NUCLEODUR® high purity silica for HPLC

NUCLEODUR® SiOH — unmodified silica for normal phase separations

Key features:

- Totally spherical high purity silica
- Pressure stable up to 600 bar
- Suitable for analytical and preparative separation of polar and midpolar compounds

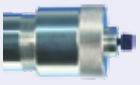
Technical characteristics:
Unmodified high purity silica; pore size 110 Å; particle sizes 3 to 50 µm; pore volume 0.9 mL/g; surface area (BET) 340 m^2/g; pH stability 2–8; metal content < 10 ppm (see page 110)

Recommended application:
Polar and midpolar compounds under normal phase conditions

USP L3

Ordering information

Eluent in column *n*-heptane

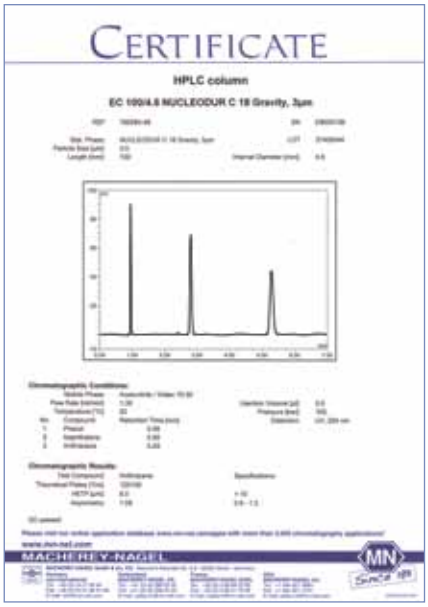
Length →	50 mm	125 mm	150 mm	250 mm
NUCLEODUR® 100-3				particle size 3 µm
EC columns				
 4.6 mm ID	**760170.46**		**760172.46**	**760173.46**
EC guard columns*			4 x 3 mm: **761966.30**	
CC guard columns**			8 x 4 mm: **761007.40**	
NUCLEODUR® 100-5				particle size 5 µm
EC columns				
 4 mm ID				**760007.40**
4.6 mm ID	**760023.46**		**760012.46**	**760007.46**
EC guard columns*			4 x 3 mm: **761967.30**	
CC guard columns**			8 x 4 mm: **761055.40**	
VarioPrep columns				
 10 mm ID	**762077.100**	**762078.100**		**762007.100**
21 mm ID	**762077.210**	**762078.210**		**762007.210**
40 mm ID			**762075.400**	**762007.400**
VP guard columns*	10 x 8 mm: **762094.80** 15 x 32 mm: **762330.320**		10 x 16 mm: **762094.160**	
EC and VarioPrep columns in packs of 1, guard columns see below				

Guard column systems Guard columns for EC columns with ID		2 mm	3 mm	4 mm	4.6 mm	Guard column holder
* Column Protection System (pack of)	EC	4/2 (3)	4/3 (3)	4/3 (3)	4/3 (3)	718966
** ChromCart® guard columns (pack of)	CC	8/3 (3)	8/3 (3)	8/4 (3)	8/4 (3)	721359
Guard columns for VarioPrep columns with ID		**8, 10 mm**	**16, 21 mm**	**32, 40 mm**	**≥ 50 mm**	
*** VP guard columns (pack of)	VP	10/8 (2)	10/16 (2)	15/32 (1)	15/50 (1)	
VP guard column holder		718251	718256	718253	718255	

For details of our column systems see pages 189–196
Unmodified NUCLEODUR® bulk material in 10–50 µm for self-packing of preparative columns see page 198

Our HPLC QC policy

- **Highest production standard**
  our facilities are EN ISO 9001:2008 certified
- **Strict quality specifications**
  for outstanding reliability
- **Perfect reproducibility** from batch to batch and within each lot
- Each column is individually tested and supplied with test chromatogram and test conditions.


CERTIFICATE

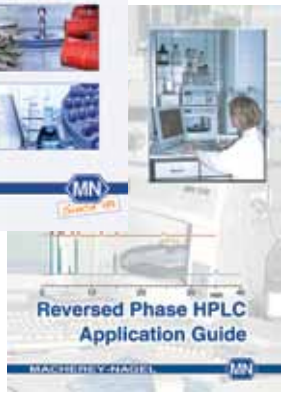
HPLC column

MACHEREY-NAGEL

Test mixture for reversed phase columns

Designation	Pack of	REF
Test mixture for reversed phase columns in acetonitrile *	1 mL	722394

Further information and many applications for our NUCLEODUR® phases are compiled in our brochure "NUCLEODUR® – Professional solutions for HPLC".



Our Reversed Phase HPLC Application Guide offers an introduction to RP chromatography and numerous applications with our NUCLEODUR® and NUCLEOSIL® phases.

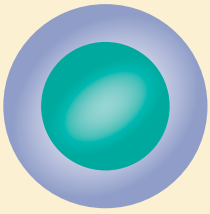
Please contact us for further literature under info@mn-net.com.

* This product contains harmful substances which must be specially labeled as hazardous. For detailed information please see MSDS.

NUCLEOSHELL® core-shell silica for HPLC

Core-shell technology

NUCLEOSHELL® 2.7 µm

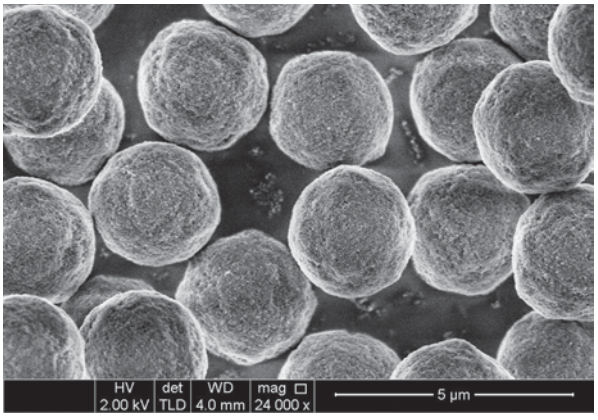


NEW!

- Solid core of silicon dioxide, homogeneous shell of porous silica
- Highest efficiency compared to traditional totally porous materials
- Pore size 90 Å; particle size 2.7 µm (core 1.7 µm); specific surface 130 m^2/g
  lower back pressure enables use on conventional LC systems
- Pressure stability 600 bar

Demands on HPLC separations are constantly increasing with respect to separation efficiency, detection limits, and the time requirements for each analysis.

Several approaches have been made to achieve fast separations without losing chromatographic performance. HPLC columns packed with particles < 2 µm show very high efficiencies (plates/meter) and allow the use of smaller column sizes with the positive side effect of significant solvent saving. However they generate a high back pressure of the mobile phase during column runs which requires specifically designed equipment.



Electron microscopic image of NUCLEOSHELL®

NUCLEOSHELL® silica particles consist of a non-porous solid core of 1.7 µm diameter and a porous outer shell of 0.5 µm thickness. Accordingly the total diameter of the particle is 2.7 µm. Utilizing a proprietary process of synthesis, NUCLEOSHELL® particles exhibit a distinct narrow particle size distribution (d_{90}/d_{10} ~ 1.1). Columns packed with NUCLEOSHELL core shell particles feature exceptional separation efficiencies with theoretical plate numbers easily comparable to totally porous sub 2 micron particles.

$$R_s = \frac{\sqrt{N}}{4}\left(\frac{\alpha - 1}{\alpha}\right)\left(\frac{k_i'}{k_i' + 1}\right)$$

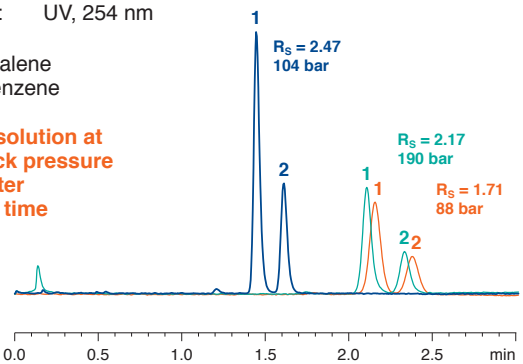
R_s = resolution
α = selectivity
k_i' = retention
N = theoretical plates $N \propto 1/d_P$
d_P = particle size

Resolution R_S as function of particle size

Columns: 50 x 4 mm
NUCLEOSHELL® RP 18, 2.7 µm
NUCLEODUR® C_{18} Gravity, 3 µm
NUCLEODUR® C_{18} Gravity, 1.8 µm
Eluent: acetonitrile – water (60:40, v/v)
Flow rate: 1 mL/min
Temperature: 25 °C
Detection: UV, 254 nm

Peaks:
1. Naphthalene
2. Ethylbenzene

Better resolution at lower back pressure and shorter retention time



MN Appl. No. 125270

Theoretical column efficiency (optimal conditions)

Silica	d_p [µm]	L [m]	HETP [µm]	Efficiency [plates/m]	L [mm]	N	R_s	Analysis time
NUCLEOSHELL®	**2.7**	**1**	**4**	**250 000**	**100**	**25 000**	**112 %**	**40 %**
NUCLEODUR®	1.8	1	4.5	222 222	100	22 000	105 %	40 %
	3	1	7.5	133 333	150	20 000	100 %	60 %
	5	1	12.5	80 000	250	20 000	100 %	100 %

Benefits of core-shell technology

Short diffusion paths

- Fast mass transfer (term C of Van Deemter equation)
- High flow velocity without peak broadening for fast LC

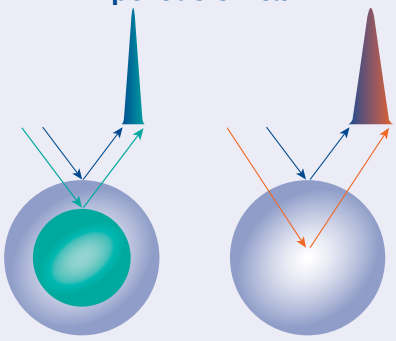
Narrow particle size distribution (d_{90}/d_{10} ~ 1.1)

- Stable packing

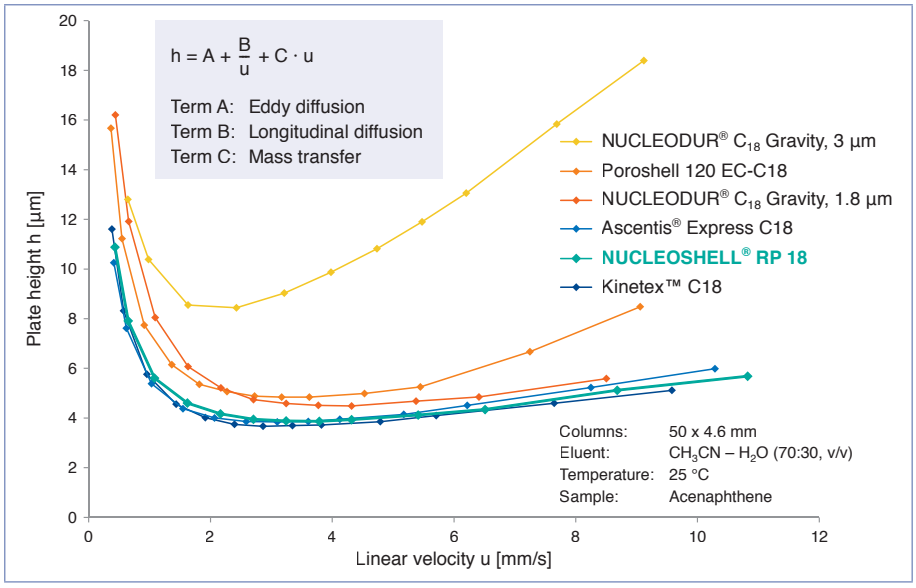
High heat transfer

- Minimized influence of frictional heat
- Efficiency of NUCLEOSHELL® ~ 250 000 m^{-1} (HETP ~ 4 µm)

Core-shell particles vs. totally porous silica



With conventional fully porous particles the mass transfer between stationary and mobile phase usually results in peak broadening at higher flow rates (C-term in van Deemter equation). The short diffusion paths in the core-shell particles reduce the dwell time of the analyte molecules in the stationary phase, so that even at high flow velocities of the mobile phase, optimal separation results can be obtained.

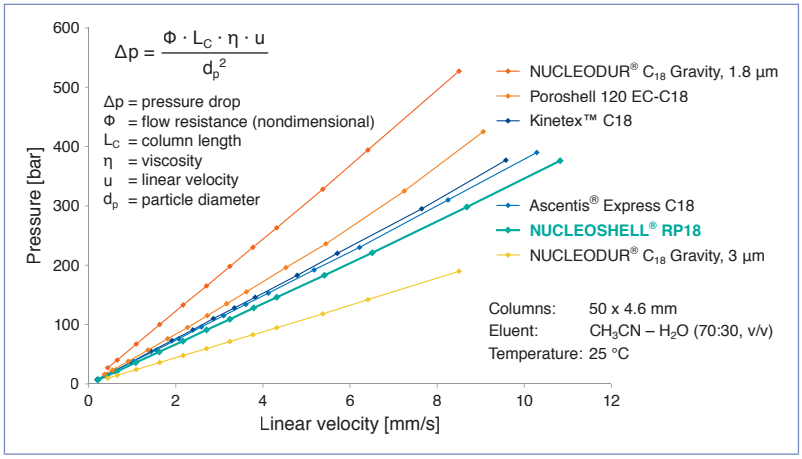


Van-Deemter plots

The van Deemter plots demonstrate how efficiency is affected by flow rate. In comparison with fully porous silicas, core-shell particles from various manufacturers maintain the efficiency optimum (max. plates/m) over a long range of increasing linear mobile phase velocity.

Pressure drop

In direct comparison with conventional sub 2 micron phases, NUCLEOSHELL® columns only generate about 60 % of the back pressure and can be operated with the majority of conventional HPLC systems. In order to develop the maximum performance of NUCLEOSHELL® columns, we recommend reducing extra column voids by using suitable capillaries (< 0.15 mm inner diameter) and specially adapted detector cells. Moreover detector settings should be optimized by increasing the measuring rate or by decrease of the time constant.



Core-shell particle technology from MACHEREY-NAGEL is an alternate route to gain highest column efficiency and resolution in HPLC at short run time, but with moderate back pressure.

NUCLEOSHELL® core-shell silica for HPLC

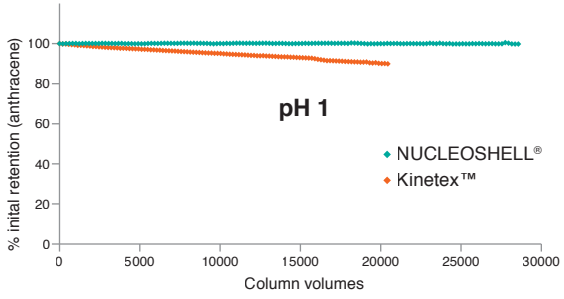
Features of NUCLEOSHELL® particles

A criterion for the long-term stability of the column at pH extremes is the percentage decrease of initial retention and initial plates, respectively.

The following figure shows a column stability test of NUCLEOSHELL® RP 18 at mobile phase levels pH 1 and pH 10 compared with three competing phases.

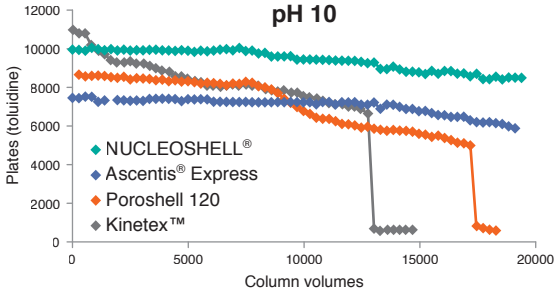
Stability under acidic and basic conditions

Column: **50 x 4.6 mm NUCLEOSHELL® RP 18, 2.7 µm**
50 x 4.6 mm Kinetex™ 2.6 µm C18
Eluent: acetonitrile – 1 % TFA in water,
pH 1 (50:50, v/v)
Flow rate: 1.3 mL/min
Temperature: 80 °C
Detection: UV, 254 nm
Analyte: anthracene



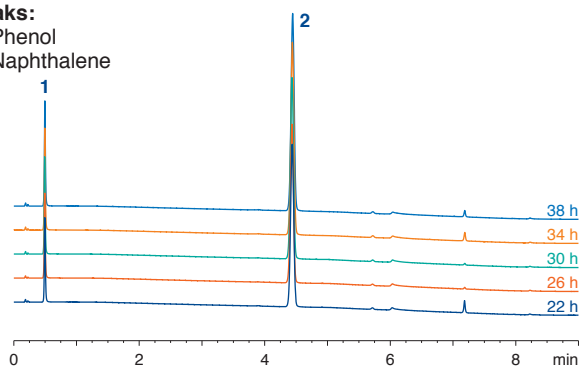
MN Appl. No. 125520 / 125530

Columns: **50 x 4.6 mm NUCLEOSHELL® RP 18, 2.7 µm**
50 x 4.6 mm Ascentis® Express C18, 2.7 µm
50 x 4.6 mm Poroshell 120 EC-C18
50 x 4.6 mm Kinetex™ 2.6 µm C18
Eluent: 20 mmol/L Na borate – 10 mmol/L NaOH – methanol,
pH 10 (21:49:30, v/v/v)
Flow rate: 1.5 mL/min
Temperature: 40 °C
Detection: UV, 220 nm
Analyte: toluidine



Temperature stability

Stability test:
Column: 50 x 2 mm NUCLEOSHELL® RP 18, 2.7 µm
Eluent: A) 10 mmol/L ammonium formate – methanol (9:1, v/v) + 120 µL formic acid, ~ pH 4
B) 10 mmol/L ammonium formate – methanol (1:9, v/v) + 120 µL formic acid, ~ pH 4
0–100 % B in 7 min
Flow rate: 0.5 mL/min, temperature **100 °C**
Detection: UV, 220 nm
Peaks:
1. Phenol
2. Naphthalene



MN Appl. No. 125400

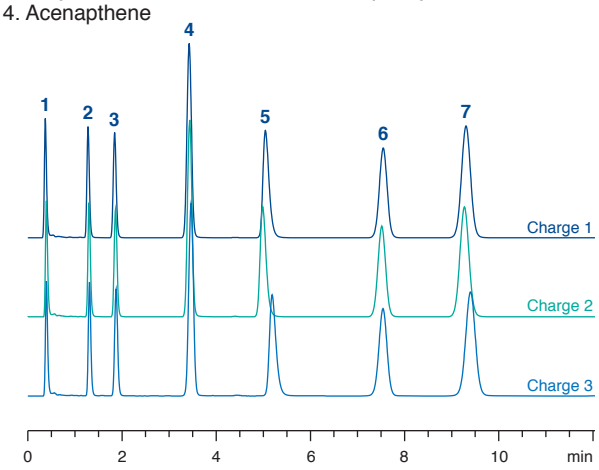
Effficiency test:
Eluent: acetonitrile – water (60:40, v/v)
Flow rate: 0.33 mL/min; temperature 25 °C
Detection: UV, 254 nm
Analyte: anthracene

	HETP [µm]	Asymmetry
Start (t = 0)	5.2	0.98
End (t = 40 h)	5.2	1.01

Columns can be operated at elevated temperatures without loss in retention, efficiency or peak symmetry.

Batch-to-batch reproducibility

Column: 50 x 4 mm NUCLEOSHELL® RP 18, 2.7 µm
Eluent: methanol – 25 mmol/L KH_2PO_4, pH 7
(70:30, v/v)
Flow rate: 1 mL/min
Temperature: 40 °C
Detection: UV, 254 nm
Peaks:
1. Uracil
2. Toluene
3. Ethylbenzene
4. Acenapthene
5. Amitriptyline
6. *o*-Terphenyl
7. Triphenylene



MN Appl. No. 125410

Uniformly shaped NUCLEOSHELL® particles combined with optimized bonding technology safeguard tightly packed columns for 100 % reproducible results.

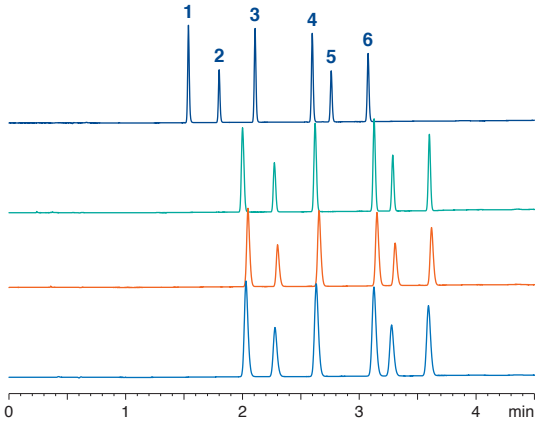
Peak capacity

The peak capacity is a measure for the number of sample analytes that can be separated on HPLC columns per time unit. Narrow peaks increase the peak capacity and thus the efficiency of the analytical column.

Peak capacity

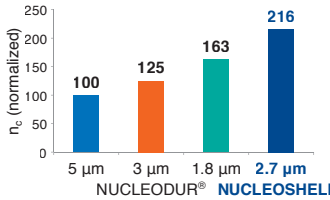
Columns: 100 x 4.6 mm
NUCLEOSHELL® RP 18, 2.7 µm
NUCLEODUR® C_{18} Gravity, 1.8 µm
NUCLEODUR® C_{18} Gravity, 3 µm
NUCLEODUR® C_{18} Gravity, 5 µm
Eluent: A) acetonitrile, B) water, 40–100 % A in 4 min
Flow rate: 1.5 mL/min
Temperature: 25 °C
Detection: UV, 230 nm

Peaks:
1. Acetophenone
2. Benzoin
3. Propiophenone
4. Butyrophenone
5. Benzophenone
6. Valerophenone



MN Appl. No. 125540

	Max. pressure [bar]	Resolution (4, 5)
NUCLEOSHELL®, 2.7 µm	**255**	**5.45**
NUCLEODUR®, 1.8 µm	450	4.14
NUCLEODUR®, 3 µm	214	2.97
NUCLEODUR®, 5 µm	142	2.30



$$n_c = 1 + \left(\frac{t_g}{W}\right)$$

n_c: peak capacity
t_g: gradient time
W: peak width (at baseline)

The example shows, that in comparison with totally porous NUCLEODUR® silica (1.8 µm) NUCLEOSHELL® provides 33 % higher peak capacity.

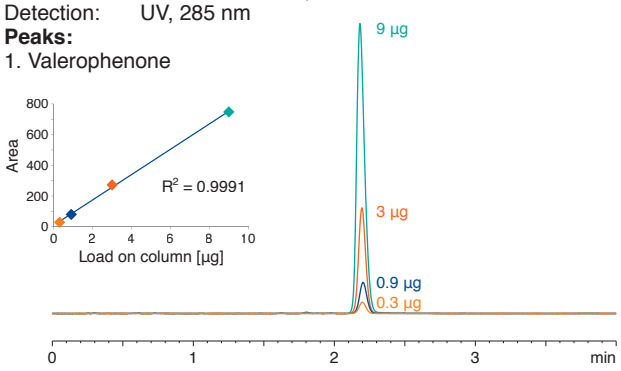
Loading capacity

NUCLEOSHELL® columns allow **reliable quantification** in a wide analytical detection range. Retention time and peak width at 50 % height remain constant with increasing columns load although core-shell particles are suspected of showing a slightly lower loading capacity compared to fully porous silica materials.

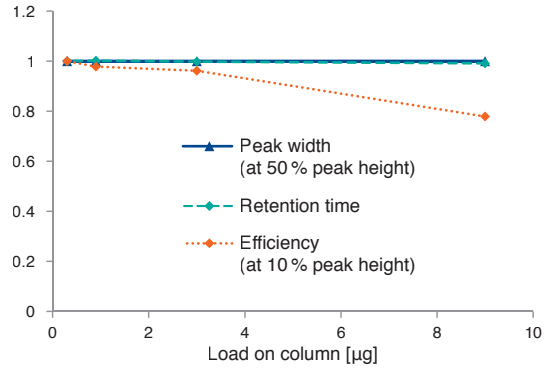
Loading capacity

Column: 50 x 3 mm NUCLEOSHELL® RP 18, 2.7 µm
Eluent: acetonitrile – 25 mmol/L KH_2PO_4, pH 3 (70:30, v/v)
Flow rate: 0.66 mL/min, temperature 30 °C
Detection: UV, 285 nm

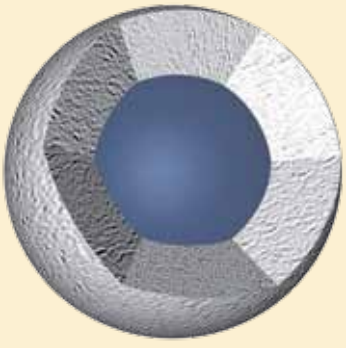
Peaks:
1. Valerophenone



Normalized column parameters



NUCLEOSHELL® modifications



The program of NUCLEOSHELL® surface modifications now comprises the following phases:

- NUCLEOSHELL® RP 18
- NUCLEOSHELL® PFP
- NUCLEOSHELL® HILIC

NUCLEOSHELL® core-shell silica for HPLC

NUCLEOSHELL® RP 18

nonpolar high density phase

Key features:

- Core-shell technology for fast and efficient HPLC
- Suitable for **LC/MS** and HPLC at pH extremes (pH 1–11)
- Superior base deactivation, ideal for method development

Technical characteristics:
Octadecyl modification, multi-endcapped; pore size 90 Å, particle size 2.7 µm, carbon content 7.5 %

Recommended application:
Overall sophisticated analytical separations, e.g., analgesics, anti-inflammatory drugs, antidepressants; herbicides; phytopharmaceuticals; immunosuppressants

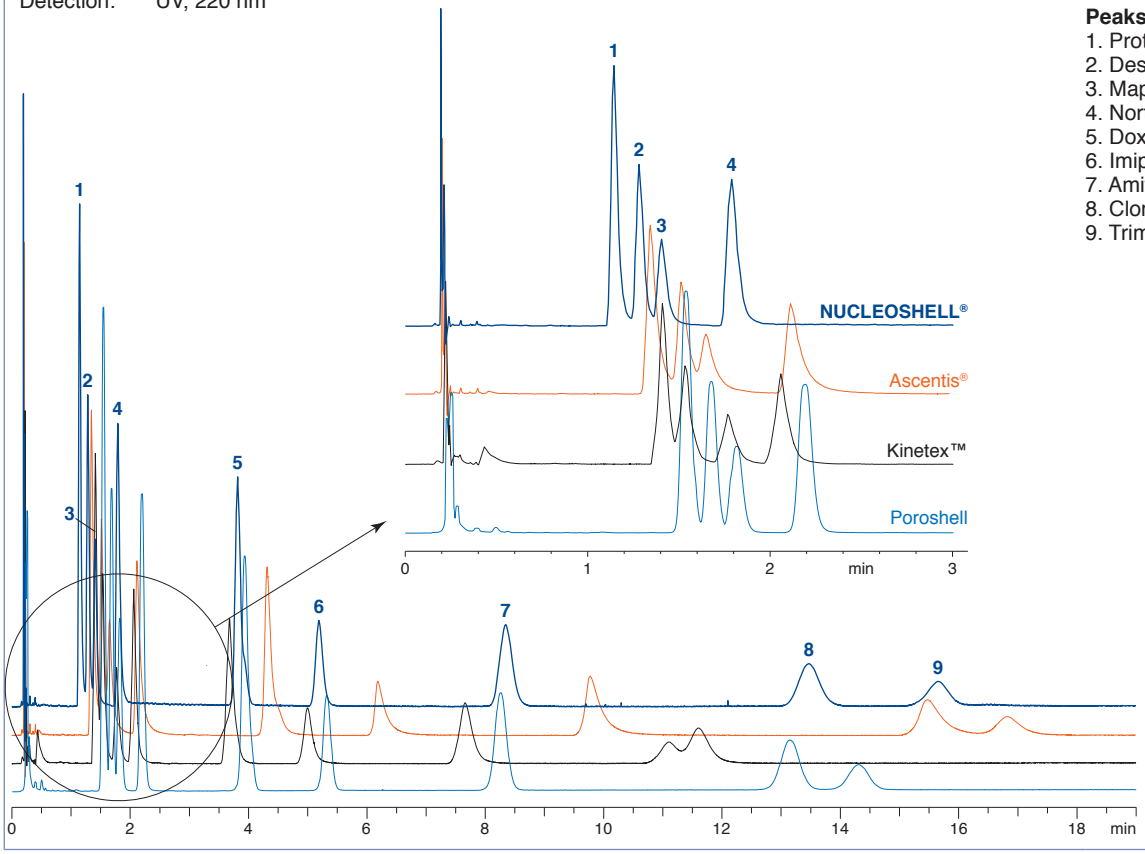
USP L1

NUCLEOSHELL® RP 18 is based on core-shell silica. A unique derivatization process generates a homogeneous surface with a high density of bonded silanes (carbon content ~7.5 %). The following thorough end-capping suppresses any unwanted polar interactions between the silica surface and the sample, which makes NUCLEOSHELL® RP 18 particularly suitable for the separation of basic and other ionizable analytes. The extremely reduced silanol activity of the phase can be demonstrated by applying basic analytes, such as tricyclic antidepressants. The chromatogram below shows a sharp elution profile (superior resolution!) of these highly polar compounds with an excellent asymmetry value for amitriptyline of 1.12.

Tricyclic antidepressants · comparison of selectivity and resolution

Columns: 50 x 4.6 mm
NUCLEOSHELL® RP 18, 2.7 µm
Ascentis® Express C18
Kinetex™ 2.6 µm C18
Poroshell 120 EC-C18
Eluent: methanol – acetonitrile – 25 mmol/L KH_2PO_4, pH 7 (22.5:22.5:55, v/v/v)
Flow rate: 2 mL/min
Pressure: **224 bar,** 239 bar, 248 bar, 212 bar
Temperature: 40 °C
Detection: UV, 220 nm

	Asymmetry (amitriptyline)	Resolution (8, 9)
NUCLEOSHELL®	**1.12**	**3.35**
Ascentis® Express	2.07	1.91
Kinetex™	1.33	n.a.
Poroshell	1.05	1.95



Peaks:
1. Protriptyline
2. Desipramine
3. Maprotiline
4. Nortriptyline
5. Doxepin
6. Imipramine
7. Amitriptyline
8. Clomipramine
9. Trimipramine

MN Appl. No. 124960

NUCLEOSHELL® core-shell silica for HPLC

The separation of 13 β-lactam antibiotics illustrates how time of analysis can be shortened to a fractional part by using core-shell particles without loss of resolution at moderate back pressure.

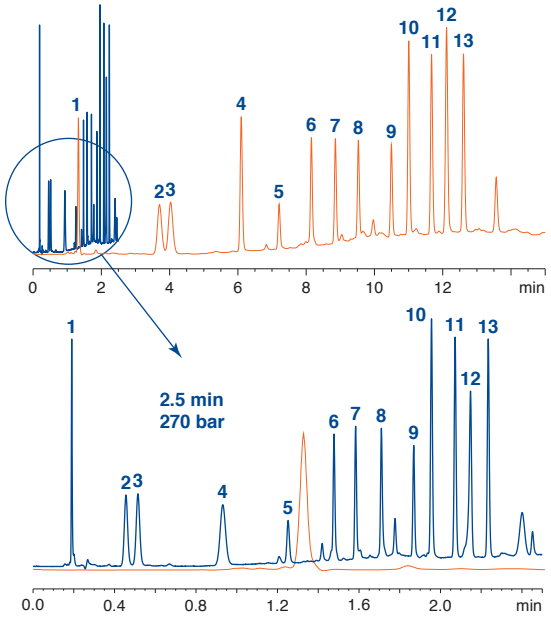
NUCLEOSHELL® RP 18 combines innovative silica technology and excellent surface deactivation, that outperforms conventional C_{18} silicas in terms of efficiency, resolution and speed. Due to the applied core-shell particle design the back pressure at elevated flow rates remains at a moderate level and in many cases permits the use of existing HPLC equipment. NUCLEOSHELL® RP 18 with extended pH stability, low bleed characteristics in LC/MS applications, and overall robustness is an ideal tool for method development and routine analyses in modern HPLC.

13 β-lactam antibiotics in less than 3 min

Columns: **50 x 4 mm NUCLEOSHELL® RP 18, 2.7 µm**
150 x 4 mm NUCLEODUR® C_{18} Gravity, 5 µm
Eluent: A) acetonitrile; B) 20 mmol/L KH_2PO_4, pH 3.5
10 % A (0.5 min) → 50 % A in 1.5 min (0.5 min 50 % A)
10 % A (3 min) → 50 % A in 9 min (3 min 50 % A)
Flow rate: **2 mL/min,** 1 mL/min
Pressure: **270 bar,** 110 bar
Temperature: 25 °C
Detection: UV, 220 nm

Peaks:

1. Amoxicillin
2. Ampicillin
3. Cephalexin
4. Cefotaxime
5. Cefoxitin
6. Cefamandole
7. Cephalothin
8. Piperacillin
9. Penicillin V
10. Oxacillin
11. Cloxacillin
12. Nafcillin
13. Dicloxacillin



MN Appl. No. 124940

Ordering information

Eluent in column acetonitrile – water

Length →	50 mm	100 mm	150 mm
NUCLEOSHELL® RP 18, 2.7 µm			particle size 2.7 µm
EC columns			
2 mm ID	**763132.20**	**763134.20**	**763136.20**
3 mm ID	**763132.30**	**763134.30**	**763136.30**
4 mm ID	**763132.40**	**763134.40**	**763136.40**
4.6 mm ID	**763132.46**	**763134.46**	**763136.46**
EC guard columns*	4 x 2 mm: **763138.20**		4 x 3 mm: **763138.30**
EC columns in packs of 1, guard columns in packs of 3; for details see page 189			

Guard column systems Guard columns for EC columns with ID		2 mm	3 mm	4 mm	4.6 mm	Guard column holder
* Column Protection System	EC	4/2	4/3	4/3	4/3	718966

NUCLEOSHELL® core-shell silica for HPLC

NUCLEOSHELL® PFP — hydrophobic pentafluorophenyl phase

Key features:

- Core-shell technology for fast and efficient HPLC
- Hydrophobic phase with alternative selectivity in comparison to classical C_{18} modifications
- Separation principle based on 4 retention mechanisms (polar interactions (H bonds), dipole-dipole, π-π, hydrophobic interactions)

Technical characteristics:
Phase with pentafluorophenyl-propyl modification, multi-endcapping; pore size 90 Å, particle size 2.7 µm; carbon content ~ 3 %; pH stability 1-9; suitable for **LC/MS**

Recommended application:
Aromatic and unsaturated compounds, phenols, halogen compounds, isomers, polar compounds like pharmaceuticals, antibiotics; strong retention of basic compounds

USP L43

Orthogonality in selectivity

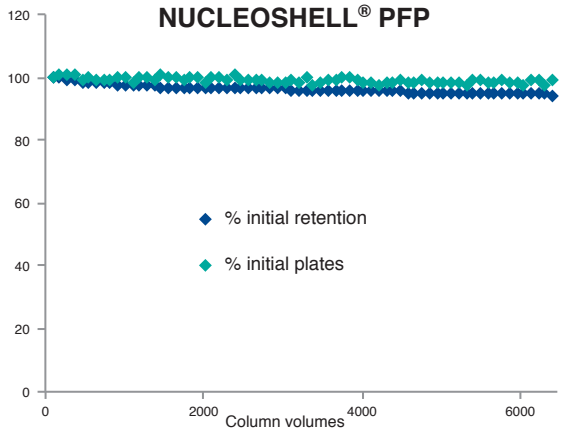
Fluorinated stationary phases in HPLC have gained increasing interest over the last years. Most common representative of fluorinated silica phases is the pentafluorophenyl modification (PFP or F5). Especially the orthogonal selectivity compared to traditional alkyl phases widens the scope in analytical HPLC. Thus NUCLEOSHELL® PFP offers an excellent selectivity especially for highly polar analytes, aromatic and unsaturated compounds, phenols or halogenated hydrocarbons.

While a typical C_{18} phase just provides hydrophobic interactions between stationary phase and analyte NUCLEOSHELL® PFP offers four different retention mechanisms: polar interactions (H bonds), dipole-dipole interactions, π-π interactions and hydrophobic interactions. Especially the pronounced ion exchange capacity and distinct steric selectivity are typical for the character of fluorinated phases.

Stability of NUCLEOSHELL® PFP at pH 1

Column: 100 x 4.6 mm NUCLEOSHELL® PFP, 2.7 µm
Eluent: acetonitrile – 0.5 % TFA, pH 1 (50:50, v/v)
Flow rate: 1.3 mL/min, temperature 60 °C
Detection: UV, 254 nm

Sample:
Ethylbenzene

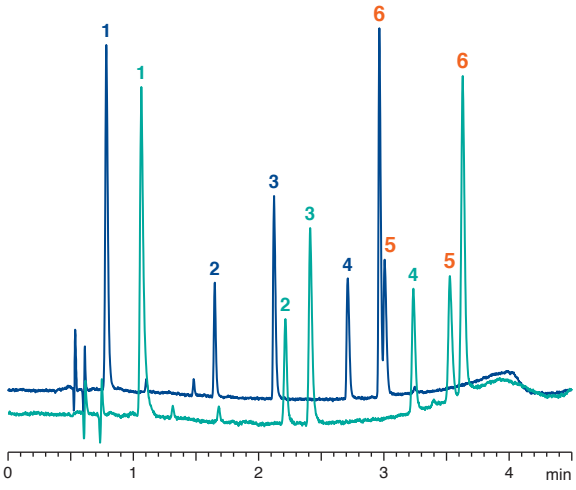


MN Appl. No. 125560

β-Blockers · orthogonal selectivity of NUCLEOSHELL® PFP

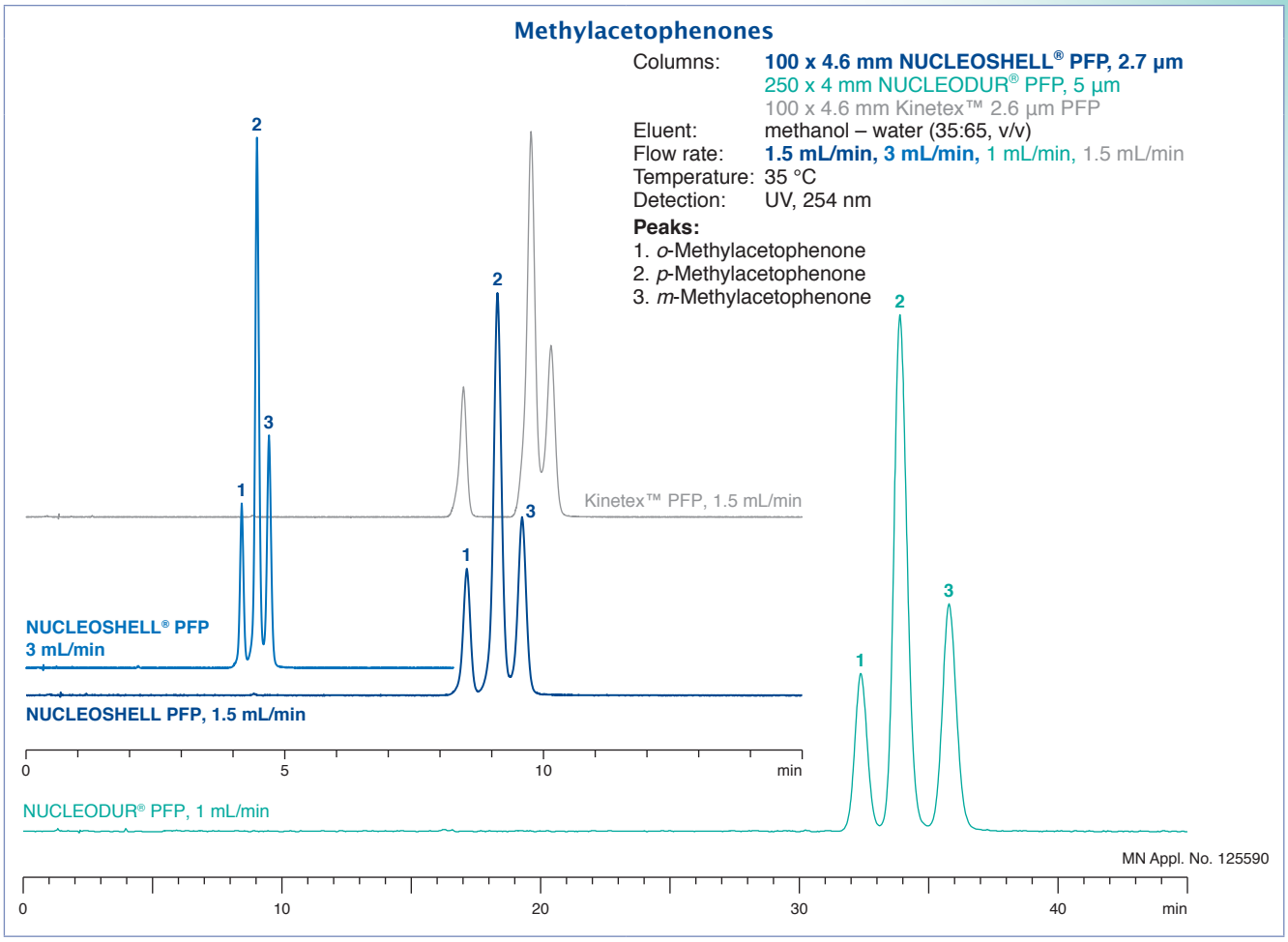
Columns: 100 x 4.6 mm
NUCLEOSHELL® RP 18, 2.7 µm
NUCLEOSHELL® PFP, 2.7 µm
Eluent: A) acetonitrile + 0.1 % formic acid
B) 0.1 % formic acid
10–35 % A in 2.5 min, 35-50 % A in 2 min
Flow rate: 1.7 mL/min
Temperature: 25 °C
Detection: UV, 280 nm

Peaks:
1. Atenolol
2. Pindolol
3. Metroprolol
4. Labetalol
5. Alprenolol
6. Propranolol



MN Appl. No. 125610

Columns for HPLC



NUCLEOSHELL® PFP combines the benefits of core-shell technology, high stability, and orthogonal selectivity. Thus it is a useful complementary tool for highly efficient separations especially of isomers, halogenated, aromatic and / or polar compounds.

Ordering information

Eluent in column acetonitrile – water

Length →	50 mm	100 mm	150 mm
NUCLEOSHELL® PFP, 2.7 µm			particle size 2.7 µm
EC columns			
2 mm ID	**763532.20**	**763534.20**	**763536.20**
3 mm ID	**763532.30**	**763534.30**	**763536.30**
4 mm ID	**763532.40**	**763534.40**	**763536.40**
4.6 mm ID	**763532.46**	**763534.46**	**763536.46**
EC guard columns*	4 x 2 mm: **763538.20**		4 x 3 mm: **763538.30**

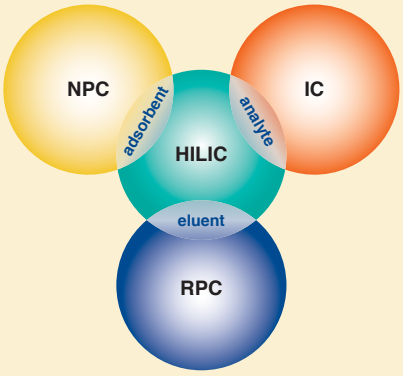
EC columns in packs of 1, guard columns in packs of 3; for details see page 189

Guard column systems Guard columns for EC columns with ID		2 mm	3 mm	4 mm	4.6 mm	Guard column holder
* Column Protection System	EC	4/2	4/3	4/3	4/3	718966

NUCLEOSHELL® core-shell silica for HPLC

NUCLEOSHELL® HILIC

zwitterionic phase



- **Key features:**
  - Core-shell technology for fast and efficient HPLC
  - Ideal for reproducible and stable chromatography of highly polar analytes
  - Very short column equilibration times
- **Technical characteristics:**
  Ammonium – sulfonic acid modified silica; pore size 90 Å, particle size 2.7 µm; carbon content 1.3 %; pH stability 2–8.5; suitable for **LC/MS**
- **Recommended application:**
  Hydrophilic compouds such as polar organic acids and bases, polar natural compounds, nucleosides, oligonucleotides, amino acids, peptides, water-soluble vitamins

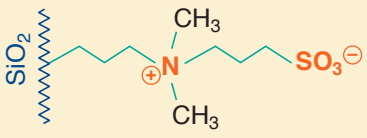
Columns for HPLC

NUCLEOSHELL® HILIC

Hydrophilic interaction chromatography (HILIC) is a separation technique using polar stationary phases and organic-aqueous mobile phases. A minimum water content of at least 2 % is indispensable to provide a permanent water layer between the adsorbent surface and the organic fraction of the mobile phase. The sample molecules become separated in a partition chromatography, in which polar analytes are more strongly retained than neutral, less hydrophilic compounds. Consequently, increasing the aqueous part in the mobile phase will diminish retention of the polar sample constituents. In this way HILIC behaves inverse to classical RP chromatography. The particular retention profile of HILIC enables the chromatography of very polar and often small molecules, which won't show any retention on C_8 or C_{18} reversed phases.

Ultra-fast separations at moderate back pressure

NUCLEOSHELL® HILIC is a core-shell technology based stationary phase with a covalently bonded 3-*N,N*-dimethylaminopropane sulfonic acid ligand (pat. pend.). The betaine character of the strong ion-exchanger results in full charge balancing and facilitates fast equilibration times.

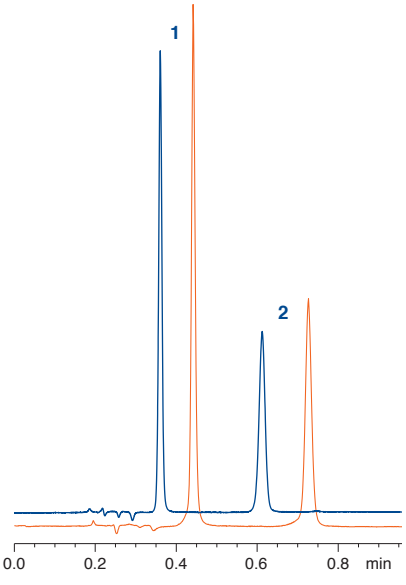


Good separation of polar compounds like the physiologically important substances creatine and creatinine can be achieved on NUCLEOSHELL® HILIC as well as on NUCLEODUR® HILIC, 1.8 µm at similar retention, but much lower back pressure.

Separation of creatine and creatinine

Columns: **50 x 4 mm NUCLEOSHELL® HILIC, 2.7 µm**
50 x 4 mm NUCLEODUR® HILIC, 1.8 µm
Eluent: acetonitrile – 10 mmol/L ammonium acetate, pH 4.0 (90:10, v/v)
Flow rate: 1.7 mL/min
Pressure: **129 bar**
180 bar
Temperature: 25 °C
Detection: UV, 210 nm

Peaks:
1. Creatinine
2. Creatine

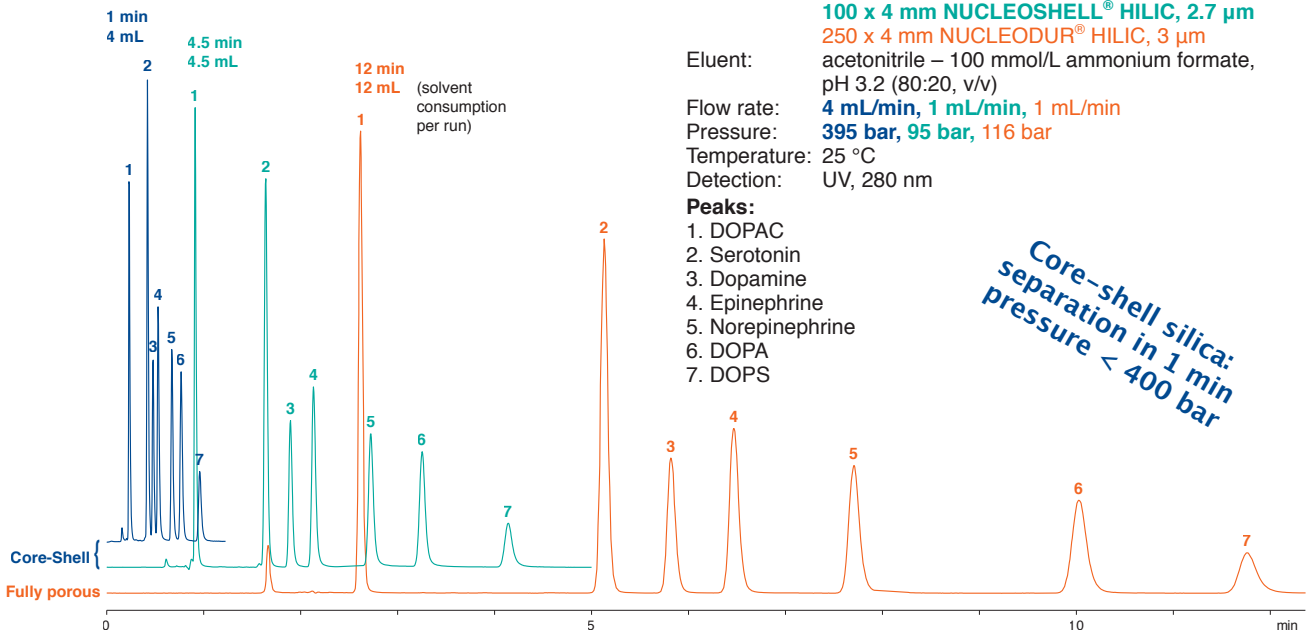


MN Appl. No. 124990

The following chromatograms show the method transfer from a fully porous 3 µm HILIC phase to 2.7 µm core-shell silica with equal selectivity features.

Run time has been cut down to 1 min. Column back pressure remains modest < 400 bar, while solvent demand is reduced to less than 35 %.

Separation of catecholamines



Columns: **100 x 4 mm NUCLEOSHELL® HILIC, 2.7 µm**
100 x 4 mm NUCLEOSHELL® HILIC, 2.7 µm
250 x 4 mm NUCLEODUR® HILIC, 3 µm
Eluent: acetonitrile – 100 mmol/L ammonium formate, pH 3.2 (80:20, v/v)
Flow rate: **4 mL/min, 1 mL/min,** 1 mL/min
Pressure: **395 bar, 95 bar,** 116 bar
Temperature: 25 °C
Detection: UV, 280 nm

Peaks:
1. DOPAC
2. Serotonin
3. Dopamine
4. Epinephrine
5. Norepinephrine
6. DOPA
7. DOPS

MN Appl. No. 125440

NUCLEOSHELL® HILIC provides stable and reproducible chromatography, comprising all the benefits of a state-of-the-art core-shell silica.

Ordering information

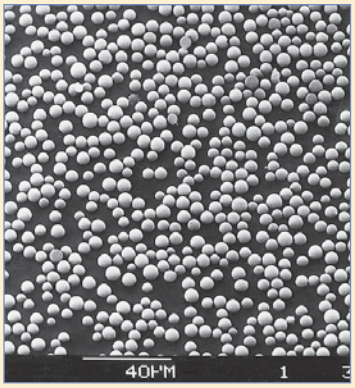
Eluent in column acetonitrile – water

Length →	50 mm	100 mm	150 mm
NUCLEOSHELL® HILIC, 2.7 µm			particle size 2.7 µm
EC columns			
2 mm ID	**763332.20**	**763334.20**	**763336.20**
3 mm ID	**763332.30**	**763334.30**	**763336.30**
4 mm ID	**763332.40**	**763334.40**	**763336.40**
4.6 mm ID	**763332.46**	**763334.46**	**763336.46**
EC guard columns*	4 x 2 mm: **763338.20**		4 x 3 mm: **763338.30**
EC columns in packs of 1, guard columns in packs of 3			

Guard column systems Guard columns for EC columns with ID		2 mm	3 mm	4 mm	4.6 mm	Guard column holder
* Column Protection System	EC	4/2	4/3	4/3	4/3	718966

For details of the EC column system please see page 189

NUCLEOSIL® standard silica for HPLC



NUCLEOSIL® is a family of totally porous spherical silicas. They feature a very pure and uniform SiO_2 structure and have gained wide acceptance as routine chromatographic packings for very different fields of modern chromatography.

- One of the first spherical silicas used in HPLC
- Developed in the early seventies, it became a world-renowned HPLC packing
- Still found in many analytical and preparative applications, it is an absolutely reliable choice in HPLC
- Largest variety of modified HPLC silicas available

Due to its particle sizes NUCLEOSIL® finds application in analytical as well as in preparative columns.

Benefits of NUCLEOSIL® silica

- High bed stability due to spherical particles
- High efficiency due to narrow particle size distribution
- High separation performance due to optimized binding techniques
- High chemical and mechanical stability
- High load capacity and recovery rates
- High reproducibility from lot to lot

Physical properties

NUCLEOSIL® is manufactured with different pore diameters (50, 100, 120, 300, 500, 1000 and 4000 Å) and particle sizes from 3 µm (only NUCLEOSIL® 50, 100 and 120) to 10 µm with very narrow fractionation.

All narrow-pore NUCLEOSIL® packings are stable up to 500 bar (7 250 psi), the wide-pore NUCLEOSIL® silicas are stable up to 300 or 400 bar (4 200 or 5 600 psi).

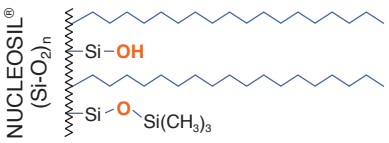
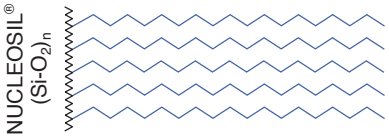
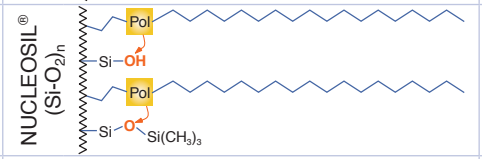
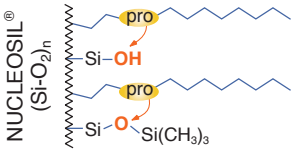
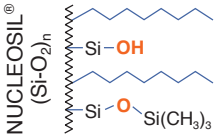
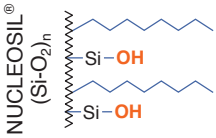
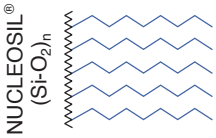
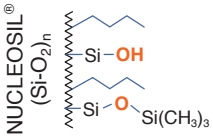
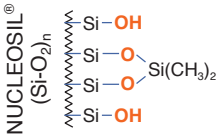
For a summary of physical properties of unmodified NUCLEOSIL® silica see page 199.

NUCLEOSIL® modifications

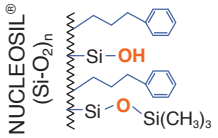
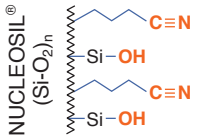
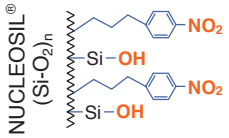
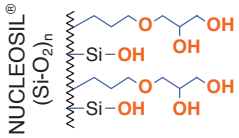
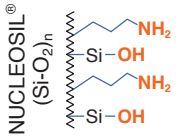
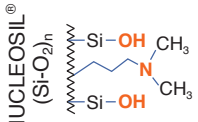
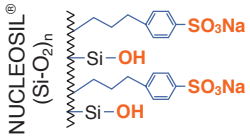
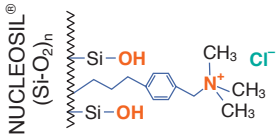
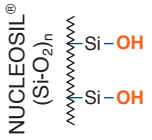
NUCLEOSIL® packings are available as unmodified silica or with numerous chemically bonded phases:

- RP phases like C_{18} AB, C_{18} HD, C_{18} Nautilus, C_{18} endcapped, Protect I, C_8 HD, C_8 ec, C_8, C_4, C_2 and Phenyl) separate mainly by hydrophobic interactions (van der Waals forces).
  The less polar the sample molecules, the more they are retained – the more polar the sample, the weaker are the hydrophobic interactions and consequently the shorter are retention times.
- Phases with chemically bonded polar groups such as CN, NO_2, NH_2, $N(CH_3)_2$, OH show selective separation properties.
  Due to the availability of different functional groups it is possible to vary the chemical characteristics of the surface and consequently the adsorption characteristics of the stationary phase.
- Silica-based ion exchangers (NUCLEOSIL® SA and SB) are stable from pH 2 to 8 and do not swell. Compared to resin-based ion exchangers they offer the advantage of constant permeability, even when the ionic strength and/or pH of the eluent are changed. The separation can be influenced by
  – the **type of buffer**
  – the **ionic strength** and
  – the **pH value**.

Summary of NUCLEOSIL® HPLC phases

NUCLEOSIL® phase	Modification	Stability	Structure	Separation principle	Page
NUCLEOSIL® RP-Phasen					
C_{18}	Octadecyl phase, medium density modification, endcapping 15 % C · **USP L1**	pH 2–8		hydrophobic (van der Waals) interactions slight residual silanol interactions	157
C_{18} HD	Octadecyl phase, high density monomeric modification, endcapping 20 % C · **USP L1**	pH 2–9		hydrophobic (van der Waals) interactions	158
C_{18} AB	Octadecyl phase, special crosslinked modification, endcapping 25 % C · **USP L1**	pH 1–9		steric interactions and hydrophobic interactions	158
C_{18} Nautilus	Octadecyl phase, embedded polar group, endcapping 16 % C · **USP L60**	pH 2–8 up to 100 % H_2O		hydrophobic interactions and polar interactions	158
Protect I	Special RP phase, protective polar group, monomeric modification, endcapping 11 % C	pH 2–8		hydrophobic interactions and polar interactions	160
C_8 ec	Octyl phase, medium density modification, endcapping 9 % C · **USP L7**	pH 2–8		hydrophobic (van der Waals) interactions slight residual silanol interactions	160
C_8	Octyl phase, no endcapping 8.5 % C · **USP L7**	pH 2–8		hydrophobic (van der Waals) interactions noticeable residual silanol interactions	160
C_8 HD	Octyl phase, high density modification, endcapping 13 % C · **USP L7**	pH 2–8		hydrophobic (van der Waals) interactions	161
C_4	Butyl phase, medium density modification, endcapping ~ 2 % C · **USP L26**	pH 2–8		hydrophobic (van der Waals) interactions residual silanol interactions	161
C_2	Dimethyl phase 3.5 % C · **USP L16**	pH 2–8		hydrophobic (van der Waals) interactions noticeable residual silanol interactions	162

NUCLEOSIL® standard silica for HPLC

NUCLEOSIL® phase	Modification	Stability	Structure	Separation principle	Page
C_6H_5 ec	Phenyl phase, medium density modification, endcapping 8% C · **USP L11**	pH 2–8		π–π interactions and hydrophobic interactions slight residual silanol interactions	200*
C_6H_5	Phenyl phase, no endcapping 8% C · **USP L11**	pH 2–8		π–π interactions and hydrophobic interactions noticeable residual silanol interactions	162
Polar NUCLEOSIL® phases and NUCLEOSIL® ion exchangers					
CN / CN-RP	Cyano (nitrile) phase **USP L10**	pH 2–8		π–π interactions, polar interactions and hydrophobic interactions	164
NO_2	Nitrophenyl	pH 2–8		π–π interactions, polar interactions and hydrophobic interactions	200*
OH (Diol)	Diol **USP L20**	pH 2–8		polar interactions (hydrogen bonds)	162
NH_2 / NH_2-RP	Amino **USP L8**	pH 2–8		polar and hydrophobic interactions, weak ion exchange interactions	163
$N(CH_3)_2$	Dimethylamino	pH 2–8		polar and hydrophobic interactions, weak ion exchange interactions	163
SA	Sulfonic acid, strongly acid cation exchanger (SCX) **USP L9**	pH 2–8		strong ion exchange interactions	164
SB	Quaternary ammonium, strongly basic anion exchanger (SAX) **USP L14**	pH 2–8		strong ion exchange interactions	165
SiOH	Unmodified spherical silica · **USP L3**	pH 2–8		polar interactions	165

* Available only as bulk packing (custom-packed columns on request)

NUCLEOSIL® octadecyl phases (C_{18})

$-(CH_2)_{17}-CH_3$

- **NUCLEOSIL® standard octadecyl phases**
  Nonpolar phases · pH stability at 20 °C: 2–8 · carbon content depending on pore size (see below) · **USP L1**
  Corresponding NUCLEODUR® phases see C_{18} ec page 133
- **NUCLEOSIL® C_{18} HD**
  Nonpolar hydrophobic high density phases, monomeric modification
  pH stability 2–9; carbon content 20% · **USP L1**
  Corresponding NUCLEODUR® phases see C_{18} Gravity page 116
- **NUCLEOSIL® C_{18} AB**
  Crosslinked hydrophobic phase, polymeric modification, inert towards acidic and basic substances with high affinity for silica; pH stability 1–9; carbon content 25%; distinct steric selectivity · **USP L1**
  Corresponding NUCLEODUR® phases see C_{18} Isis page 120
- **NUCLEOSIL® C_{18} Nautilus**
  Stable in 100% aqueous eluents; carbon content 16% · **USP L60**
  Interesting polar selectivity features, very good base deactivation
  Corresponding NUCLEODUR® phases see C_{18} PolarTec page 124
- **Wide pore octadecyl phases**
- All octadecyl phases are endcapped

Custom-packed columns with different column dimensions are available on request.

Ordering information

Eluent in column acetonitrile – water

Length →	100 mm	125 mm	150 mm	250 mm	Guard columns	
NUCLEOSIL® 50-5 C_{18} ec	particle size 5 µm, pore size 50 Å, endcapped, 14.5% C					
EC columns					EC guard col.*	CC guard col.**
4.6 mm ID				720098.46	721473.30	721829.40
NUCLEOSIL® 100-3 C_{18}	particle size 3 µm, pore size 100 Å, endcapped, 15% C					
EC columns					EC guard col.*	CC guard columns**
4 mm ID		720150.40		720133.40	721022.30	721866.40
4.6 mm ID	720841.46	720150.46	720949.46	720133.46	721022.30	721866.40
NUCLEOSIL® 100-5 C_{18}	particle size 5 µm, pore size 100 Å, endcapped, 15% C					
EC columns					EC guard col.*	CC guard col.**
2 mm ID		720002.20	720120.20	720014.20	721074.20	721602.30
3 mm ID		720002.30	720120.30	720014.30	721074.30	721602.30
4 mm ID	720141.40	720002.40	720120.40	720014.40	721074.30	721602.40
4.6 mm ID	720141.46	720002.46	720120.46	720014.46	721074.30	721602.40
VarioPrep columns						VP guard col.***
10 mm ID				715340.100		715360.80
21 mm ID				715340.210		715360.160
NUCLEOSIL® 100-7 C_{18}	particle size 7 µm, pore size 100 Å, endcapped, 15% C					
EC columns						
4 mm ID				720018.40		
4.6 mm ID		720951.46	720110.46	720018.46		
VarioPrep columns						VP guard col.***
8 mm ID				715332.80		715360.80
10 mm ID				715332.100		715360.80
16 mm ID				715332.160		715360.160
21 mm ID				715332.210		715360.160

NUCLEOSIL® standard silica for HPLC

Length →	100 mm	125 mm	150 mm	250 mm	Guard columns	
NUCLEOSIL® 100-10 C_{18}	particle size 10 µm, pore size 100 Å, endcapped, 15 % C					
EC columns						
4 mm ID				720023.40		
4.6 mm ID		720701.46	720140.46	720023.46		
NUCLEOSIL® 120-3 C_{18}	particle size 3 µm, pore size 120 Å, endcapped, 11 % C					
EC columns					EC guard col.*	CC guard col.**
4 mm ID	720149.40	720040.40		720055.40	721075.30	721606.40
4.6 mm ID	720149.46	720040.46	720740.46	720055.46	721075.30	721606.40
NUCLEOSIL® 120-5 C_{18}	particle size 5 µm, pore size 120 Å, endcapped, 11 % C					
EC columns					EC guard col.*	CC guard col.**
4 mm ID		720051.40		720041.40	721070.30	721783.40
4.6 mm ID		720051.46	720730.46	720041.46	721070.30	721783.40
NUCLEOSIL® 120-7 C_{18}	particle size 7 µm, pore size 120 Å, endcapped, 11 % C					
EC columns						
4 mm ID				720042.40		
NUCLEOSIL® 120-10 C_{18}	particle size 10 µm, pore size 120 Å, endcapped, 11 % C					
EC columns						
4 mm ID				720043.40		
4.6 mm ID				720043.46		
NUCLEOSIL® 100-3 C_{18} HD	particle size 3 µm, pore size 100 Å, 20 % C					
EC columns					EC guard col.*	CC guard col.**
4 mm ID		720191.40			721196.30	721494.40
4.6 mm ID		720191.46	720193.46		721196.30	721494.40
NUCLEOSIL® 100-5 C_{18} HD	particle size 5 µm, pore size 100 Å, 20 % C					
EC columns					EC guard col.*	CC guard col.**
4 mm ID		720296.40		720280.40	721072.30	721853.40
4.6 mm ID		720296.46	720294.46	720280.46	721072.30	721853.40
NUCLEOSIL® 100-5 C_{18} AB	particle size 5 µm, pore size 100 Å, 25 % C					
EC columns					EC guard col.*	CC guard col.**
2 mm ID		720935.20		720936.20	721073.20	721603.30
3 mm ID		720935.30		720936.30	721073.30	721603.30
4 mm ID		720935.40		720936.40	721073.30	721603.40
4.6 mm ID		720935.46	720305.46	720936.46	721073.30	721603.40
NUCLEOSIL® 100-3 C_{18} Nautilus	particle size 3 µm, pore size 100 Å, 16 % C					
EC columns					EC guard col.*	CC guard col.**
4 mm ID		720472.40			721649.30	721611.40
4.6 mm ID		720472.46	720471.46		721649.30	721611.40

NUCLEOSIL® standard silica for HPLC

Length →	100 mm	125 mm	150 mm	250 mm	Guard columns	
NUCLEOSIL® 100-5 C_{18} Nautilus				particle size 5 µm, pore size 100 Å, 16 % C		
EC columns					EC guard col.*	CC guard col.**
4 mm ID		**720430.40**		**720431.40**	**721133.30**	**721140.40**
4.6 mm ID		**720430.46**	**720432.46**	**720431.46**	**721133.30**	**721140.40**

Wide pore silica packings

Many biologically interesting molecules can not be separated using conventional narrow pore silicas with pore sizes of about 100 Å.

This is why MACHEREY-NAGEL offers a complete line of wide pore packings with pore sizes of 300, 500, 1000 and 4000 Å. These materials can also be used for size exclusion chromatography (SEC).

Length →	250 mm	Guard columns	
NUCLEOSIL® 300-5 C_{18}	particle size 5 µm, pore size 300 Å, endcapped, 6.5 % C		
EC columns		EC guard col.*	CC guard col.**
4 mm ID	**720065.40**	**721085.30**	**721608.40**
4.6 mm ID	**720065.46**	**721085.30**	**721608.40**
NUCLEOSIL® 300-7 C_{18}	particle size 7 µm, pore size 300 Å, endcapped, 6.5 % C		
VarioPrep columns			VP guard col.***
10 mm ID	**715806.100**		**715360.80**
21 mm ID	**715806.210**		**715360.160**
NUCLEOSIL® 500-7 C_{18}	particle size 7 µm, pore size 500 Å, endcapped, 2 % C		
EC columns			
4.6 mm ID	**720074.46**		
NUCLEOSIL® 1000-7 C_{18}	particle size 7 µm, pore size 1000 Å, endcapped, ~ 1 % C		
EC columns			
4.6 mm ID	**720077.46**		
NUCLEOSIL® 4000-7 C_{18}	particle size 7 µm, pore size 4000 Å, endcapped, < 1 % C		
EC columns			
4.6 mm ID	**720085.46**		

EC and VarioPrep columns in packs of 1, guard columns see below

Guard column systems						Guard column holder
Guard columns for EC columns with ID		**2 mm**	**3 mm**	**4 mm**	**4.6 mm**	
* Column Protection System (pack of)	EC	4/2 (3)	4/3 (3)	4/3 (3)	4/3 (3)	718966
** ChromCart® guard columns (pack of)	CC	8/3 (3)	8/3 (3)	8/4 (3)	8/4 (3)	721359
Guard columns for VarioPrep columns with ID		**8, 10 mm**	**16, 21 mm**	**32, 40 mm**	**≥ 50 mm**	
*** VP guard columns (pack of)	VP	10/8 (2)	10/16 (2)	15/32 (1)	15/50 (1)	
VP guard column holder		718251	718256	718253	718255	

For details of our column systems see pages 189-196

NUCLEOSIL® bulk materials for self-packing of columns see page 199 and following.

NUCLEOSIL® standard silica for HPLC

NUCLEOSIL® 100 Protect I — special RP phase with protective polar group

- RP phase with pronounced hydrophilic properties, monomeric coating, endcapped
  carbon content 11 % C

Ordering information

Eluent in column acetonitrile – water

EC columns  Length:	125 mm	150 mm	250 mm	EC guard columns*	CC guard columns**
NUCLEOSIL® 100-5 Protect I			particle size 5 µm, pore size 100 Å		
4 mm ID	**720175.40**		**720170.40**	**721157.30**	**721154.40**
4.6 mm ID	**720175.46**	**720174.46**	**720170.46**	**721157.30**	**721154.40**

NUCLEOSIL® octyl phases (C_8) — $-(CH_2)_7-CH_3$

- **NUCLEOSIL® standard octyl phases**
  Nonpolar phases for RP and ion-pairing chromatography · **USP L7**
  Endcapped and non-endcapped modifications available; pH stability at 20 °C: 2–8
  Carbon content depending on pore size (see below)
  Corresponding NUCLEODUR® phases see C_8 ec page 133
- **NUCLEOSIL® C_8 HD**
  Nonpolar high density phases, monomeric modification, endcapped;
  Corresponding NUCLEODUR® phases see C_8 Gravity page 116
- Recommended for separation of moderately to highly polar (water-soluble) compounds
  applications: steroids, nucleosides, cyclodextrins, pharmacological plant constituents

Custom-packed columns with different column dimensions are available on request

Ordering information

Eluent in column acetonitrile – water

EC columns  Length:	125 mm	150 mm	250 mm	EC guard columns*	CC guard columns**
NUCLEOSIL® 100-5 C_8 ec			particle size 5 µm, pore size 100 Å ; endcapped, 9 % C		
4.6 mm ID			**720165.46**	**721096.30**	**721805.40**
NUCLEOSIL® 100-5 C_8			particle size 5 µm, pore size 100 Å ; not endcapped, 8.5 % C		
4 mm ID	**720001.40**		**720013.40**	**721194.30**	**721601.40**
4.6 mm ID	**720001.46**	**720990.46**	**720013.46**	**721194.30**	**721601.40**
NUCLEOSIL® 100-7 C_8			particle size 7 µm, pore size 100 Å ; not endcapped, 8.5 % C		
4.6 mm ID			**720017.46**		
NUCLEOSIL® 100-10 C_8			particle size 10 µm, pore size 100 Å ; not endcapped, 8.5 % C		
4 mm ID			**720022.40**		
4.6 mm ID			**720022.46**		

NUCLEOSIL® standard silica for HPLC

EC columns	Length:	125 mm	150 mm	250 mm	EC guard columns*	CC guard columns**
NUCLEOSIL® 120-3 C_8		particle size 3 µm, pore size 120 Å ; not endcapped, 6.5 % C				
4 mm ID		**720071.40**			**721093.30**	**721785.40**
4.6 mm ID		**720071.46**	**720214.46**		**721093.30**	**721785.40**
NUCLEOSIL® 120-5 C_8		particle size 5 µm, pore size 120 Å ; not endcapped, 6.5 % C				
4 mm ID		**720050.40**		**720052.40**	**721095.30**	**721787.40**
4.6 mm ID		**720050.46**	**720735.46**	**720052.46**	**721095.30**	**721787.40**
NUCLEOSIL® 300-5 C_8		particle size 5 µm, pore size 300 Å ; not endcapped, ~ 3 % C				
4.6 mm ID				**720062.46**	**721061.30**	**721101.40**
NUCLEOSIL® 100-5 C_8 HD		particle size 5 µm, pore size 100 Å, 13 % C				
4 mm ID				**720196.40**	**721071.30**	**721500.40**
4.6 mm ID			**720194.46**	**720196.46**	**721071.30**	**721500.40**

EC columns in packs of 1, guard columns in packs of 3

NUCLEOSIL® butyl phases (C_4)

$-(CH_2)_3-CH_3$

- Endcapped phases for RP and ion-pairing chromatography · **USP L26**
- pH stability at 20 °C: 2–8; carbon content ~ 2 %
- Recommended for separation of macromolecules and hydrophobic substances
- Retention times are shorter than on C_8 and C_{18} phases

For butyl phases for biochemical separations please refer to page 182.

Ordering information

Eluent in column acetonitrile – water

EC columns	Length:	250 mm	EC guard columns*	CC guard columns**
NUCLEOSIL® 120-5 C_4		particle size 5 µm, pore size 120 Å		
4.6 mm ID		**720096.46**	**721083.30**	**721889.40**
NUCLEOSIL® 300-5 C_4		particle size 5 µm, pore size 300 Å		
4 mm ID		**720059.40**	**721916.30**	**721607.40**
4.6 mm ID		**720059.46**	**721916.30**	**721607.40**

EC columns in packs of 1, guard columns in packs of 3

Guard column systems Guard columns for EC columns with ID		2 mm	3 mm	4 mm	4.6 mm	Guard column holder
* Column Protection System	EC	4/2	4/3	4/3	4/3	718966
** ChromCart® guard columns	CC	8/3	8/3	8/4	8/4	721359

For details of our column systems see pages 189–196

NUCLEOSIL® standard silica for HPLC

NUCLEOSIL® dimethyl phase (C_2)

$-(CH_3)_2$

- Non-endcapped phase for RP and ion-pairing chromatography · **USP L16**
- pH stability at 20 °C: 2–8; carbon content 3.5 %
- Retention times are much shorter than for the other RP phases

Ordering information

Eluent in column acetonitrile – water

EC columns	Length: 250 mm	EC guard columns*	CC guard columns**
NUCLEOSIL® 100-7 C_2	particle size 7 µm, pore size 100 Å		
4.6 mm ID	**720089.46**	**721030.30**	**721069.40**

NUCLEOSIL® phenyl phases (C_6H_5)

$-(CH_2)_3-C_6H_5$

- Relatively nonpolar, non-endcapped phases for RP and ion pairing chromatography · **USP L11**
- Polarity similar to C_8, but with different selectivity for PAHs, polar aromatics, fatty acids etc.
- pH stability at 20 °C: 2–8; carbon content 8 %
- Recommended for separation of moderately polar compounds

Ordering information

Eluent in column acetonitrile – water

EC columns	Length: 250 mm	EC guard columns*	CC guard columns**
NUCLEOSIL® 100-5 C_6H_5	particle size 5 µm, pore size 100 Å, not endcapped		
4.6 mm ID	**720956.46**	**721137.30**	**721862.40**
NUCLEOSIL® 100-7 C_6H_5	particle size 7 µm, pore size 100 Å, not endcapped		
4 mm ID	**720019.40**		
4.6 mm ID	**720019.46**		

NUCLEOSIL® diol phases

$-(CH_2)_3-O-CH_2-\underset{\displaystyle OH}{\underset{|}{CH}}-\underset{\displaystyle OH}{\underset{|}{CH_2}}$

- Dihydroxypropyl modified silica for RP and NP chromatography · **USP L20**
- Less polar than unmodified silica, very easily wettable with water
- pH stability at 20 °C: 2–8; carbon content 5 %

Ordering information

Eluent in column is *n*-heptane. When using an eluent which is not miscible with *n*-heptane (e.g., water), it is necessary to rinse the columns with THF first.

EC columns	Length: 250 mm	EC guard columns*	CC guard columns**
NUCLEOSIL® 100-5 OH (Diol)	particle size 5 µm, pore size 100 Å		
4.6 mm ID	**720143.46**	**721142.30**	**721478.40**

NUCLEOSIL® amino phases

$-(CH_2)_3-NH_2$

- Aminopropyl modified polar silica phase · pH stability at 20 °C: 2–8; carbon content 3.5 % · **USP L8**
  Corresponding NUCLEODUR® phases see page 140
- For multi-mode chromatography:

  NP chromatography with hexane, dichloromethane or 2-propanol as mobile phase for polar compounds such as substituted anilines, esters, chlorinated pesticides

  RP chromatography of polar compounds like carbohydrates in aqueous-organic eluent systems

  Anion exchange chromatography of anions and organic acids using common buffers (e.g., acetate or phosphate) in conjunction with organic modifiers (e.g., acetonitrile)

Ordering information

Eluent in column is *n*-heptane (except for NH_2 RP). When using an eluent which is not miscible with *n*-heptane (e.g., water), it is necessary to rinse the column with THF first.

EC column	Length: 250 mm	EC guard columns*	CC guard columns**
NUCLEOSIL® 100-3 NH_2	particle size 3 µm, pore size 100 Å; eluent in column *n*-heptane		
4.6 mm ID	**720275.46**	**721933.30**	**721122.40**
NUCLEOSIL® 100-5 NH_2	particle size 5 µm, pore size 100 Å; eluent in column *n*-heptane		
4.6 mm ID	**720095.46**	**721020.30**	**721605.40**
NUCLEOSIL® 100-5 NH_2-RP	particle size 5 µm, pore size 100 Å; eluent in column acetonitrile – water (80:20)		
4.6 mm ID	**720095.46RP**	**721155.30**	**721605.40RP**
NUCLEOSIL® 100-10 NH_2	particle size 10 µm, pore size 100 Å; eluent in column *n*-heptane		
4.6 mm ID	**720025.46**		

NUCLEOSIL® dimethylamino phase

$-(CH_2)_3-N(CH_3)_2$

- Weakly basic anion exchanger for the separation of many anions; pH stability at 20 °C: 2–8; 4 % C
- Can also be used in a similar way as the NH_2 phase

Ordering information

Eluent in column is *n*-heptane. When using an eluent which is not miscible with *n*-heptane (e.g., water), it is necessary to rinse the columns with THF first.

EC columns	Length: 250 mm	EC guard columns*	CC guard columns**
NUCLEOSIL® 100-5 $N(CH_3)_2$	particle size 5 µm, pore size 100 Å		
4.6 mm ID	**720994.46**	**721158.30**	**721610.40**

EC columns in packs of 1, guard columns in packs of 3

Guard column systems Guard columns for EC columns with ID		2 mm	3 mm	4 mm	4.6 mm	Guard column holder
* Column Protection System	EC	4/2	4/3	4/3	4/3	718966
** ChromCart® guard columns	CC	8/3	8/3	8/4	8/4	721359

For details of our column systems see pages 189–196

NUCLEOSIL® standard silica for HPLC

NUCLEOSIL® cyano phases

$-(CH_2)_3 - CN$

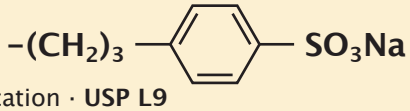
- Polar to midpolar cyano (nitrile) modified silica · **USP L10**
- For reversed phase and normal phase chromatography:
  Normal phase: with low-polarity solvents for many compounds, which can also be separated on unmodified silica, however, due to the rapid equilibration much more suitable for gradient separations
  Reversed phase: with different selectivity than C_{18}, C_8 or phenyl modified packings
- pH stability at 20 °C: 2–8; carbon content 5 % for 100 Å pores, ~ 3 % for 120 Å pores
  Corresponding NUCLEODUR® phases see page 138

Ordering information

Eluent in column (except for NUCLEOSIL® 100-5 CN-RP) is *n*-heptane. When using an eluent which is not miscible with *n*-heptane (e.g., water), it is necessary to rinse the column with THF first.

EC columns	Length: 250 mm	EC guard columns*	CC guard columns**
NUCLEOSIL® 100-5 CN	particle size 5 µm, pore size 100 Å ; eluent in column *n*-heptane		
4 mm ID	**720090.40**	**721078.30**	**721604.40**
4.6 mm ID	**720090.46**	**721078.30**	**721604.40**
NUCLEOSIL® 100-5 CN-RP	particle size 5 µm, pore size 100 Å; eluent in column acetonitrile – water		
4 mm ID	**720205.40**	**721039.30**	**721917.40**
4.6 mm ID	**720205.46**	**721039.30**	**721917.40**
NUCLEOSIL® 100-10 CN	particle size 10 µm, pore size 100 Å; eluent in column *n*-heptane		
4 mm ID	**720024.40**		
4.6 mm ID	**720024.46**		
NUCLEOSIL® 120-7 CN	particle size 7 µm, pore size 120 Å; eluent in column *n*-heptane		
4 mm ID	**720057.40**		
4.6 mm ID	**720057.46**		

NUCLEOSIL® SA phases



- Strongly acidic cation exchanger (SCX) with benzenesulfonic acid modification · **USP L9**
- Capacity ~ 1 meq/g; pH stability at 20 °C: 2–8; carbon content 6.5 %

Ordering information

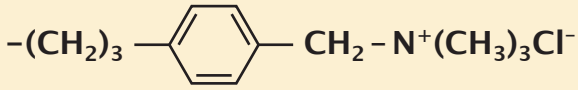
Eluent in column 0.15 mol/L $(NH_4)_2HPO_4$, pH 5

EC columns	Length: 125 mm	150 mm	250 mm	EC guard columns*	CC guard columns**
NUCLEOSIL® 100-5 SA			particle size 5 µm, pore size 100 Å		
4 mm ID			**720097.40**	**721024.30**	**721487.40**
4.6 mm ID	**720709.46**	**720182.46**	**720097.46**	**721024.30**	**721487.40**

NUCLEOSIL® standard silica for HPLC

EC columns 	125 mm	Length: 150 mm	250 mm	EC guard columns*	CC guard columns**
NUCLEOSIL® 100-10 SA				particle size 10 µm, pore size 100 Å	
4.6 mm ID			**720028.46**		

NUCLEOSIL® SB phases



- Strongly basic anion exchanger (SAX) with quaternary ammonium modification · **USP L14**
- Capacity ~ 1 meq/g; pH stability at 20 °C: 2–8; carbon content 10%

Ordering information

Eluent in column 0.15 mol/L $(NH_4)_2HPO_4$, pH 5

EC columns 	125 mm	Length: 150 mm	250 mm	EC guard columns*	CC guard columns**
NUCLEOSIL® 100-5 SB				particle size 5 µm, pore size 100 Å	
4.6 mm ID	**720989.46**	**720183.46**	**720996.46**	**721025.30**	**721885.40**
NUCLEOSIL® 100-10 SB				particle size 10 µm, pore size 100 Å	
4.6 mm ID			**720029.46**		

NUCLEOSIL® SiOH

unmodified silica

- Spherical silica, pH stability 2–8 · **USP L3**

For physical properties of unmodified NUCLEOSIL® materials please see page 199; maximum working pressure for the EC columns listed below is 400 bar.

Ordering information

Eluent in column is *n*-heptane. When using an eluent which is not miscible with *n*-heptane (e.g., water), it is necessary to rinse the column with THF first.

EC columns 	Length:	250 mm	EC guard columns*	CC guard columns**
NUCLEOSIL® 50-5			particle size 5 µm, pore size 50 Å	
4.6 mm ID		**720093.46**	**721167.30**	**721600.40**
NUCLEOSIL® 100-5			particle size 5 µm, pore size 100 Å	
4.6 mm ID		**720099.46**	**721518.30**	**721872.40**

EC columns in packs of 1, guard columns in packs of 3

Guard column systems Guard columns for EC columns with ID		2 mm	3 mm	4 mm	4.6 mm	Guard column holder
* Column Protection System	EC	4/2	4/3	4/3	4/3	718966
** ChromCart® guard columns	CC	8/3	8/3	8/4	8/4	721359

For details of our column systems see pages 189–196

Analytical columns with LiChrospher®

LiChrospher® packings manufactured by E. Merck (D)

Phase	USP	Particle size	Pore size	Modification	Endcapped	Carbon content
LiChrospher® 100 RP 8, 5 µm	L7	nom. 5 µm	100 Å	octyl	–	12.5 %
LiChrospher® 100 RP 8 ec, 5 µm	L7	nom. 5 µm	100 Å	octyl	✓	12.5 %
LiChrospher® 100 RP 18, 5 µm	L1	nom. 5 µm	100 Å	octadecyl	–	21 %
LiChrospher® 100 RP 18 ec, 5 µm	L1	nom. 5 µm	100 Å	octadecyl	✓	21 %
LiChrospher® 60 RP select B, 5 µm	L7	nom. 5 µm	60 Å	octyl	✓	12 %

All phases as packed ChromCart® cartridges 

ChromCart® columns require the CC connecting kit (REF 721690, see page 192).

Ordering information

Eluent in column acetonitrile – water

	Length → 125 mm	150 mm	250 mm	Guard columns
LiChrospher® 100 RP 8, 5 µm				
2 mm ID	728025.20		728026.20	728051.30
3 mm ID	728025.30		728026.30	728051.30
4 mm ID	728025.40		728026.40	728051.40
4.6 mm ID	728025.46	728027.46	728026.46	728051.40
LiChrospher® 100 RP 8 ec, 5 µm				
2 mm ID	728028.20		728029.20	728052.30
3 mm ID	728028.30		728029.30	728052.30
4 mm ID	728028.40		728029.40	728052.40
4.6 mm ID	728028.46	728030.46	728029.46	728052.40
LiChrospher® 100 RP 18, 5 µm				
2 mm ID	728031.20		728032.20	728053.30
3 mm ID	728031.30		728032.30	728053.30
4 mm ID	728031.40		728032.40	728053.40
4.6 mm ID	728031.46	728033.46	728032.46	728053.40
LiChrospher® 100 RP 18 ec, 5 µm				
2 mm ID	728034.20		728035.20	728054.30
3 mm ID	728034.30		728035.30	728054.30
4 mm ID	728034.40		728035.40	728054.40
4.6 mm ID	728034.46	728036.46	728035.46	728054.40
LiChrospher® 60 RP select B, 5 µm				
2 mm ID	728037.20		728038.20	728055.30
3 mm ID	728037.30		728038.30	728055.30
4 mm ID	728037.40		728038.40	728055.40
4.6 mm ID	728037.46	728039.46	728038.46	728055.40

8 mm ChromCart® guard column cartridges in packs of 3, all other columns in packs of 1.

HPLC columns for special separations

Summary

Separation / mechanism	Recommended column	Specification of the phase	Page
Environmental analysis			
Anion exchange chromatography of inorganic anions	NUCLEOGEL® Anion I	Strongly basic polymer-based anion exchanger	171
	NUCLEOSIL® Anion II	Strongly basic silica-based anion exchanger	
RP chromatography of PAHs	NUCLEODUR® C_{18} PAH	NUCLEODUR® polymer-coated with C_{18} groups · **USP L1**	168
	NUCLEOSIL® 100-5 C_{18} PAH	NUCLEOSIL® 100 polymer-coated with C_{18} groups · **USP L1**	170
Enantiomer separation			
Formation of inclusion complexes	NUCLEODEX α-PM, β-PM, γ-PM and β-OH	Silica-based permethylated and underivatized cyclodextrin phases · **USP L45**	172
Polar and π-π interactions	NUCLEOCEL *DELTA*	Silica-based modified cellulose phases · **USP L40**	174
Ligand exchange	NUCLEOSIL® CHIRAL-1	Covalently bonded amino acid - Cu(II) complexes · **USP L32**	176
Charge-transfer-, dipole-dipole interactions and others	NUCLEOSIL® CHIRAL-2, NUCLEOSIL® CHIRAL-3	Silica-based brush type phases · **USP L36**	177
Enantioselective binding to chiral protein surface structures	RESOLVOSIL BSA-7	Silica-based protein phase (BSA)	175
Biological macromolecules			
Anion exchange chromatography of oligonucleotides + nucleic acids	NUCLEOGEN® DEAE	Silica-based DEAE anion exchanger	178
Anion exchange chromatography of proteins and peptides	NUCLEOSIL® 4000-7 PEI	Silica-based polymeric polyethyleneimine network	180
Anion exchange chromatography of peptides, large proteins and oligonucleotides	NUCLEOGEL® SAX	Polymer-based strongly basic anion exchanger · **USP L23**	181
Cation exchange chromatography of proteins, peptides and carbohydrates	NUCLEOGEL® SCX	Polymer-based strong cation exchanger **USP L22**	181
Reversed phase chromatography of proteins, peptides and oligonucleotides	NUCLEOSIL® MPN	Monomerically bonded alkyl chains on silica · **USP L1** / **USP L26**	182
	NUCLEOSIL® PPN	Polymerically bonded alkyl chains on silica · **USP L1**	183
	NUCLEOGEL® RP 300	Polystyrene - divinylbenzene polymer **USP L21**	184
Reversed phase chromatography of small molecules	NUCLEOGEL® RP 100	Small pore macroporous PS-DVB polymer **USP L21**	184
Food analysis · Sugars			
RP chromatography of mono- and oligosaccharides	NUCLEOSIL® Carbohydrate	Silica-based special amino phase **USP L8**	185
Separation of sugars, alcohols, org. acids based on ion exclusion, ion exchange, size exclusion, ligand exchange, NP and RP effects	NUCLEOGEL® SUGAR 810 H, Ca	Resins with sulfonic acid modification in different ionic forms: H form **USP L17** · Ca form **L19** · Pb form **L34** · Na form **L58**	186
Separation of sugars, alcohols, org. acids based on steric exclusion, ligand exchange and partition effects	NUCLEOGEL® SUGAR Ca, Na, Pb		187
	NUCLEOGEL® ION 300 OA		187
Gel permeation chromatography (GPC)			
Water-insoluble compounds	NUCLEOGEL® GPC	Polystyrene - divinylbenzene polymer	188

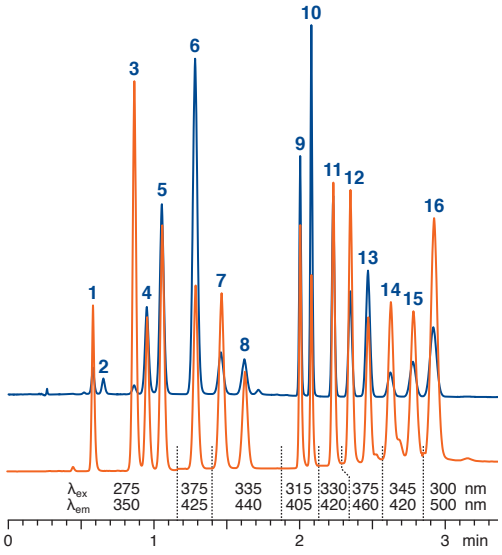
HPLC columns for environmental analyses

NUCLEODUR® C_{18} PAH — special octadecyl phase for PAH analyses

- Base material NUCLEODUR® silica, particle sizes 1.8 and 3 µm, pore size 110 Å; polymeric coating · **USP L1**
- Allows efficient gradient separation of the 16 PAHs according to EPA
- Detection of separated PAHs with UV (250–280 nm), diode array or fluorescence detection at different wavelengths for excitation and emission (acenaphthylene cannot be analyzed with fluorescence detection)

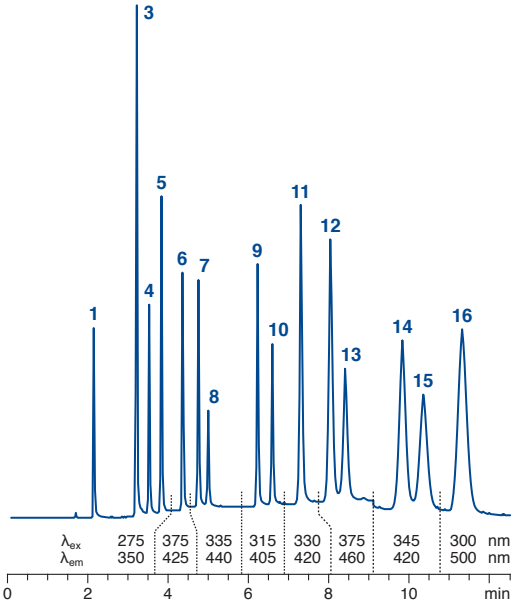
Analysis of 16 EPA PAHs with or without acetonitrile

Separation with acetonitrile
Column: 100 x 4 mm NUCLEODUR® C_{18} PAH, 3 µm
Eluent: A) methanol – water (80:20, v/v)
B) acetonitrile
2–20 % B in 1.2 min, 20–100 % B in 0.5 min, 100 % B for 2.5 min, 100–2 % B in 0.4 min
Flow rate: 2.5 mL/min, temperature 35 °C
Detection: UV, 254 nm
fluorescence (see chromatogram)



MN Appl. No. 123820

Separation without acetonitrile
Column: 125 x 4 mm NUCLEODUR® C_{18} PAH, 3 µm
Eluent: A) water
B) methanol
65–97 % B in 6 min, 97 % B for 5 min, 97–65 % B in 0.5 min
Flow rate: 2 mL/min, temperature 35 °C
Detection: fluorescence (see chromatogram)



MN Appl. No. 123830

Peaks:
1. Naphthalene
2. Acenaphthylene (not detectable by fluorescence)
3. Acenaphthene
4. Fluorene
5. Phenantrene
6. Anthracene
7. Fluoranthene
8. Pyrene
9. Benz[a]anthracene
10. Chrysene
11. Benzo[b]fluoranthene
12. Benzo[k]fluoranthene
13. Benzo[a]pyrene
14. Dibenz[ah]anthracene
15. Benzo[ghi]perylene
16. Indeno[1,2,3-cd]pyrene

Ordering information · EC columns

Eluent in column acetonitrile – water (70:30, v/v)

Length →	100 mm	125 mm	150 mm	250 mm	EC guard columns*	CC guard columns**
NUCLEODUR® C_{18} PAH, 1.8 µm						
2 mm ID	**760773.20**				**761970.20**	
3 mm ID	**760773.30**				**761970.30**	
4 mm ID	**760773.40**				**761970.30**	
NUCLEODUR® C_{18} PAH, 3 µm						
3 mm ID	**760783.30**	**760784.30**	**760785.30**	**760786.30**	**761971.30**	**761780.30**
4 mm ID	**760783.40**	**760784.40**	**760785.40**	**760786.40**	**761971.30**	**761780.40**

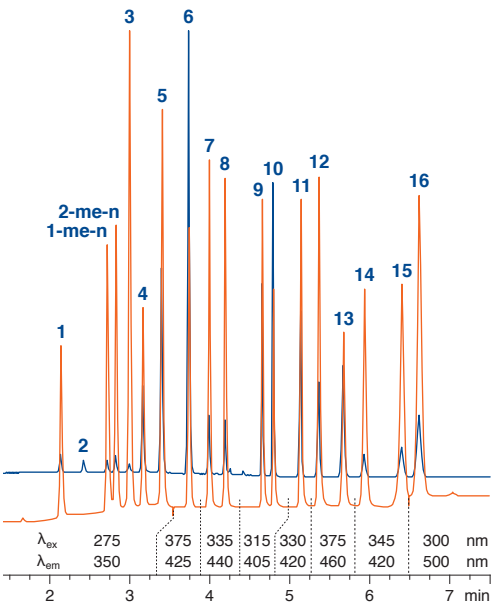
Guard columns for EC columns with ID		2 mm	3 mm	4 mm	4.6 mm	
* Column Protection System	EC	4/2	4/3	4/3	4/3	718966
** ChromCart® guard columns	CC	8/3	8/3	8/4	8/4	721359

Separation of 18 PAHs on NUCLEODUR® C_{18} PAH

Column: 125 x 4 mm NUCLEODUR® C_{18} PAH, 3 µm
Eluent: A) methanol – water (70:30, v/v)
B) acetonitrile
0–20 % B in 1.5 min,
20–50 % B in 1.5 min,
50–100 % B in 1.0 min,
100 % B for 3 min,
100–0 % B in 0.5 min
Flow rate: 1.5 mL/min
Temperature: 35 °C
Injection: UV: 1 µL, fluorescence: 0.5 µL
Detection: UV, 254 nm
fluorescence
(see chromatogram)

Peaks:
(concentrations 10 ng/µL per compound)
1.–16. see opposite page
1-me-n: 1-methylnaphthalene
2-me-n: 2-methylnaphthalene

MN Appl. No. 123840

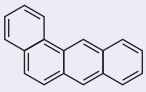


Analysis of polycyclic aromatic hydrocarbons (PAHs) by HPLC

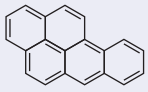
Polycyclic aromatic hydrocarbons (PAHs) are chemical compounds that consist of fused aromatic rings and do not contain heteroatoms or carry substituents. As a pollutant, they are of concern because some compounds have been identified as carcinogenic, mutagenic, and teratogenic. PAHs are natural components of coal or gas. They are delivered to our environment by pyrolysis (incomplete burning) of organic materials like coal, oil, fuel, wood, tobacco, … and hence can be found globally. Today most PAHs accrue from anthropogenic processes – but also natural origins (forest fire) are possible. Regarding to past pollutions an important impact had production of coke and gas from black coal. Waste products (e.g., tar) from coking or gas plants are often origin of serious ground water pollutions.

Since a number of PAHs (e.g., benzo[a]pyrene, 3-methylcholanthrene and benzanthracene) have been proven to be carcinogenic, control of the PAH content of food, water and soil is an important task for routine analysis. For choice and limiting values of the polycyclics we refer to the governmental regulations, which exist in many countries (e.g., EPA method 610 of the United States Environmental Protection Agency).

PAHs can be determined by different chromatographic techniques (TLC, GC, HPLC). Thus the 6 PAHs according to German drinking water specification (TVO) can, e.g., be analyzed by TLC (see German Standard DIN 38 409), while a much larger number of polycyclic aromatics can be determined by GC or HPLC.



benz[a]anthracene



benzo[a]pyrene

HPLC columns for PAH analysis

For PAH analyses we have developed specially modified C_{18} phases based on NUCLEODUR® and NUCLEOSIL® which allow efficient gradient separation of 16 PAHs according to EPA. Detection of the separated PAHs can be achieved by UV (250–280 nm), with diode array or with fluorescence detection at different wavelengths for excitation and emission. Acenaphthylene cannot be analyzed with fluorescence detection. For cost-effective routine PAH analysis we recommend applications using methanol instead of acetonitrile as eluent. For rapid analysis NUCLEODUR® C_{18} PAH (3 µm) in short columns (100 mm) provides excellent results at high flow rates. Hereby separation of 16 PAHs according to EPA can be achieved in less than 3 min.

Tightened regulations require determination of 2 additional PAHs (1- and 2-methylnaphthalene) – so we developed highly efficient methods for 18 PAHs on the NUCLEODUR® C_{18} PAH.

References

Determination of PASH in Diesel fuel by HPLC and photodiode-array detection; J. Bunot, W. Herbel, H. Steinhart, J. High Res. Chrom. **15** (1992) 682-685

GIT Spezial Chromat. **2** (1992) 80-85

HPLC columns for environmental analyses

NUCLEOSIL® 100-5 C_{18} PAH — special octadecyl phase for PAH analyses

- Base material NUCLEOSIL® silica, particle size 5 µm, pore size 100 Å; polymeric coating · **USP L1**
- Recommended for efficient gradient separation of the 16 PAHs according to EPA
- Detection of the separated PAH with UV (250–280 nm), diode array or fluorescence detection at different wavelengths for excitation and emission (acenaphthylene cannot be analyzed with fluorescence detection)

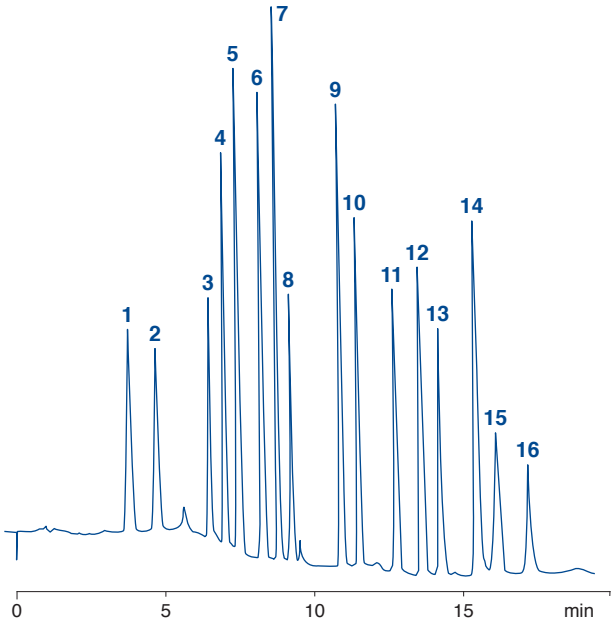
Separation of the PAH standard according to EPA (REF 722393)

Column: 150 x 4 mm NUCLEOSIL® 100-5 C_{18} PAH
Eluent: A) methanol – water (80:20)
B) acetonitrile – tetrahydrofuran (93:7)
0–100 % B in 10 min, 5 min 100 % B
Flow rate: 1 mL/min
Pressure: 140 bar
Temperature: 20 °C
Detection: UV, 260 nm

Peaks: (10 µg/mL each in acetonitrile)

1. Naphthalene
2. Acenaphthylene
3. Acenaphthene
4. Fluorene
5. Phenantrene
6. Anthracene
7. Fluoranthene
8. Pyrene
9. Benz[a]anthracene
10. Chrysene
11. Benzo[b]fluoranthene
12. Benzo[k]fluoranthene
13. Benzo[a]pyrene
14. Dibenz[ah]anthracene
15. Benzo[ghi]perylene
16. Indeno[1,2,3-cd]pyrene

MN Appl. No. 115040



Ordering information

Eluent in column acetonitrile – water (70:30, v/v)

EC columns 	Length →	150 mm	250 mm	EC guard columns*	CC guard columns**
NUCLEOSIL® 100-5 C_{18} PAH					
2 mm ID			720117.20	721168.20	721599.30
3 mm ID		720923.30	720117.30	721168.30	721599.30
4 mm ID		720923.40	720117.40	721168.30	721599.40
4.6 mm ID			720117.46	721168.30	721599.40
PAH standard according to EPA for HPLC					
PAH standard for HPLC #	16 PAH according to EPA method 610 in acetonitrile (1 mL) for composition see chromatogram above			722393	

Guard column systems Guard columns for EC columns with ID		2 mm	3 mm	4 mm	4.6 mm	Guard column holder
* Column Protection System	EC	4/2	4/3	4/3	4/3	718966
** ChromCart® guard columns	CC	8/3	8/3	8/4	8/4	721359

EC columns in packs of 1, guard columns in packs of 3.

For details of our column systems see pages 189–196

This product contains harmful substances which must be specially labeled as hazardous. For detailed information please see MSDS.

Anion columns

for analysis of inorganic anions

NUCLEOGEL® Anion I

- Strongly basic polymer-based anion exchanger, particle size 10 µm; pH stability 1–14
- Eluent in column 4 mmol/L salicylate buffer pH 7.8
- Contrary to the silica-based phase also suited for fluoride analysis

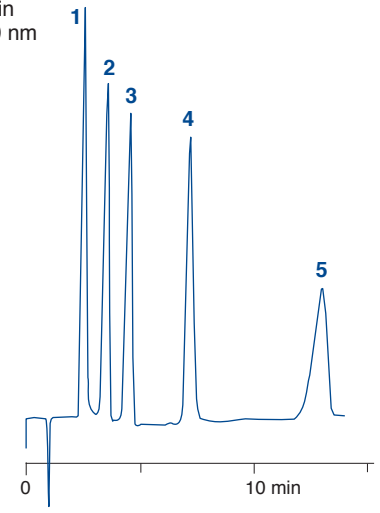
NUCLEOSIL® Anion II

- Base material NUCLEOSIL® silica, particle size 10 µm, pore size 300 Å
  strongly basic anion exchanger, exchange capacity 50 µeq/g, pH stability 2–7.5
- Eluent in column 0.15 mol/L $(NH_4)_2HPO_4$ buffer pH 5.2
  recommended buffer concentration for separation of inorganic anions: 2 mmol/L phthalate
- Preferred method of detection: conductivity or negative UV detection

Separation of an anion standard

Column: 250 x 4 mm NUCLEOSIL® Anion II
Eluent: 2 mmol/L potassium hydrogen phthalate, pH 5.7
Flow rate: 2 mL/min
Detection: UV, 280 nm

Peaks:
1. $H_2PO_4^-$
2. Cl^-
3. NO_2^-
4. NO_3^-
5. SO_4^{2-}

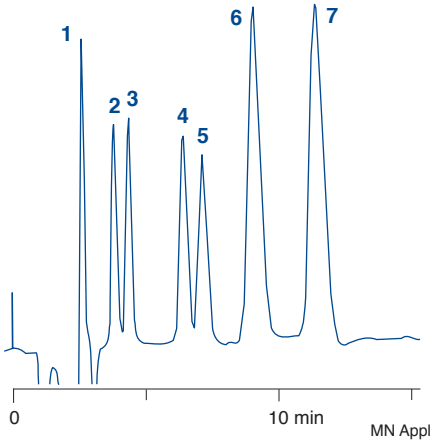


MN Appl. No. 106440

Separation of inorganic anions

Column: 120 x 4.6 mm NUCLEOGEL® Anion I
Eluent: 4 mmol/L salicylic acid – Tris pH 7.8
Flow rate: 1 mL/min
Detection: UV, 254 nm

Peaks:
1. F^-
2. Cl^-
3. NO_2^-
4. Br^-
5. NO_3^-
6. PO_4^{3-}
7. SO_4^{2-}



MN Appl. No. 115050

Ordering information

	Length →	120 mm	250 mm	Guard columns
NUCLEOGEL® Anion I				
Valco type columns 	4.6 mm ID	**719533**		**719543**
NUCLEOSIL® Anion II				
EC columns 	4 mm ID		**720094.40**	**721452.40**

NUCLEOGEL® Anion I Valco type guard columns measure 21 x 4 mm and require the guard column holder C, REF 719538, see page 193 (columns in packs of 1, guard columns in packs of 2).

As guard columns for NUCLEOSIL® Anion II EC columns use 8 x 4 mm ChromCart® cartridges with guard column adapter EC, REF 721359 (see page 191, columns and guard column cartridges in packs of 1).

NUCLEODEX columns

enantiomer separation based on cyclodextrins

- Base material NUCLEOSIL® silica, particle size 5 µm, pore size 100 Å
  modified cyclodextrins as chiral selectors
- **NUCLEODEX β-OH:** β-cyclodextrin (R = H; n = 2) · **USP L45**

  Separation based on hydrogen bonds and dipole interactions between functional groups of the analyte and hydroxyl groups of the cyclodextrin

  Examples for successful enantiomer separations: chlorthalidone and other compounds, which require free hydroxyl groups for enantioselective interactions

  Eluent in column CH_3OH – 0.1% TEAA pH 4 (55:45)

For all permethylated phases the ability to form hydrogen bonds is reduced, the hydrophobicity of the phase is increased compared to β-OH, resulting in shorter retention times.

- **NUCLEODEX α-PM:** permethylated α-cyclodextrin (R = CH_3; n = 1)

  Examples for successful enantiomer separations: mecoprop and dichlorprop as free carboxylic acids, trans-stilbene oxide, styrene oxide

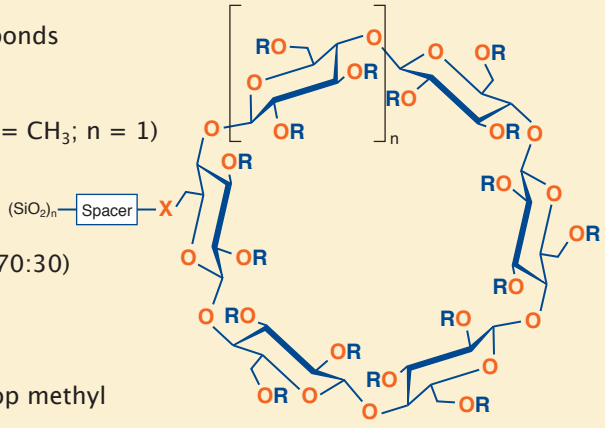
  Eluent in column CH_3OH – 50 mmol/L phosphate pH 3 (70:30)
- **NUCLEODEX β-PM:** permethylated β-cyclodextrin (R = CH_3; n = 2) · **USP L45**

  Examples for successful enantiomer separations: mephobarbital (prominal), pesticide derivatives mecoprop methyl and dichlorprop methyl

  Eluent in column CH_3OH – 0.1% TEAA pH 4 (65:35)
- **NUCLEODEX γ-PM:** permethylated γ-cyclodextrin (R = CH_3; n = 3)

  Examples for successful enantiomer separations: steroids or other larger molecules

  Eluent in column CH_3OH – 0.1% TEAA pH 4 (55:45)



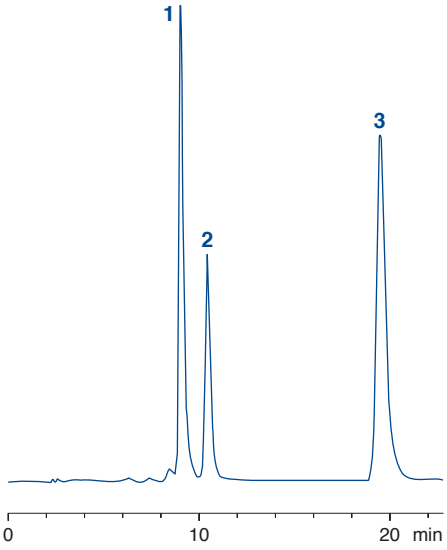
NUCLEODEX phases are especially suited for the control of optical purity, but also for semipreparative separations and for the analysis of positional and cis-trans isomers.

For numerous separations on NUCLEODEX phases please visit our website: ***www.mn-net.com/apps***.

Separation of the positional isomers of nitroaniline

Column: 200 x 4 mm NUCLEODEX β-OH
Eluent: methanol – 0.1 % triethylammonium acetate pH 4.0 (50:50, v/v)
Flow rate: 0.7 mL/min
Pressure: 180 bar
Detection: UV, 254 nm
Injection: 1 µL

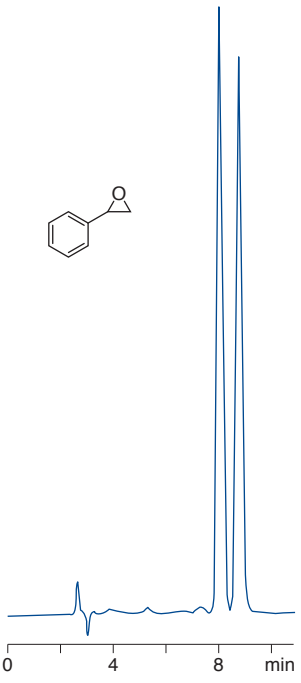
Peaks:
1. *m*-Nitroaniline
2. *o*-Nitroaniline
3. *p*-Nitroaniline



MN Appl. No. 101420

Enantiomer separation of styrene oxide

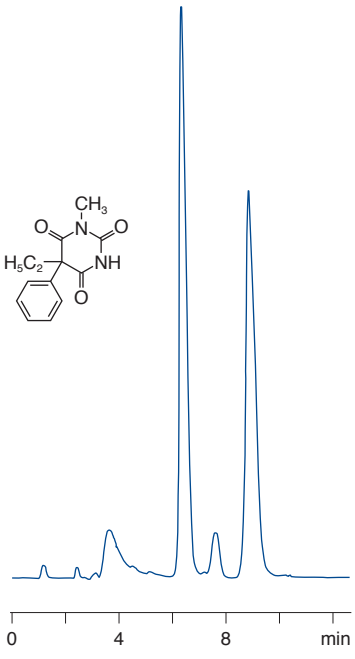
Column: 200 x 4 mm NUCLEODEX α-PM
Eluent: methanol – 0.1 % triethylammonium acetate pH 4.0 (60:40, v/v)
Flow rate: 0.7 mL/min
Pressure: 160 bar
Detection: UV, 230 nm
Injection: 2 µL



MN Appl. No. 106160

Enantiomer separation of mephobarbital

Column: 200 x 4 mm NUCLEODEX β-PM
Eluent: methanol – 0.1 % triethylammonium acetate pH 4.0 (55:45, v/v)
Flow rate: 0.7 mL/min
Pressure: 180 bar
Detection: UV, 254 nm
Injection: 1 µL



MN Appl. No. 105800

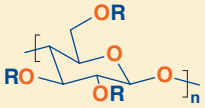
Ordering information

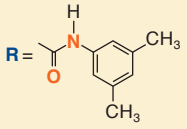
EC columns	Length: 200 mm	EC guard columns*	CC guard columns**
NUCLEODEX β-OH			
4 mm ID	**720124.40**	**721171.30**	**721460.40**
NUCLEODEX α-PM			
4 mm ID	**720127.40**	**721469.30**	**721464.40**
NUCLEODEX β-PM			
4 mm ID	**720125.40**	**721176.30**	**721462.40**
NUCLEODEX γ-PM			
4 mm ID	**720752.40**	**721178.30**	**721466.40**
NUCLEODEX CC screening kit		**721920**	
contains one CC 30/4 each with NUCLEODEX β-OH, α-PM, β-PM and γ-PM as well as one CC column holder 30 mm			

* EC 4/3 guard columns for EC columns with 4 mm ID require the Column Protection System guard column holder (REF 718966, see page 190).
** CC 8/4 guard columns for EC columns with 4 mm ID require the guard column adapter EC (REF 721359, see page 191).
Columns and guard columns in packs of 1.

HPLC columns for enantiomer separation

NUCLEOCEL *DELTA* enantiomer separation based on a cellulose derivative





- Base material silica,
  chiral selector cellulose tris-(3,5-dimethylphenylcarbamate) · **USP L40**
- Similar phases: Chiralcel® OD, Kromasil® CelluCoat™, Eurocel® 01, Lux™ Cellulose-1

  High resolution type (S) with 5 µm particle size, allows use of shorter columns (150 mm) for faster separations, pressure stability up to ~150 bar (2000 psi), pH stability 1-9

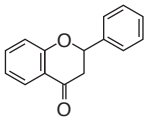
  NUCLEOCEL DELTA for normal phase applications:
  eluent in column *n*-heptane – 2-propanol (90:10, v/v)
  typical eluents are heptane – propanol mixtures

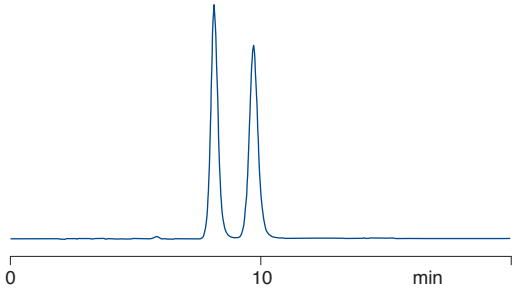
  NUCLEOCEL DELTA-RP for reversed phase applications:
  eluent in column acetonitrile – water (40:60, v/v)
  designed for use either in polar organic mode or with eluents containing high concentrations of chaotropic salts such as perchlorate
- **Recommended application:** pharmaceutically active compounds, chiral pollutants (e.g., herbicides, PCB), chiral compounds in food (dyes, preservatives), chiral catalysts and bioorganic compounds

Enantiomer separation of flavanone

Column: 250 x 4.6 mm NUCLEOCEL *DELTA S*
Eluent: *n*-heptane – 2-propanol (90:10, v/v)
Flow rate: 1 mL/min
Temperature: 25 °C
Detection: UV, 254 nm
Injection: 5 µL, 1 µg/µL

α = 1.29
R_s = 2.6



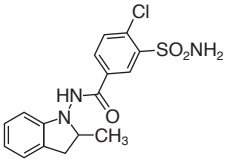


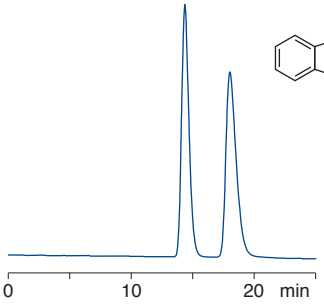
MN Appl. No. 121260

Enantiomer separation of indapamide

Column: 250 x 4.6 mm NUCLEOCEL *DELTA-RP S*
Eluent: acetonitrile – water (40:60, v/v)
Flow rate: 0.5 mL/min
Temperature: 40 °C
Detection: UV, 254 nm
Injection: 5 µL, 1 µg/µL

α = 1.3
R_s = 2.6





MN Appl. No. 121230

Ordering information

	Length →	150 mm	250 mm	EC guard columns*	CC guard columns**
EC columns 	**NUCLEOCEL *DELTA S*, 5 µm**		Eluent *n*-heptane – 2-propanol (90:10, v/v)		
	4.6 mm ID		**720445.46**	**721185.30**	**721002.40**
	NUCLEOCEL *DELTA-RP S*, 5 µm		Eluent acetonitrile – water (40:60, v/v)		
	4.6 mm ID	**720451.46**	**720450.46**	**721186.30**	**721003.40**

* EC 4/3 guard columns for EC columns with 4.6 mm ID require the Column Protection System guard column holder (REF 718966, see page 190).

** CC 8/4 guard columns for EC columns with 4.6 mm ID require the guard column adapter EC (REF 721359, see page 191).

Columns and guard columns in packs of 1

RESOLVOSIL BSA-7 protein phase for enantiomer separation

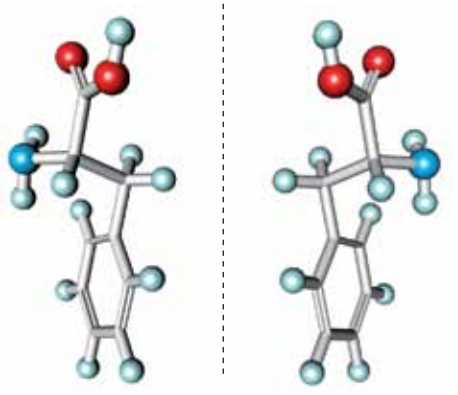
- Base material NUCLEOSIL® silica, particle size 7 µm, pore size 300 Å
  chiral selector bovine serum albumin (BSA)
- Separation based on selective interaction of proteins with low molecular compounds, i.e. principles of bio-affinity, including hydrophobic interactions (similar to a true reversed phase), interactions of polar groups and steric effects
- **Recommended application:**
  Amino acid derivatives, aromatic amino acids, aromatic sulfoxides, barbiturates, benzodiazepinones, benzoin and benzoin derivatives, β-blockers, coumarin derivatives, and for monitoring stereoselective microbial and enzymatic conversions

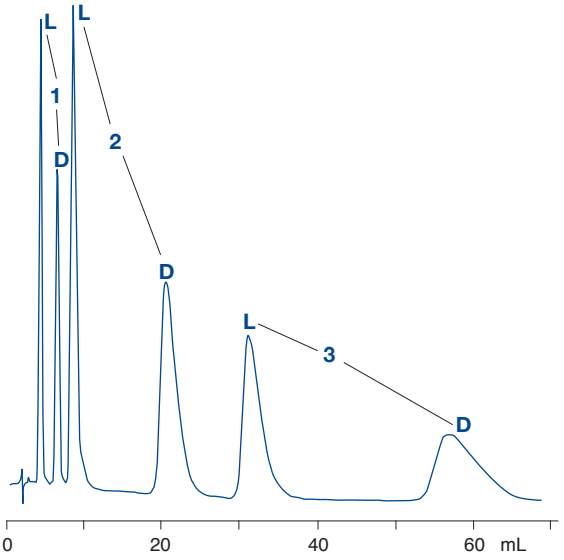
Enantiomer separation of *N*-benzoyl-*D,L*-amino acids

S. Allenmark et al. in "Affinity chromatography and biological recognition" (I. Chaiken, M. Wilchek, and I. Parikh. Eds.), Academic Press, New York, 1983, 259–260

Column: 150 x 4 mm RESOLVOSIL BSA-7
Eluent: 50 mmol/L phosphate buffer pH 6.5 + 1 % 1-propanol
Flow rate: 0.70 mL/min
Detection: UV, 225 nm

Peaks:
1. Serine
2. Alanine
3. Phenylalanine





MN Appl. No. 105450

Ordering information

Eluent in column 0.1 mol/L phosphate buffer pH 7.5, 2% 1-propanol

EC columns 	Length:	200 mm	EC guard columns*	CC guard columns**
RESOLVOSIL BSA-7				
4 mm ID		**720046.40**	**721402.30**	**721702.40**

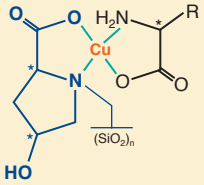
* EC 4/3 guard columns for EC columns with 4 mm ID require the Column Protection System guard column holder (REF 718966, see page 190).

** CC 8/4 guard columns for EC columns with 4 mm ID require the guard column adapter EC (REF 721359, see page 191).

Columns and guard columns in packs of 1

HPLC columns for enantiomer separation

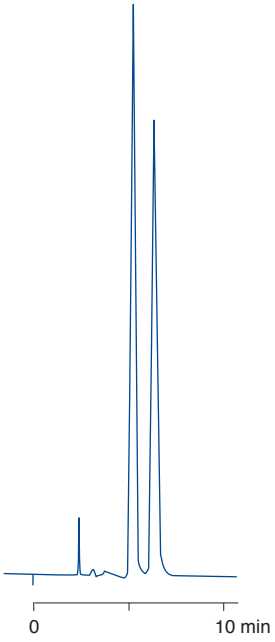
NUCLEOSIL® CHIRAL-1 enantiomer separation based on ligand exchange



- Base material NUCLEOSIL® silica, particle size 5 µm, pore size 120 Å
  chiral selector L-hydroxyproline – Cu^{2+} complexes · **USP L32**
- Principal interaction mode:
  formation of ternary mixed-ligand complexes with Cu(II) ions; differences in the stability of the diastereomeric complexes cause chromatographic separation
- **Recommended application:**
  Enantiomers with two polar functional groups with the correct spacing such as α-amino acids, α-hydroxycarboxylic acids (e.g., lactic acid), *N*-alkyl-α-amino acids etc.

D,L-alanine enantiomers

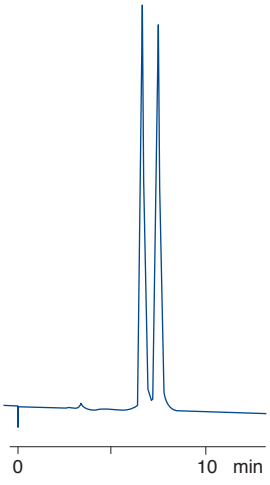
Column:	250 x 4 mm NUCLEOSIL® CHIRAL-1
Eluent:	0.5 mmol/L $CuSO_4$
Flow rate:	1 mL/min
Pressure:	60 bar
Temperature:	60 °C
Detection:	UV, 250 nm



MN Appl. No. 105410

D,L-threonine enantiomers

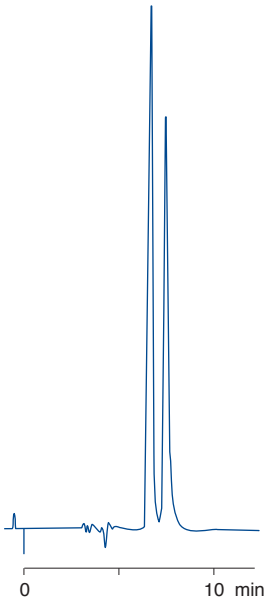
Column:	250 x 4 mm NUCLEOSIL® CHIRAL-1
Eluent:	0.25 mmol/L $CuSO_4$
Flow rate:	0.8 mL/min
Pressure:	65 bar
Temperature:	60 °C
Detection:	UV, 240 nm



MN Appl. No. 105410

Lactic acid enantiomers

Column:	250 x 4 mm NUCLEOSIL® CHIRAL-1
Eluent:	0.5 mmol/L $CuSO_4$
Flow rate:	0.8 mL/min
Temperature:	80 °C
Detection:	UV, 240 nm
Injection:	1 µL



MN Appl. No. 105560

Ordering information

Eluent in column 0.5 mmol/L copper sulfate solution

		Length 250 mm	EC guard columns*	CC guard columns**
NUCLEOSIL® CHIRAL-1				
EC columns	4 mm ID	**720081.40**	**721188.30**	**721455.40**

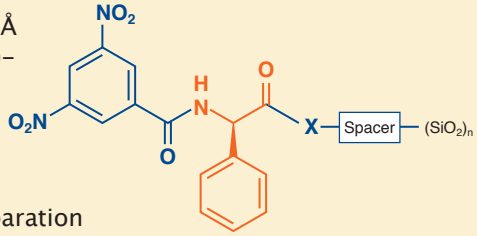
* EC 4/3 guard columns for EC columns with 4 mm ID require the Column Protection System guard column holder (REF 718966, see page 190).

** CC 8/4 guard columns for EC columns with 4 mm ID require the guard column adapter EC (REF 721359, see page 191).

Columns and guard columns in packs of 1

NUCLEOSIL® CHIRAL-2 / NUCLEOSIL® CHIRAL-3

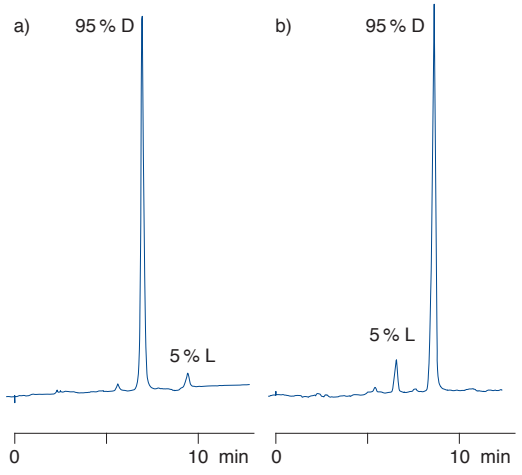
enantiomer separation in organic eluent systems



- Base material NUCLEOSIL® silica, particle size 5 µm, pore size 100 Å chiral selector for NUCLEOSIL® CHIRAL-2 is *N*-(3,5-dinitrobenzoyl)-*D*-phenylglycine, for CHIRAL-3 the optical antipode is used, "brush type" phases · CHIRAL-3 = **USP L36**
- Principle interaction modes: charge-transfer interactions, hydrogen bonds, dipole-dipole interactions and steric effects
- **Recommended application:** analysis of stereoisomers such as separation of enantiomers and diastereomers, control of optical purity of plant protectives (pesticides, e.g., propionic acid derived herbicides) pharmaceuticals etc. and for product control in chiral organic syntheses
- For control of optical purity of a substance, the columns NUCLEOSIL® CHIRAL-2 and NUCLEOSIL® CHIRAL-3 allow to select conditions such that the minor enantiomer, present as an impurity, is eluted before the main peak. Overlapping peaks are avoided. This makes an exact quantification of the impurity much easier.

Control of optical purity of mecoprop methyl

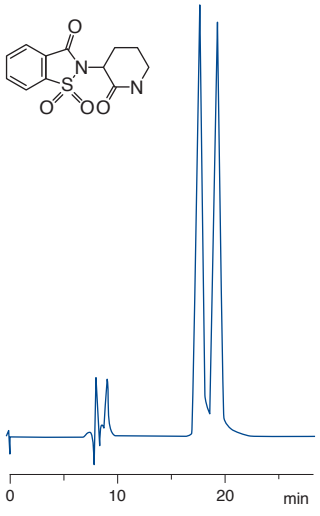
Columns: a) 250 x 4 mm NUCLEOSIL® CHIRAL-2
b) 250 x 4 mm NUCLEOSIL® CHIRAL-3
Eluent: *n*-heptane – 2-propanol – TFA (100:0.05:0.05, v/v/v)
Flow rate: 1 mL/min, ambient temperature
Detection: UV, 230 nm
Injection: 1 µL (sample with 90 % ee)



MN Appl. No. 111360

Enantiomer separation of *D,L*-supidimide

Column: 250 x 4 mm NUCLEOSIL® CHIRAL-2
Eluent: tetrahydrofuran – n-heptane (10:3, v/v)
Flow rate: 1.0 mL/min
Detection: UV, 220 nm



MN Appl. No. 105690

Ordering information

Eluent in column *n*-heptane – 2-propanol – TFAA (100:0.05:0.05, v/v/v)

		Length 250 mm	EC guard columns*	CC guard columns**
EC columns 	**NUCLEOSIL® CHIRAL-2**			
	4 mm ID	**720088.40**	**721190.30**	**721458.40**
	NUCLEOSIL® CHIRAL-3			
	4 mm ID	**720350.40**	**721190.30**	**721458.40**

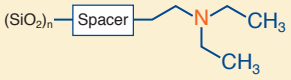
Guard columns for NUCLEOSIL® CHIRAL-2 and CHIRAL-3 are identical.

* EC 4/3 guard columns for EC columns with 4 mm ID require the Column Protection System guard column holder (REF 718966, see page 190).

** CC 8/4 guard columns for EC columns with 4 mm ID require the guard column adapter EC (REF 721359, see page 191).
EC columns and EC guard columns in packs of 1, CC guard columns in packs of 3

HPLC columns for biochemical separations

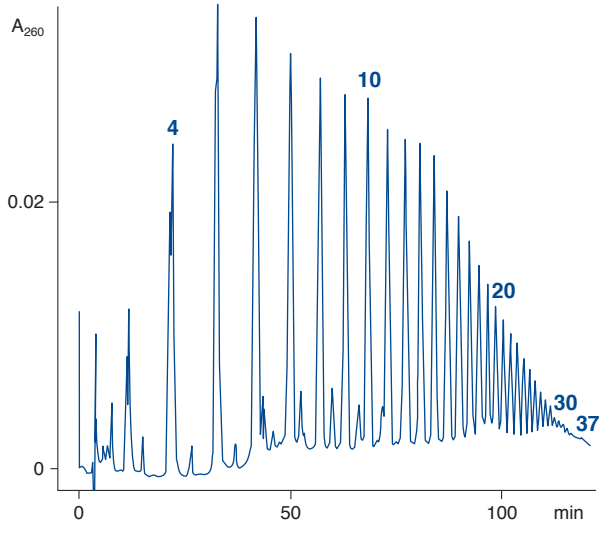
NUCLEOGEN® columns — anion exchange chromatography of nucleic acids



- Base material silica, particle size 7 µm
  DEAE anion exchanger
- **NUCLEOGEN® 60-7 DEAE:** pore size 60 Å
  Separation of oligonucleotides up to chain lengths of 40 bases with recoveries > 95 %
  capacity 200 A_{260}/mL (~ 300 A_{260} for a 125 x 4 mm ID column, 1875 A_{260} for a 125 x 10 mm ID column); preparative separations possible when using higher flow rates and longer gradient times
- **NUCLEOGEN® 500-7 DEAE:** pore size 500 Å
  Separation of tRNA, 5S RNA, viroids and messenger RNA in the intermediate molecular weight range (25–1 000 kDa) with recoveries > 95 %
  capacity 730 A_{260} for a 125 x 6 mm ID column, 1940 A_{260} for a 125 x 10 mm ID column
- **NUCLEOGEN® 4000-7 DEAE:** pore size 4000 Å
  Separation of plasmids, DNA restriction fragments, ribosomal RNA, messenger RNA and viral RNA, i.e. very high molecular weight nucleic acids (e.g., 1–50 MDa)
  capacity 120 A_{260} for a 125 x 6 mm ID column, 350 A_{260} for a 125 x 10 mm ID column
- For more separations of deoxyoligonucleotides, plasmids and DNA restriction fragments visit our website ***www.mn-net.com/apps***

Separation of oligo(rA)$_n$

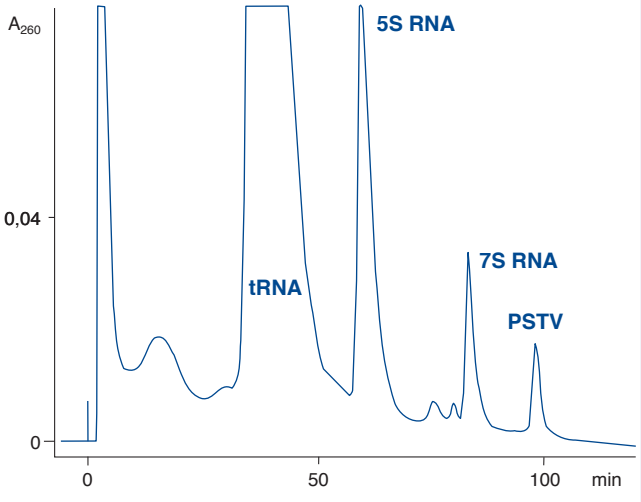
Column: 125 x 4 mm NUCLEOGEN® 60-7 DEAE
Eluent: A) 20 mmol/L phosphate buffer, pH 5.5, 5 mol/L urea; B) buffer A + 1 mol/L KCl; 0–100 % B in 200 min
Flow rate: 2 mL/min, 110 bar
Temperature: ambient
Detection: UV, 260 nm



MN Appl. No. 115180

Preparative separation of a crude RNA extract of viroid (PSTV) infected tomato plants

D. Riesner, BioEngineering **1** (1988) 42–48
Column: 125 x 6 mm NUCLEOGEN® 500-7 DEAE
Eluent: A) 250 mmol/L KCl, 20 mmol/L phosphate buffer pH 6.6, 5 mol/L urea; B) 1 mol/L KCl, 20 mmol/L phosphate buffer pH 6.6, 5 mol/L urea
0–50 % B in 120 min, 50–100 % B in 250 min
Flow rate: 3 mL/min, 40 bar, ambient temperature
Detection: 260 nm



MN Appl. No. 107490

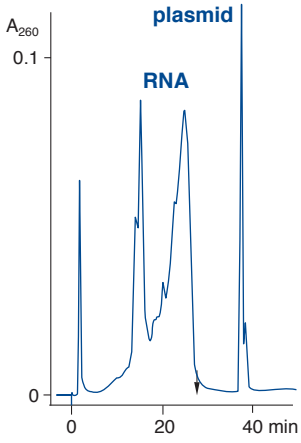
For information on DNA/RNA purification kits please ask for our catalog "Bioanalysis"

Separation of plasmid pBR 322

M. Colpan, D. Riesner, private communication

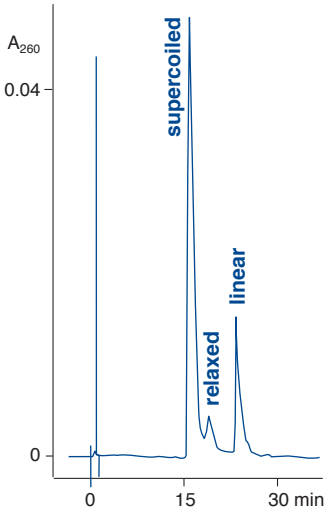
A) isolation of plasmid DNA from a crude cell lysate

Sample: 5 µg plasmid pBR 322 containing cleared lysate from *E. coli*
Column: 125 x 6 mm NUCLEOGEN® 4000-7 DEAE
Eluent: A) 20 mmol/ K phosphate buffer pH 6.9; 5 mol/L urea
B) eluent A + 1.5 mol/L KCl, 20–100 % B in 50 min;
arrow = ionic strength of 850 mmol/L
Flow rate: 1.0 mL/min, 70 bar, ambient temperature
Detection: UV, 260 nm



B) separation of supercoiled plasmid from relaxed and linear forms

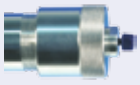
Sample: plasmid pBR 322, supercoiled, relaxed and linear
Column: 125 x 6 mm NUCLEOGEN® 4000-7 DEAE
Eluents: A) 20 mmol/L phosphate buffer pH 6.8; 6 mol/L urea; B) eluent A + 2 mol/L KCl
42–100 % B in 230 min
Flow rate: 1.5 mL/min, 45 bar, ambient temperature



MN Appl. No. 107480

Ordering information

Eluent in column methanol

	Length →	125 mm	Guard columns
EC columns  **Valco type columns**  **VarioPrep columns** 			
NUCLEOGEN® 60-7 DEAE			
EC analytical columns			
4 mm ID		736596.40	736400.40
VarioPrep preparative columns			
10 mm ID		736597.100	736400.40
NUCLEOGEN® 500-7 DEAE			
Valco type analytical columns			
6 mm ID		736598	736400.40
VarioPrep preparative columns			
10 mm ID		736599.100	736400.40
NUCLEOGEN® 4000-7 DEAE			
Valco type analytical columns			
6 mm ID		736601	736400.40
VarioPrep preparative columns			
10 mm ID		736602.100	736400.40

ChromCart® NUCLEOGEN® guard columns are 30 mm long and require the CC column holder 30 mm, REF 721823, see page 192 (columns in packs of 1, guard columns in packs of 2).

HPLC columns for biochemical separations

NUCLEOSIL® 4000-7 PEI — anion exchange of proteins and peptides

- Base material NUCLEOSIL® silica, particle size 7 µm, pore size 4000 Å
  polymeric, covalently bonded polyethyleneimine network, weakly basic anion exchanger
  ion exchange capacity 0.15 mmol/g; protein binding capacity 61 mg BSA/g
  pH stability 2–8.5; max. working pressure 250 bar
- Separation principle: reversible adsorption of negatively charged substances to positively charged groups on the exchanger material and their subsequent displacement by either increasing ionic strength or pH changes in the mobile phase

  High selectivity for numerous proteins; e.g., β-lactoglobulins A and B, two proteins differing in just two amino acids, can be separated in only 10 minutes; biological activity of purified proteins is preserved

  Good binding and desorption kinetics for nucleotides as well
- More examples for the purification of different peptides and proteins can be found in our application database at ***www.mn-net.com/apps***

Recovery of proteins

Column: 50 x 4 mm NUCLEOSIL® 4000-7 PEI
Eluent: 10 mmol/L NaH_2PO_4, 1.5 mol/L NaCl, pH 7.0
Flow rate: 1 mL/min
Sample: 50 µg of each protein

Protein	Recovery [%]
Myoglobin	100
Transferrin	95
Ovalbumin	98
Bovine serum albumin	100
Glucose oxidase	100
α-Amylase	100
Soybean trypsin inhibitor	100
β-Lactoglobulin	97
Ferritin	85

Recovery of specific enzyme activity after HPLC

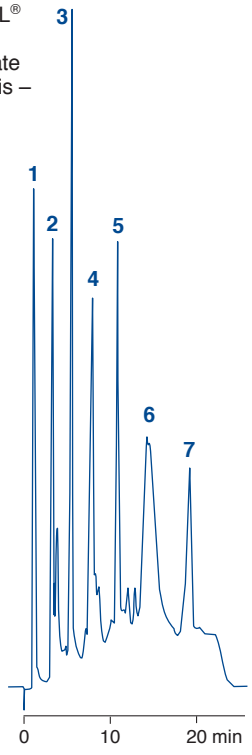
Columns: 50 x 4 mm NUCLEOSIL® 4000-7 PEI
Eluent: A) 20 mmol/L Tris-HCl pH 8.5; B) A + 1.5 mol/L NaCl; 0–100 % B in 5 min, 1 mL/min, 30 bar
Detection: UV, 280 nm

Enzyme	Recovery [%]
Catalase (bovine liver)	93
L-Lactic dehydrogenase LDH-1 isoenzyme (porcine heart)	102
Callicrein (porcine pancreas)	98
Glucose oxidase (Aspergillus niger)	104
Peroxidase (horseradish)	100

Separation of protein standards

Column: 125 x 4 mm NUCLEOSIL® 4000-7 PEI
Eluent: A) 2 mmol/L Tris – acetate pH 8.0; B) 20 mmol/L Tris – acetate pH 8.0 + 1.5 mol/L KCl 0–40 % B in 20 min
Flow rate: 1 mL/min
Pressure: 76 bar
Detection: UV, 280 nm
Injection: 20 µL

Peaks:
1. Catalase
2. Myoglobin
3. a-Amylase
4. Transferrin
5. a-Lactalbumin
6. Glucose oxidase
7. Soybean trypsin inhibitor



MN Appl. No. 108310

Ordering information

Eluent in column methanol

EC columns	Length 125 mm	CC guard columns
NUCLEOSIL® 4000-7 PEI		
4 mm ID	**720402.40**	**721091.40**

CC 8/4 guard columns for EC columns with 4 mm ID require the guard column adapter EC (REF 721359, see page 191).
Columns in packs of 1, guard columns in packs of 2

NUCLEOGEL® SAX anion exchange of biological macromolecules

- Polymer-based strongly basic anion exchanger $-N^+(CH_3)_3$, gel matrix quaternized PEI; particle size 8 µm, pore size 1000 Å · **USP L23**
- pH working range 1–13, max. working pressure 200 bar
- **Recommended application:** purification of peptides, large proteins and oligonucleotides, high capacity for proteins even at pH 10

Ordering information

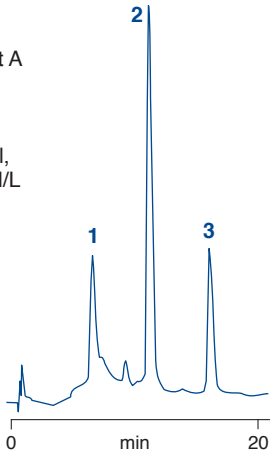
Eluent in column 0.1 mol/L Na_2SO_4 + 0.2 % NaN_3

Valco type columns	Length 50 mm	Guard columns
NUCLEOGEL® SAX		pore size 1000 Å
4.6 mm ID	**719469**	**719600**

Separation of hen's egg white

Sample: frozen egg white was thawed, filtered and diluted 1:8 with eluent A
Column: 50 x 4.6 mm NUCLEOGEL® SAX 1000-8
Eluent: A) 0.01 mol/L Tris-HCl, pH 7.5; B) A + 0.5 mol/L NaAc, pH 7.5; 0–100 % B in 20 min
Flow rate: 1 mL/min
Injection: 50 µL
Detection: UV, 280 nm

Peaks:
1. Conalbumin
2. Ovalbumin
3. not identified

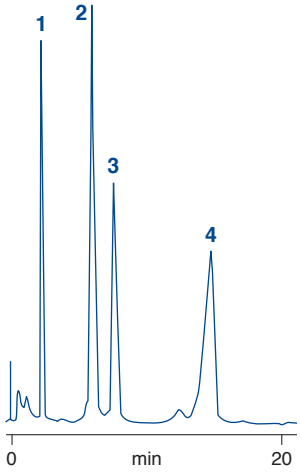


MN Appl. No. 115200

Separation of protein standards

Column: 50 x 4.6 mm NUCLEOGEL® SCX 1000-8
Eluent: A) 0.02 mol/L KH_2PO_4, pH 6.0 B) A + 0.5 mol/L NaCl, pH 6.0 0–100 % B in 20 min
Flow rate: 1 mL/min
Detection: UV, 280 nm

Peaks:
1. Myoglobin
2. α-Chymotrypsinogen A
3. Cytochrome C
4. Lysozyme



MN Appl. No. 108260

NUCLEOGEL® SCX cation exchange of biological macromolecules

- Polymer-based strongly acidic cation exchanger $-SO_3^-$, hydrophilic gel matrix; particle size 8 µm, pore size 1000 Å · **USP L22**
- pH working range 1–13, max. working pressure 200 bar
- **Recommended application:** proteins, peptides and carbohydrates with high isoelectric point

Ordering information

Eluent in column 0.1 mol/L Na_2SO_4 + 0.2 % NaN_3

Valco type columns	Length 50 mm	Guard columns
NUCLEOGEL® SCX		pore size 1000 Å
4.6 mm ID	**719475**	**719540**

NUCLEOGEL® SAX and SCX Valco type guard columns measure 5 x 3 mm and require the guard column holder B, REF 719539 (see page 193). Columns in packs of 1, guard columns in packs of 2

HPLC columns for biochemical separations

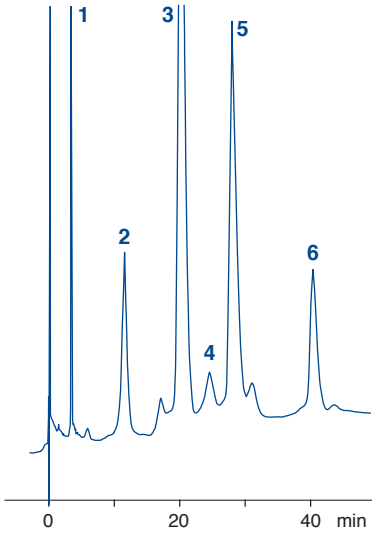
NUCLEOSIL® MPN — RP chromatography of biological macromolecules

- Silica-based reversed phase materials with monomerically bonded alkyl chains, brush type structure predominantly hydrophobic forces with a small portion of hydrophilic interactions
- **NUCLEOSIL® 100-5 C_{18} MPN:** octadecyl phase, particle size 5 µm, pore size 100 Å · **USP L1**
  dynamic protein binding capacity per g packing: 6 mg BSA, 110 mg cytochrome C
- **NUCLEOSIL® 300-5 C_4 MPN:** butyl phase, particle size 5 µm, pore size 300 Å · **USP L26**
  dynamic protein binding capacity per g packing: 14 mg BSA, 27 mg cytochrome C
  especially suited for the purification of larger, hydrophobic peptides and very different proteins
- pH working range 2–8, max. working pressure 250 bar
- Maximum separation efficiency can be achieved when the injected protein mass does not exceed 1–2 % of the maximum protein loading capacity.

Separation of haemoglobin chains

Column: 250 x 4 mm NUCLEOSIL® 300-5 C4 MPN
Eluent: A) 20 % acetonitrile, 80 % water, 0.1 % TFA
B) 60 % acetonitrile, 40 % water, 0.1 % TFA
40–60 % B in 60 min
Flow rate: 1 mL/min
Detection: UV, 220 nm

Peaks:
1. Hem
2. β-globin
3. α-globin
4. $^{A}\gamma^{T}$-globin
5. $^{G}\gamma$-globin
6. $^{A}\gamma^{I}$-globin



MN Appl. No. 108240

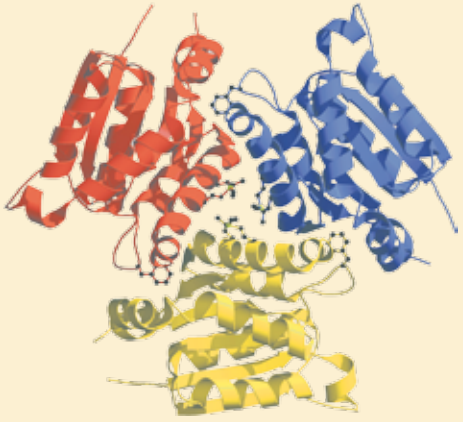
Ordering information

Eluent in column methanol

		Length 250 mm	CC guard columns
EC columns	**NUCLEOSIL® 100-5 C_{18} MPN**		
	4 mm ID	**720231.40**	
	NUCLEOSIL® 300-5 C_4 MPN		
	4 mm ID	**720245.40**	**721113.40**

CC 8/4 guard columns for EC columns with 4 mm ID require the guard column adapter EC (REF 721359, see page 191).
Columns in packs of 1, guard columns in packs of 2

NUCLEOSIL® PPN



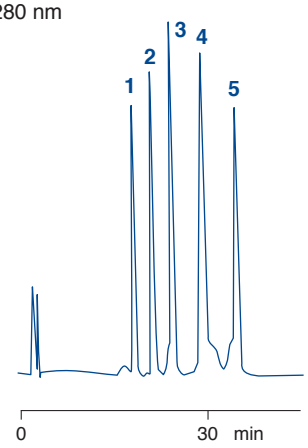
RP chromatography of biological macromolecules

- Silica-based reversed phase materials with polymerically bonded alkyl chains; exclusively hydrophobic interactions
- **NUCLEOSIL® 100-5 C_{18} PPN:**
  octadecyl phase, particle size 5 µm, pore size 100 Å · **USP L1**
  dynamic protein binding capacity per g packing: 8 mg BSA, 64 mg cytochrome C; suited for the separation of peptides and proteins up to about 40 kD, also suited for basic peptides
- **NUCLEOSIL® 500-5 C_{18} PPN:**
  octadecyl phase, particle size 5 µm, pore size 500 Å · **USP L1**
  dynamic protein binding capacity per g packing: 22 mg BSA, 40 mg cytochrome C; especially suited for large peptides and medium-size hydrophilic proteins
- pH working range 1–9, max. working pressure 250 bar

Separation of a protein standard

Column: 125 x 4 mm NUCLEOSIL® 100-5 C_{18} PPN
Eluent: A) 0.1 % TFA in H_2O
B) 0.08 % TFA in CH_3CN
20–60 % B in 10 min
Flow rate: 1.0 mL/min
Detection: UV, 280 nm

Peaks:
1. Ribonuclease
2. Cytochrome C
3. Lysozyme
4. β-Lactoglobulin
5. Ovalbumin

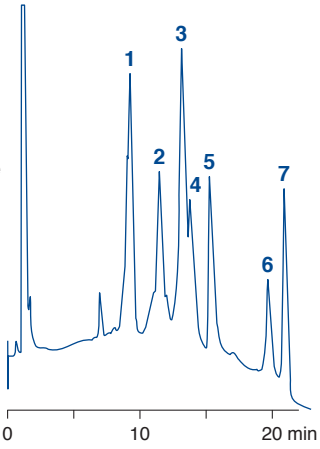


MN Appl. No. 108220

Separation of pancreatic secretion of piglets

Column: 125 x 4 mm NUCLEOSIL® 500-5 C_{18} PPN
Eluents: A) 0.1 % TFA in H_2O
B) 0.08 % TFA in CH_3CN
30–50 % B in 14 min, then 50–65 % B in 6 min
Flow rate: 1 mL/min
Detection: UV, 215 nm

Peaks:
1. Trypsin + trypsinogen
2. Proelastase
3. Lipase
   + α-chymotrypsin
4. Chymotrypsinogen
5. α-Amylase
6., 7. Procarboxypeptidase



MN Appl. No. 108280

Ordering information

Eluent in column methanol

	Length →	125 mm	250 mm	CC guard columns
EC columns 	**NUCLEOSIL® 100-5 C_{18} PPN**			
	4 mm ID	**720251.40**	**720252.40**	**721594.40**
	NUCLEOSIL® 500-5 C_{18} PPN			
	4 mm ID	**720257.40**	**720258.40**	**721687.40**

CC 8/4 guard columns for EC columns with 4 mm ID require the guard column adapter EC (REF 721359, see page 191).
Columns in packs of 1, guard columns in packs of 2

HPLC columns for biochemical separations

NUCLEOGEL® RP columns

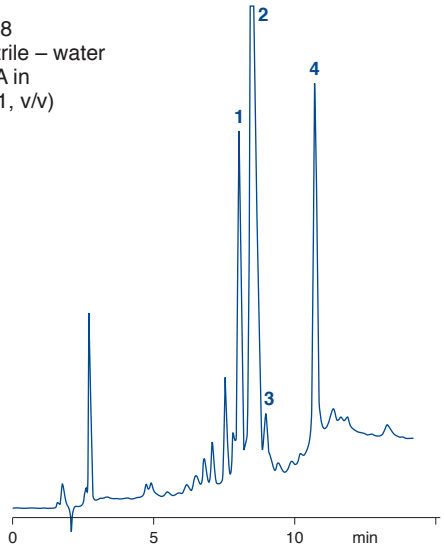
RP columns for biochemical applications

- Polystyrene resin cross-linked with divinylbenzene, available particle sizes 5 µm and 8 µm, available pore sizes 100 Å and 300 Å · **USP L21**
  pH working range 1–13, max. working pressure 180 bar
- Small pore columns for reversed phase separation of small molecules such as pharmaceuticals with basic properties, e.g., organic heterocycles; also suited for separation of nucleosides and nucleotides up to 5000 Da; allow gradient as well as isocratic elution
- Wide pore columns are especially recommended for large biomolecules
  higher background hydrophobicity compared to silica phases

Analysis of the synthetic acyl carrier protein ACP(65–74)

Column: 150 x 4.6 mm NUCLEOGEL® RP 100-8
Eluent: A) 0.1 % TFA in acetonitrile – water (1:99, v/v); B) 0.1 % TFA in acetonitrile – water (99:1, v/v)
10–60 % B in 20 min
Flow rate: 1 mL/min
Detection: UV, 220 nm

Peaks:
1. ACP(66-74)(H-Gln)
2. ACP(65-74)
3. ACP(66-74)(Glp)
4. Thioanisole



MN Appl. No. 108500

Ordering information

Eluent in column acetonitrile – water

	Length →	50 mm	150 mm	250 mm	Guard columns
Valco type analytical columns					
NUCLEOGEL® RP 100-5				pore size 100 Å, particle size 5 µm	
4.6 mm ID			719454	719455	719542
NUCLEOGEL® RP 100-8				pore size 100 Å, particle size 8 µm	
4.6 mm ID			719456	719520	719542
NUCLEOGEL® RP 300-5				pore size 300 Å, particle size 5 µm	
4.6 mm ID		719459			719542
NUCLEOGEL® RP 300-8				pore size 300 Å, particle size 8 µm	
4.6 mm ID		719460			719542

Valco type guard columns measure 5 x 3 mm snd require the guard column holder B, REF 719539, see page 193.
Columns in packs of 1, guard columns in packs of 2

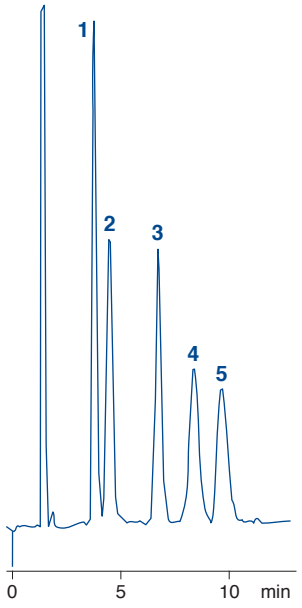
NUCLEOSIL® Carbohydrate — separation of mono- and disaccharides

- Matrix: NUCLEOSIL® silica with amino modification, particle size 10 µm · **USP L8**
- **Recommended application:** RP separation of mono- and disaccharides

Separation of sugars

Column: 250 x 4 mm NUCLEOSIL® Carbohydrate
Eluent: acetonitrile – water (79:21, v/v)
Flow rate: 2 mL/min
Temperature: 25 °C
Detection: RI
Injection: 10 µL

Peaks:
1. Fructose
2. Glucose
3. Saccharose
4. Maltose
5. Lactose



MN Appl. No. 102480

For the separation of oligosaccharides with longer chains ($10 < n < 40$) our phase NUCLEOSIL® 300-5 C_{18} can be successfully applied (see Application No. 102730 at ***www.mn-net.com***). In this case a very flat gradient allows good resolution of the carbohydrates. For ordering information of this phase please see page 159.

Ordering information

Eluent in column acetonitrile – water (79:21, v/v)

EC columns 	Length 250 mm	EC guard columns*	CC guard columns**
NUCLEOSIL® Carbohydrate			
4 mm ID	**720905.40**	**721170.30**	**721595.40**

* EC 4/3 guard columns for EC columns with 4 mm ID require the Column Protection System guard column holder (REF 718966, see page 190).

** CC 8/4 guard columns for EC columns with 4 mm ID require the guard column adapter EC (REF 721359, see page 191).

Columns and guard columns in packs of 1

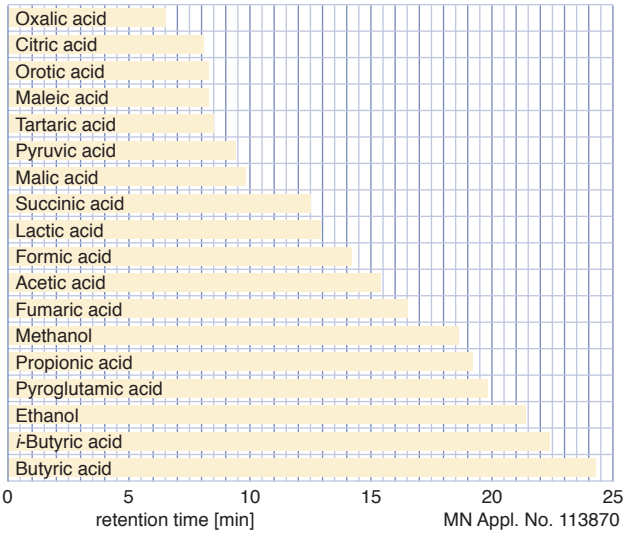
HPLC columns for sugar analysis

NUCLEOGEL® SUGAR 810 — separation of sugars

- Sulfonated polystyrene – divinylbenzene resins in different ionic forms · due to a different selectivity pattern compared to NUCLEOGEL® SUGAR columns, the range of application is considerably enlarged
- Separation mechanism includes ion exclusion, ion exchange, size exclusion, ligand exchange as well as NP and RP chromatography
- **H^+ form:** separation of sugars, sugar alcohols and organic acids · **USP L17**
  eluent in column 5 mmol/L H_2SO_4
- **Ca^{2+} form:** separation of mono-, di- and oligosaccharides · **USP L19** · eluent in column water

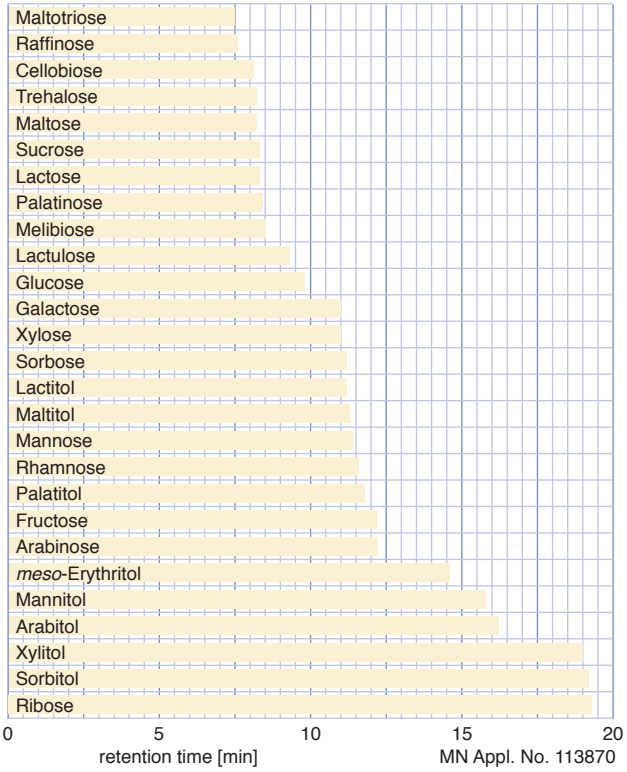
Organic acids and alcohols

Column: 300 x 7.8 mm NUCLEOGEL® SUGAR 810 H
Eluent: 5 mmol/L H_2SO_4
Flow rate: 0.6 mL/min
Temperature: 35 °C
Detection: RI
Injection: 5 µL



Sugars and sugar alcohols

Column: 300 x 7.8 mm NUCLEOGEL® SUGAR 810 Ca
Eluent: water , flow rate 0.6 mL/min
Detection: RI



Ordering information

Valco type columns	Length 300 mm	Guard columns
NUCLEOGEL® SUGAR 810 H		
7.8 mm ID	**719574**	**719575**
NUCLEOGEL® SUGAR 810 Ca		
7.8 mm ID	**719570**	**719571**

ChromCart NUCLEOGEL® SUGAR 810 guard columns measure 30 x 4 mm and require the CC column holder 30 mm, REF 721823, see page 192.

Columns in packs of 1, guard columns in packs of 2

NUCLEOGEL® ION 300 OA / SUGAR — separation of sugars

- Sulfonated spherical PS/DVB resins in different ionic forms; mean particle size 10 µm, pore size 100 Å
- Separation mechanism includes steric exclusion, ligand exchange and partition effects, ligand exchange being the predominant force, since the hydrated metal ions form strong interactions with the hydroxyl groups of the sample molecules. The intensity of these interactions decreases in the sequence Pb, Ca, Na

  NUCLEOGEL® ION 300 OA: H^+ form for separation of sugars, alcohols and organic acids · **USP L17** eluent in column 5 mmol/L H_2SO_4

  NUCLEOGEL® SUGAR:

  Ca^{2+} form: separation of mono- and oligosaccharides, sugar alcohols · **USP L19**

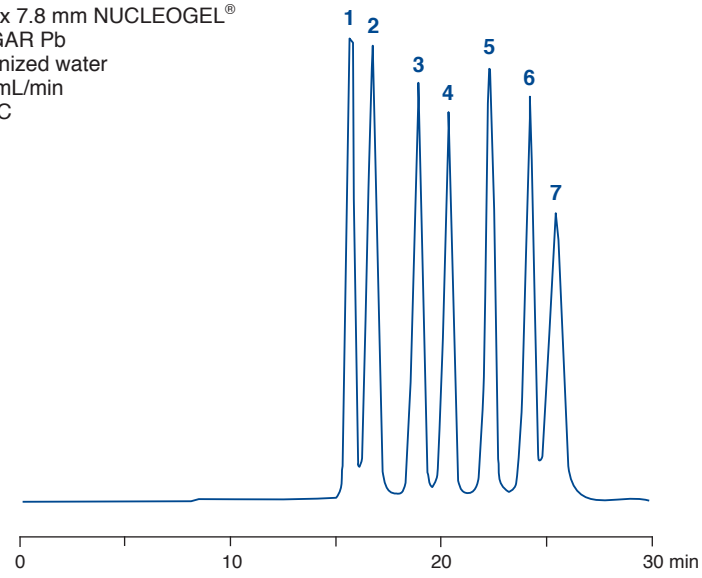
  Pb^{2+} form: separation of mono- and disaccharides from food and biological samples · **USP L34**

  Na^+ form: separation of oligosaccharides from starch hydrolysates and food · **USP L58**
- Eluent in column for Ca, Na and Pb phases: water + 0.02 % azide
- Recommended operating temperatures: 60–95 °C; maximum pressure 70 bar

Separation of carbohydrates

Column: 300 x 7.8 mm NUCLEOGEL® SUGAR Pb
Eluent: deionized water
Flow rate: 0.4 mL/min
Temperature: 80 °C
Detection: RI

Peaks:
1. Sucrose
2. Maltose
3. Glucose
4. Xylose
5. Galactose
6. Arabinose
7. Mannose



MN Appl. No. 102430

Ordering information

Valco type columns	Length 300 mm	Guard columns
NUCLEOGEL® ION 300 OA		
7.8 mm ID	**719501**	**719537**
NUCLEOGEL® SUGAR Ca		
6.5 mm ID	**719531**	**719535**
NUCLEOGEL® SUGAR Pb		
7.8 mm ID	**719530**	**719534**
NUCLEOGEL® SUGAR Na		
7.8 mm ID	**719532**	**719536**

Valco-Typ guard columns measure 21 x 4 mm and require the guard column holder C, REF 719538, see page 193.
Columns in packs of 1, guard columns in packs of 2

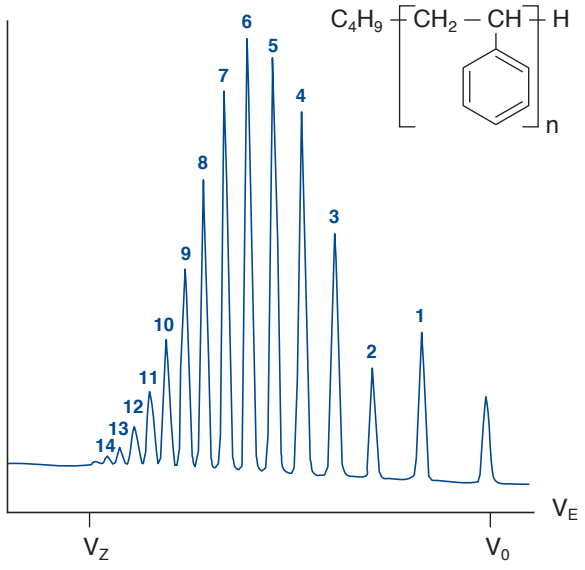
Columns for gel permeation chromatography

NUCLEOGEL® GPC

for GPC of water-insoluble substances

- Highly crosslinked macroporous, spherical polystyrene – divinylbenzene polymer matrix with good mechanical stability

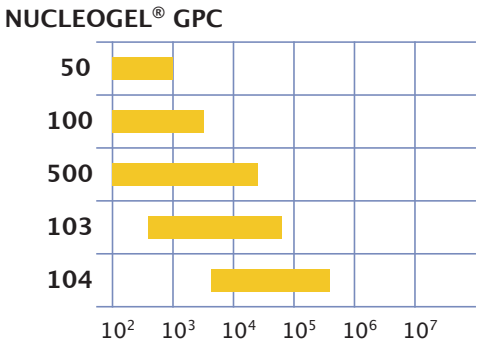
Chromatogram of styrene oligomers



Exclusion volume

Dead time

Working ranges for polystyrene



[MW in Da]

Ordering information

Eluent in column toluene

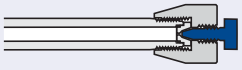
Phase	Exclusion limit [kDa]	Application	Column 300 x 7.7 mm
Valco type analytical columns			
5 µm particle size			
NUCLEOGEL GPC 50	2	low molecular weight organics	**719402**
NUCLEOGEL GPC 100	4	oligomers, oils	**719403**
NUCLEOGEL GPC 500	25	low molecular weight polymers	**719404**
NUCLEOGEL GPC 103	60	low molecular weight polymers	**719405**
NUCLEOGEL GPC 104	500	polymers up to 500 kDa	**719406**
		guard columns 50 x 7.7 mm	**719409**
10 µm particle size			
NUCLEOGEL GPC 50	2	low molecular weight organics	**719410**
NUCLEOGEL GPC 100	4	oligomers, oils	**719411**
NUCLEOGEL GPC 500	25	low molecular weight polymers	**719412**
NUCLEOGEL GPC 103	60	low molecular weight polymers	**719413**
NUCLEOGEL GPC 104	500	polymers up to 500 kDa	**719414**
		guard columns 50 x 7.7 mm	**719418**

Columns and guard columns in packs of 1

EC standard columns for analytical HPLC

- Analytical column system manufactured from stainless steel
  M8 outer threads on both ends
  combination of sealing element and very fine-meshed stainless steel screen, PTFE ring and fitting adaptor
  column heads SW 12, with inner threads M8 x 0.75 and UNF 10-32 (= 1/16" connection)
- As screw-on guard column system we recommend the **Column Protection System** used with EC guard column cartridges with 4 mm length (see next page).
- As built-in guard columns ChromCart® guard column cartridges with 8 mm length can be used with the guard column adapter EC (see page 191).
- Supplied with NUCLEODUR®, NUCLEOSHELL® and NUCLEOSIL® spherical silicas

Available standard dimensions of EC columns

ID [mm]	Length [mm]										End fitting design
	20	30	50	75	100	125	150	200	250	300	
2	+	+	+	+	+	+	+	+	+	+	
3	+	+	+	+	+	+	+	+	+	+	
4	+	+	+	+	+	+	+	+	+	+	
4.6	+	+	+	+	+	+	+	+	+	+	

Please ask for availability of certain phases

Guard columns for EC columns

(packs of 3 cartridges)		EC column with ID 2 mm	3 mm	4 mm	4.6 mm	Use guard column holder
EC guard columns for the Column Protection System guard column holder	EC	4/2	4/3	4/3	4/3	REF 718966
ChromCart® guard columns for the EC guard column adapter	CC	8/3	8/3	8/4	8/4	REF 721359

Accessories and replacement parts for EC columns · ordering information

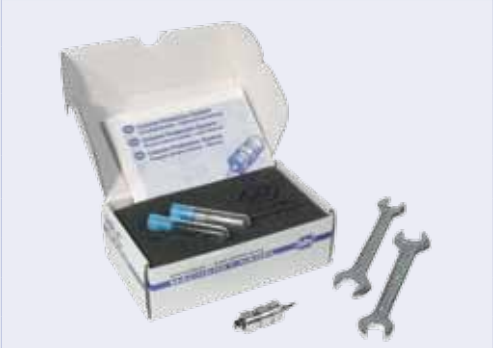
Description	Pack of	REF
EC fitting adapter	1	718987
EC column head (nut)	1	718988
EC PTFE sealing ring	4	718992
3-part sealing combination for EC columns	5 kits	718998

Column Protection System

Innovative and universal guard column holder system suitable for all analytical HPLC columns with 1/16" fittings

- Cartridges filled with special NUCLEODUR®, NUCLEOSIL® and NUCLEOSHELL® HPLC adsorbents
- Ideal protection for your analytical main column → significant increase in column lifetime
- Minimized dead volume → suitable also for ultra-fast HPLC
- Special ferrules → pressure stability up to 1034 bar (15 000 psi)
- Visual contamination check → in-time changing of the guard column
- Guard column length 4 mm, 2 mm ID (for main columns with 2 mm ID) and 3 mm ID (for main columns with 3, 4 and 4.6 mm)
- UNIVERSAL RP guard columns suitable for all HPLC columns under RP conditions

Content of the Column Protection System



Description	REF
Column Protection System	**718966**
	Contents
Cartridge holder	1
Capillaries	2
Ferrules	3
Wrenches	2
Manual	1

Replacement parts for the Column Protection System · Ordering information

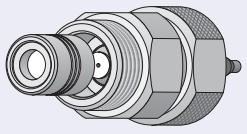
Description	Pack of	REF
Ferrules	5	**718967**
Replacement connector including O-ring	1	**718968**
Capillary tubes, nuts and metal ferrules	3	**718969**
Wrench (size 12 and 14 mm)	1	**718970**
EC 4/2 UNIVERSAL RP guard column (for main columns with 2 mm ID)	3	**728777.20**
EC 4/2 UNIVERSAL RP guard column (for main columns with 2 mm ID), value pack	9	**728778.20**
EC 4/3 UNIVERSAL RP guard column (for main columns with 3, 4 and 4.6 mm ID)	3	**728777.30**
EC 4/3 UNIVERSAL RP guard column (for main columns with 3, 4 and 4.6 mm ID), value pack	9	**728778.30**

Visual contamination check

The cartridge is fitted with a special filter membrane:

If this silver membrane is contaminated (bright or dark discoloration), it is advisable to replace the cartridge.

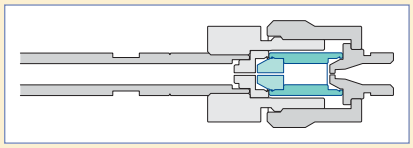
If the contaminations are colorless, replace the cartridge as soon as the pressure rises or the chromatographic performance decreases.



EC guard column adapter

Standard built-in guard column adapter system suitable for EC columns

- Cartridges filled with specified NUCLEODUR® and NUCLEOSIL® HPLC adsorbents
- Ideal protection for your analytical EC main column → significant increase of column lifetime
- Guard column length 8 mm, 3 mm ID (for main columns with 2 and 3 mm ID) and 4 mm ID (for main columns with 4 and 4.6 mm ID)



EC guard column adapter · Ordering information

Description	Pack of	REF
EC guard column adapter	**1**	**721359**

Installation of the EC guard column adapter

1. Unscrew the column head
2. Remove the fitting

3. Unscrew the EC guard column adapter

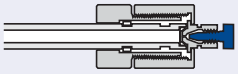
4. Screw the adapter sleeve onto the column
5. Insert the CC guard column

6. Screw the nut of the guard column adapter in place

ChromCart® cartridge system

- Analytical column system manufactured from stainless steel (US patent 5,342,515)
- Rapid and convenient installation
  columns are changed without removal of capillary connections
  all unions are screwed by hand
  easy installation of guard cartridges without special adaptor
  connection of columns of different lengths and inner diameters with one type of connecting kit (see below)
- Supplied with LiChrospher® silica manufactured by E. Merck

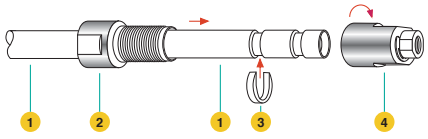
Available standard dimensions of ChromCart® cartridges

ID [mm]	Length [mm] 8*	125	150	250	End fitting design
2	–	+	+	+	
3	+	+	+	+	
4	+	+	+	+	
4.6	–	+	+	+	

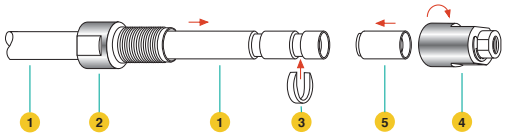
* Please note that 3 mm ID guard column cartridges are also applicable for 2 mm ID CC columns, and 4 mm ID guard column cartridges are also used for 4.6 mm ID CC columns.

Connection of ChromCart® cartridges and guard column cartridges

Use of 1 analytical column without guard column



Use of column and guard column



Legend

1. Analytical column
2. Sleeve
3. Guide ring
4. Nut
5. Guard column

Accessories for the ChromCart® cartridge system · Ordering information

Description	Pack of	REF
CC connecting kit (consists of 2 nuts with end fittings, two sleeves and two guide rings)	1 kit	**721690**
CC nut with end fitting	1 set	**721691**
CC sleeve with outer threads	1	**721692**
CC guide ring	1	**721693**
CC guard column holder 8 mm for stand-alone operation of 8 mm CC cartridges	1	**721820**
CC column holder 30 mm for stand-alone operation of 30 mm CC cartridges	1	**721823**

Microbore columns

- Analytical column system for rapid HPLC and **LC/MS** analyses with high resolution
- Available lengths: 40, 60, 100, 125, 150, 200, 250 and 300 mm, available IDs: 0.05, 0.075, 0.1, 0.15, 0.3, 0.4, 0.5, 0.75, 1, 1.5 mm
- Microbore columns up to 0.3 mm ID are fused silica capillaries, while microbore columns with 0.3–1.5 mm ID are stainless steel columns.
- On request, microbore columns and guard columns can be custom-packed with NUCLEODUR® and NUCLEOSIL® phases.

Advantages of microbore columns

Only small sample volumes required

Highest detection sensitivity

Low flow rate = reduced eluent consumption

- Time saving + reduced eluent consumption = reduced cost

Change of flow rate and solvent saving as a function of the column inner diameter

ID [mm]	Flow rate [mL/min]	Solvent saving	Increase in sensitivity
4.6	1.3	–	–
4.0	1.0	~ 25 %	~ 1.3
3.0	0.56	~ 57 %	~ 2.4
2.0	0.25	~ 81 %	~ 5.3
1.0	0.06	~ 95 %	~ 21.7

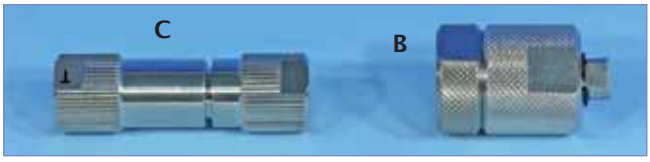
For a constant length relative to a column with 4.6 mm ID and a flow rate of 1.3 mL/min for isocratic application

Valco type columns

- Analytical column system manufactured from stainless steel
  available inner diameters:
  4.6 mm ID (1/4" OD) and 7.7 mm (3/8" OD)
- Mainly used for some phases for special separations

Accessories for Valco type columns · Ordering information

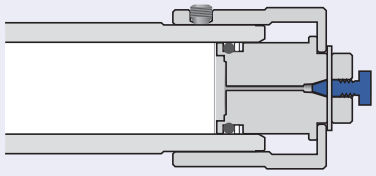
Description	Pack of	REF
Guard column holder B for VA guard columns 5 x 3 mm	1	**719539**
Guard column holder C for VA guard columns 21 x 4 mm	1	**719538**
Frits 2 µm for 4.6 mm ID columns	5	**719485**
Frits 2 µm for 7.7 mm ID columns	5	**719486**



VarioPrep (VP) columns for preparative HPLC

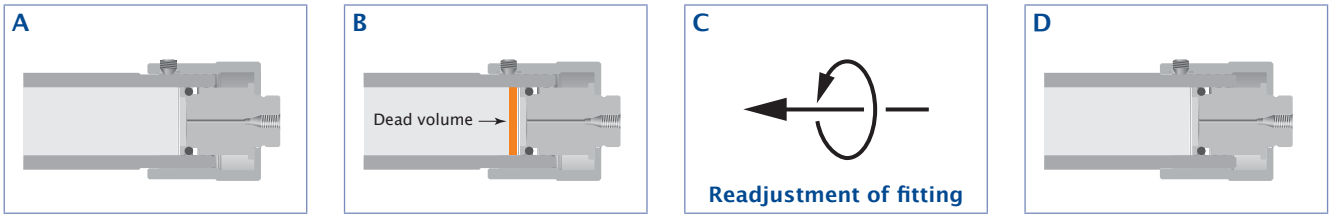
- Column system for preparative HPLC, manufactured from stainless steel with two adjustable end fittings, suitable for frequent use of back-flushing techniques
- Allows compensation of a dead volume, which could result at the column inlet after some time of operation, without need for opening the column
- Can be packed with all NUCLEODUR® and NUCLEOSIL® spherical silicas

Available standard dimensions of VarioPrep columns with axially adjustable end fittings

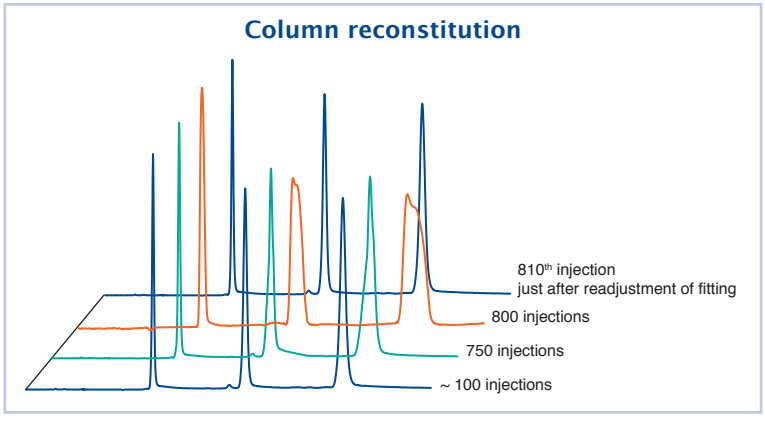
ID [mm]	Length [mm] 10*	15*	Length [mm] 50	75	100	125	150	250	500	End fitting design
8	+		+		+	+	+	+		
10			+		+	+	+	+		
16	+		+		+	+	+	+		
21			+	+	+	+	+	+		
32		+			+		+	+		
40			+		+	+	+	+	+	
50		+			+		+	+		
80								+	+	

* 10 x 8, 10 x 16, 15 x 32 and 15 x 50 mm ID columns are used as guard columns and require the respective holders, see next page.

The VarioPrep principle

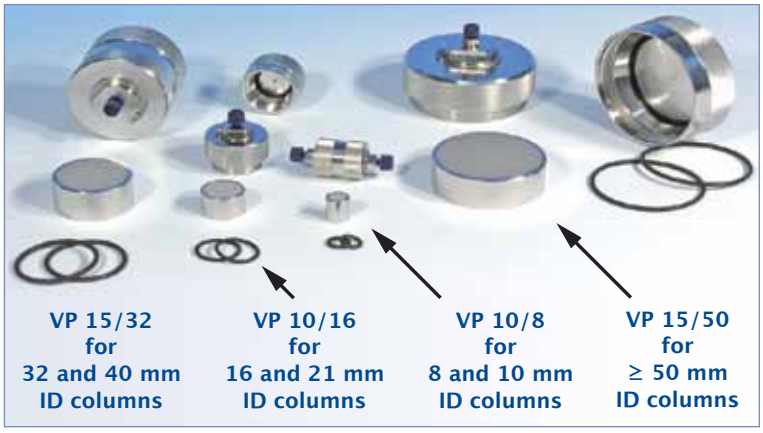


VarioPrep columns are produced with highest packing quality and bed density (**A**). Due to intensive chemical and/or mechanical exposure of the column adsorbent, shrinking of the column bed can occur (**B**; orange gap). in this even unlikely case readjustment of the VarioPrep column fitting (**C**; turning the nut at the column inlet clockwise) will eliminate the emerged dead volume (**D**). The performance of the VarioPrep column is completely reconstituted and column lifetime is significantly extended.



Reconstitution of VarioPrep column performance

- Slight peak broadening and deformation after 800 injections under strongly demanding conditions (pH 11; 50 °C; sample in DMSO)
- Readjustment of the column fitting restores column performance and prolongs column lifetime noticeably.

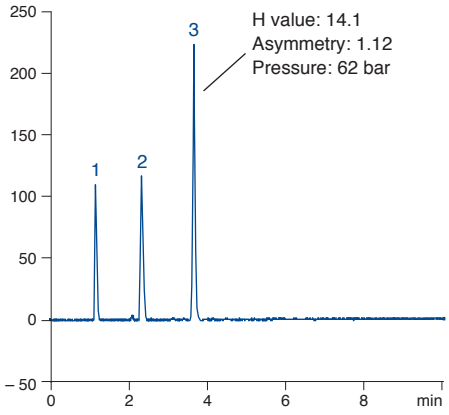


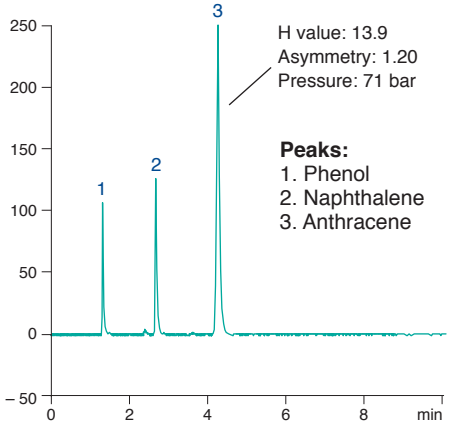
The improved guard column system for (semi-) preparative HPLC

- Easy handling and cartridge exchange
- Robust hardware
- Free rotary plunger fittings – low O-ring abrasion
- Cost-efficient cartridges
- Minimally invasive / no disturbance of the separation efficiency of main column
- Low back pressure
- Designed for pressures up to 400 bar

Column performance without and with guard column

Columns: **125 x 16 mm NUCLEODUR® C_{18} HTec, 5 µm**
125 x 16 mm NUCLEODUR® C_{18} HTec, 5 µm + 10 x 16 mm NUCLEODUR® C_{18} HTec guard column
Eluent: acetonitrile – water (80:20, v/v)
Flow rate: 16 mL/min
Temperature: 22 °C





Using VarioPrep guard columns provides ideal protection of your main column – symmetry, pressure and retention stay almost constant.

Technical data

1/16" thread · free rotary plunger fittings – low O-ring abrasion · stainless steel

Guard cartridge	Holder REF	Holder ID	Recommended for column ID	Preferred capillary ID	Typical flow rate
VP 10/8	**718251**	8 mm	8 and 10 mm ID	0.17 and 0.25 mm	1–12 mL/min
VP 10/16	**718256**	16 mm	16 and 21 mm ID	0.17, 0.25 and 0.5 mm	2–32 mL/min
VP 15/32	**718253**	32 mm	32 and 40 mm ID	0.25, 0.5 and 1.0 mm	5–150 mL/min
VP 15/50	**718255**	50 mm	≥ 50 mm ID	0.5 and 1.0 mm	20–250 mL/min

Guard column holders for VarioPrep columns · Ordering information

VP guard columns for VarioPrep columns with ID					Pack of [guard columns]	Replacement O-ring (pack of 2)	Holder	
	8, 10 mm	16, 21 mm	32, 40 mm	≥ 50 mm			ID	REF
VP	10/8				2	**718975**	8 mm	**718251**
VP		10/16			2	**718976**	16 mm	**718256**
VP			15/32		1	**718977**	32 mm	**718253**
VP				15/50	1	**718978**	50 mm	**718255**

For REF numbers of individual VP guard column cartridges see respective NUCLEODUR® and NUCLEOSIL® phases.

HPLC fittings and capillary tubing

Replacement parts for VarioPrep columns · Ordering information

Description	Pack of	REF
for VarioPrep columns with 10 mm ID		
VP plunger fitting 10 mm without sealing ring	1	718837
VP nut 10 mm	1	718842
VP sealing element set 10 mm	1 set	718931
VP sealing ring set 10 mm	1 set	718852
VP MN Inert sealing combination 10 mm	1 set	718848
for VarioPrep columns with 21 mm ID		
VP plunger fitting 21 mm without sealing ring	1	718861
VP nut 21 mm	1	718862
VP sealing element set 21 mm	1 set	718853
VP sealing ring set 21 mm	1 set	718854
VP MN Inert sealing combination 21 mm	1 set	718870

Accessories for stainless steel HPLC columns

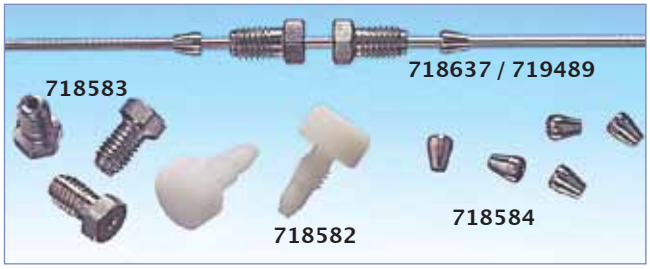
- Stainless steel columns are most frequently used in HPLC. The material is corrosion resistant, pressure stable and easy to work mechanically.

Stainless steel capillary tubing

Length	OD	ID	Pack of	REF
Capillary tubing in coils				
3 m	1/16"	0.25 mm	1 coil	718737
3 m	1/16"	0.5 mm	1 coil	718738
1 m	1/16"	0.12 mm	1 coil	718790
1 m	1/16"	0.25 mm	1 coil	718735
1 m	1/16"	0.5 mm	1 coil	718736

Capillary tubing, cut pieces, ready-to-use				
50 mm	1/16"	0.12 mm	2	718731
100 mm	1/16"	0.12 mm	2	718732
200 mm	1/16"	0.12 mm	2	718733
300 mm	1/16"	0.12 mm	2	718734
100 mm	1/16"	0.25 mm	5	718588
200 mm	1/16"	0.25 mm	5	718635
300 mm	1/16"	0.25 mm	5	718589
100 mm	1/16"	0.5 mm	5	718516
300 mm	1/16"	0.5 mm	5	718517
50 mm	1/32"	0.12 mm	2	718670
100 mm	1/32"	0.12 mm	2	718671
200 mm	1/32"	0.12 mm	2	718672
50 mm	1/32"	0.25 mm	2	718673
100 mm	1/32"	0.25 mm	2	718674
50 mm	1/32"	0.5 mm	2	718676
100 mm	1/32"	0.5 mm	2	718677
200 mm	1/32"	0.5 mm	2	718678

Stainless steel column accessories



Description	Pack of	REF
Capillary accessories		
1/16" column end caps (plastic)	4	718582
1/16" nut for connecting 1/16" capillaries	5	718583
1/16" ferrule	5	718584
Capillary unions		
Type 1: 100 mm x 1/16" x 0.25 mm	1	718637
Type 2: 100 mm x 1/16" x 0.12 mm	1	719489
Knife file	1	706121
Cutter for 1/16" capillary tubing	1	706290

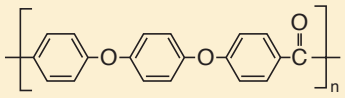
Stainless steel eluent filters			
for 1/16" tubing	2 µm frits	1	718750
for 1/16" tubing	10 µm frits	1	718752
for 1/8" tubing	2 µm frits	1	718751
for 1/8" tubing	10 µm frits	1	718753

For accessories and replacement parts for EC columns see page 189, for accessories and replacement parts for ChromCart® cartridges see page 192, for accessories and replacement parts for VarioPrep columns see page 195 and above.

PEEK accessories

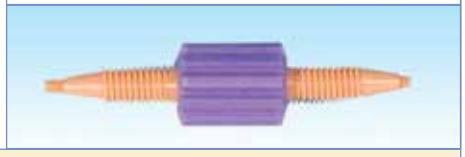
- PEEK (= polyether ether ketone) is a high performance polymer belonging to the group of polyarylether ketones (PAEK), which meets all requirements of HPLC columns with respect to chemical resistance and mechanical stability. In some fields of application in HPLC like, e.g., in ion chromatography and chromatography of biopolymers, PEEK fulfils the requirements for a nonmetallic material.

PEEK



- All fittings can be tightened by hand. The following table summarizes the available PEEK products.

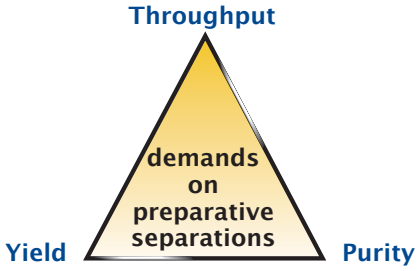
Ordering information

Description	Pack of	REF	
PEEK fittings			
1/16" PEEK fingertight fitting, 1-part combination nut + ferrule	1	**718770**	
1/16" PEEK fingertight nut	1	**718771**	
1/16" PEEK ferrule for REF 718771	1	**718772**	
1/16" PEEK double ferrule	1	**718775**	
1/16" PEEK union, both sides inner threads, equipped with 2 fingertight nuts and double ferrules	1	**718766**	
1/16" PEEK union, both sides inner threads, however without nuts and without ferrules	1	**718767**	
1/16" PEEK union, both sides outer threads	1	**718768**	
PEEK standard capillaries			
OD / ID [mm] / Length			
1/16" / 0.13 / 1 m	1	**718765**	
1/16" / 0.17 / 1 m	1	**718760**	
1/16" / 0.25 / 1 m	1	**718761**	
1/16" / 0.5 / 1 m	1	**718762**	
1/16" / 0.75 / 1 m	1	**718763**	
Tools for PEEK capillaries			
Guillotine cutter for PEEK and PTFE capillaries	1	**718769**	
Clean-Cut cutter for different capillary outer diameters	1	**718755**	

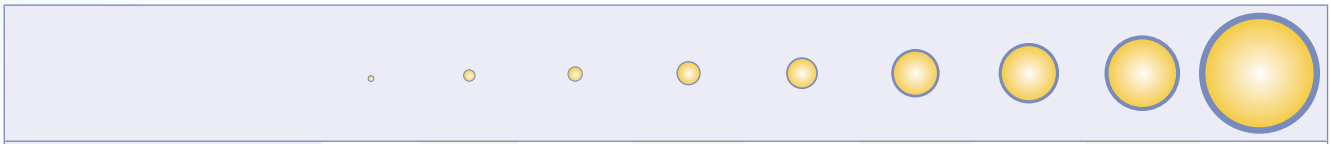
NUCLEODUR® high purity silica for HPLC

Basic rules of preparative HPLC

Basically, preparative HPLC follows the same rules as analytical scale chromatography. However, there are important differences in the aims of the two techniques. In analytical HPLC chromatographers focus on peak shape, and resolution of all eluted analytes, whereas in preparative chromatography yield and purity of the final product, as well as cost-effectiveness of the method, are emphasized.



Scale up factors and parameters for typical MN column dimensions



ID x length [mm]	4 x 250	8 x 250	10 x 250	16 x 250	21 x 250	32 x 250	40 x 250	50 x 250	80 x 250
Linear scale-up factor	1	4	6.25	16	27.6	64	100	156.3	400
Typical sample mass* [mg]	0.02–2	0.08–8	0.13–13	0.3–35	0.6–60	1.3–130	2–210	3–350	10–850
Typical flow rate [mL/min]	0.5–1.5	2–6	3–9	8–24	14–40	32–96	50–150	80–250	200–600

* For RP material; the maximum amounts given here always depend on the separation problem and on the sample composition. In some cases half of the amount given can cause drastic overload, in other cases the maximum amounts can be even higher still giving acceptable separations.

NUCLEODUR® bulk packings

- Totally spherical high purity silica
- Pore size 110 Å, pore volume 0.9 mL/g, surface (BET) 340 m^2/g, density 0.47 g/mL, pressure stability 600 bar
- Larger particles for preparative applications

Ordering information

Phase	Endcapped	Carbon content	Particle size	Pack of 100 g	Pack of 1000 g
NUCLEODUR® C_{18} HTec premium octadecyl phases (see page 130)					
NUCLEODUR® 100-5 C_{18} HTec	yes	18% C	5 µm	**713830.0100**	**713830.1**
NUCLEODUR® 100-7 C_{18} HTec	yes	18% C	7 µm	**713831.0100**	**713831.1**
NUCLEODUR® 100-10 C_{18} HTec	yes	18% C	10 µm	**713832.0100**	**713832.1**
NUCLEODUR® C_{18} ec standard octadecyl phases (see page 133)					
NUCLEODUR® 100-10 C_{18} ec	yes	17.5% C	10 µm	**713611.0100**	**713611.1**
NUCLEODUR® 100-12 C_{18} ec	yes	17.5% C	12 µm	**713618.0100**	**713618.1**
NUCLEODUR® 100-16 C_{18} ec	yes	17.5% C	16 µm	**713621.0100**	**713621.1**
NUCLEODUR® 100-20 C_{18} ec	yes	17.5% C	20 µm	**713601.0100**	**713601.1**
NUCLEODUR® 100-30 C_{18} ec	yes	17.5% C	30 µm	**713631.0100**	**713631.1**
NUCLEODUR® 100-50 C_{18} ec	yes	17.5% C	50 µm	**713550.0100**	**713550.1**
Unmodified NUCLEODUR® silica (see page 142)					
NUCLEODUR® 100-10			10 µm	**713610.0100**	**713610.1**
NUCLEODUR® 100-12			12 µm	**713615.0100**	**713615.1**
NUCLEODUR® 100-16			16 µm	**713620.0100**	**713620.1**
NUCLEODUR® 100-20			20 µm	**713600.0100**	**713600.1**
NUCLEODUR® 100-30			30 µm	**713630.0100**	**713630.1**
NUCLEODUR® 100-50			50 µm	**713551.0100**	**713551.1**

NUCLEOSIL® bulk packings

- Spherical silica
- pH stability 2–8 (for NUCLEOSIL® 100–5 C_{18} AB 1–9)
- For characterization of our NUCLEOSIL® silica see page 154

Physical properties of unmodified NUCLEOSIL® materials

Phase	Pore size	Pore volume	Surface (BET)	Density	Pressure stability*
NUCLEOSIL® 50	50 Å	0.8 mL/g	420 m^2/g	0.45 g/mL	500 bar
NUCLEOSIL® 100	100 Å	1 mL/g	350 m^2/g	0.36 g/mL	500 bar
NUCLEOSIL® 120	120 Å	0.65 mL/g	200 m^2/g	0.55 g/mL	500 bar
NUCLEOSIL® 300	300 Å	0.8 mL/g	100 m^2/g	0.45 g/mL	400 bar
NUCLEOSIL® 500	500 Å	0.8 mL/g	35 m^2/g	0.45 g/mL	400 bar
NUCLEOSIL® 1000	1000 Å	0.8 mL/g	25 m^2/g	0.45 g/mL	300 bar
NUCLEOSIL® 4000	4000 Å	0.7 mL/g	10 m^2/g	0.48 g/mL	300 bar

For description of individual modifications see chapter "Columns with NUCLEOSIL®" from page 157.
* Maximum packing pressure of NUCLEOSIL® bulk packings

Ordering information

Phase	Endcapped	Carbon content	Pore size	Particle size	Pack of 10 g	Pack of 100 g
Octadecyl phases						$-(CH_2)_{17}-CH_3$
NUCLEOSIL® 50–5 C_{18} ec	yes	14.5 % C	50 Å	5 µm	**712031.10**	**712031.100**
NUCLEOSIL® 100–5 C_{18} AB	yes	24 % C	100 Å	5 µm	**712952.10**	**712952.100**
NUCLEOSIL® 100–3 C_{18}	yes	15 % C	100 Å	3 µm	**712370.10**	**712370.100**
NUCLEOSIL® 100–5 C_{18}	yes	15 % C	100 Å	5 µm	**712130.10**	**712130.100**
NUCLEOSIL® 100–7 C_{18}	yes	15 % C	100 Å	7 µm	**712140.10**	**712140.100**
NUCLEOSIL® 100–10 C_{18}	yes	15 % C	100 Å	10 µm	**712150.10**	**712150.100**
NUCLEOSIL® 120–3 C_{18}	yes	11 % C	120 Å	3 µm	**712460.10**	**712460.100**
NUCLEOSIL® 120–5 C_{18}	yes	11 % C	120 Å	5 µm	**712470.10**	**712470.100**
NUCLEOSIL® 120–7 C_{18}	yes	11 % C	120 Å	7 µm	**712480.10**	**712480.100**
NUCLEOSIL® 120–10 C_{18}	yes	11 % C	120 Å	10 µm	**712490.10**	**712490.100**
NUCLEOSIL® 300–5 C_{18}	yes	6.5 % C	300 Å	5 µm	**712520.10**	**712520.100**
NUCLEOSIL® 300–7 C_{18}	yes	6.5 % C	300 Å	7 µm	**712530.10**	**712530.100**
NUCLEOSIL® 300–10 C_{18}	yes	6.5 % C	300 Å	10 µm	**712540.10**	**712540.100**
NUCLEOSIL® 500–7 C_{18}	yes	2 % C	500 Å	7 µm	**712760.10**	**712760.100**
NUCLEOSIL® 1000–7 C_{18}	yes	~ 1 % C	1000 Å	7 µm	**712790.10**	**712790.100**
NUCLEOSIL® 4000–7 C_{18}	yes	<1 % C	4000 Å	7 µm	**712926.10**	**712926.100**
Octyl phases						$-(CH_2)_7-CH_3$
NUCLEOSIL® 50–5 C_8 ec	yes	9 % C	50 Å	5 µm	**712032.10**	**712032.100**
NUCLEOSIL® 100–5 C_8 ec	yes	9 % C	100 Å	5 µm	**712101.10**	**712101.100**
NUCLEOSIL® 100–5 C_8	no	8.5 % C	100 Å	5 µm	**712100.10**	**712100.100**
NUCLEOSIL® 100–7 C_8	no	8.5 % C	100 Å	7 µm	**712110.10**	**712110.100**
NUCLEOSIL® 100–10 C_8	no	8.5 % C	100 Å	10 µm	**712120.10**	**712120.100**
NUCLEOSIL® 120–3 C_8	no	6.5 % C	120 Å	3 µm	**712570.10**	**712570.100**
NUCLEOSIL® 120–5 C_8	no	6.5 % C	120 Å	5 µm	**712580.10**	**712580.100**
NUCLEOSIL® 120–7 C_8	no	6.5 % C	120 Å	7 µm	**712500.10**	**712500.100**
NUCLEOSIL® 120–10 C_8	no	6.5 % C	120 Å	10 µm	**712590.10**	**712590.100**
NUCLEOSIL® 300–5 C_8	no	~ 3 % C	300 Å	5 µm	**712650.10**	**712650.100**
NUCLEOSIL® 300–7 C_8	no	~ 3 % C	300 Å	7 µm	**712550.10**	**712550.100**
NUCLEOSIL® 300–10 C_8	no	~ 3 % C	300 Å	10 µm	**712660.10**	**712660.100**
NUCLEOSIL® 500–7 C_8	no	<1 % C	500 Å	7 µm	**712830.10**	**712830.100**

NUCLEOSIL® standard silica for HPLC

Packings for liquid chromatography

Phase	Endcapped	Carbon content	Pore size	Particle size	Pack of 10 g	Pack of 100 g
Phenyl phases						$-(CH_2)_3-C_6H_5$
NUCLEOSIL® 100-5 C_6H_5 ec	yes	8% C	100 Å	5 µm	**712311.10**	**712311.100**
NUCLEOSIL® 100-5 C_6H_5	no	8% C	100 Å	5 µm	**712310.10**	**712310.100**
NUCLEOSIL® 100-7 C_6H_5	no	8% C	100 Å	7 µm	**712340.10**	**712340.100**
NUCLEOSIL® 120-7 C_6H_5	no	6.5% C	120 Å	7 µm	**712510.10**	**712510.100**
NUCLEOSIL® 300-7 C_6H_5	no	~ 3% C	300 Å	7 µm	**712670.10**	**712670.100**
NUCLEOSIL® 500-7 C_6H_5	no	~ 2% C	500 Å	7 µm	**712923.10**	**712923.100**
NUCLEOSIL® 1000-7 C_6H_5	no	~ 1% C	1000 Å	7 µm	**712924.10**	**712924.100**
Butyl phases						$-(CH_2)_3-CH_3$
NUCLEOSIL® 120-5 C_4	yes	~ 4% C	120 Å	5 µm	**712290.10**	**712290.100**
NUCLEOSIL® 300-5 C_4	yes	~ 2% C	300 Å	5 µm	**712620.10**	**712620.100**
NUCLEOSIL® 300-7 C_4	yes	~ 2% C	300 Å	7 µm	**712630.10**	**712630.100**
NUCLEOSIL® 300-10 C_4	yes	~ 2% C	300 Å	10 µm	**712640.10**	**712640.100**
NUCLEOSIL® 500-7 C_4	yes	<1% C	500 Å	7 µm	**712750.10**	**712750.100**
NUCLEOSIL® 1000-7 C_4	yes	<1% C	1000 Å	7 µm	**712780.10**	**712780.100**
NUCLEOSIL® 4000-7 C_4	yes	<1% C	4000 Å	7 µm	**712925.10**	**712925.100**
Dimethyl phases						$-(CH_3)_2$
NUCLEOSIL® 100-7 C_2	no	3.5% C	100 Å	7 µm	**712080.10**	**712080.100**
Cyano phases (nitrile)						$-(CH_2)_3-CN$
NUCLEOSIL® 100-5 CN		5% C	100 Å	5 µm	**712160.10**	**712160.100**
NUCLEOSIL® 100-10 CN		5% C	100 Å	10 µm	**712170.10**	**712170.100**
NUCLEOSIL® 120-7 CN		~ 3% C	120 Å	7 µm	**712600.10**	**712600.100**
NUCLEOSIL® 300-7 CN		~ 2.5% C	300 Å	7 µm	**712820.10**	**712820.100**
NUCLEOSIL® 500-7 CN		~ 2% C	500 Å	7 µm	**712840.10**	**712840.100**
Nitro phases						$-(CH_2)_3-C_6H_4-NO_2$
NUCLEOSIL® 100-5 NO_2		~ 4.5% C	100 Å	5 µm	**712180.10**	**712180.100**
NUCLEOSIL® 100-10 NO_2		~ 4.5% C	100 Å	10 µm	**712190.10**	**712190.100**
Diol phases						$-(CH_2)_3-O-CH_2-CH(OH)-CH_2OH$
NUCLEOSIL® 100-7 OH (Diol)		5% C	100 Å	7 µm	**712350.10**	**712350.100**
NUCLEOSIL® 300-7 OH (Diol)		~ 1.5% C	300 Å	7 µm	**712560.10**	**712560.100**
NUCLEOSIL® 500-7 OH (Diol)		~ 1.5% C	500 Å	7 µm	**712740.10**	**712740.100**
NUCLEOSIL® 1000-7 OH (Diol)		~ 1% C	1000 Å	7 µm	**712770.10**	**712770.100**
NUCLEOSIL® 4000-7 OH (Diol)		~ 1% C	4000 Å	7 µm	**712927.10**	**712927.100**
Amino phases						$-(CH_2)_3-NH_2$
NUCLEOSIL® 100-5 NH_2		3.5% C	100 Å	5 µm	**712200.10**	**712200.100**
NUCLEOSIL® 100-10 NH_2		3.5% C	100 Å	10 µm	**712210.10**	**712210.100**
NUCLEOSIL® 120-7 NH_2		~ 2% C	120 Å	7 µm	**712610.10**	**712610.100**
NUCLEOSIL® 300-7 NH_2		~ 2% C	300 Å	7 µm	**712919.10**	**712919.100**
Dimethylamino phases						$-(CH_2)_3-N(CH_3)_2$
NUCLEOSIL® 100-5 $N(CH_3)_2$		4% C	100 Å	5 µm	**712220.10**	**712220.100**
NUCLEOSIL® 100-10 $N(CH_3)_2$		4% C	100 Å	10 µm	**712230.10**	**712230.100**
Cation exchanger, strongly acidic (SCX)						$-(CH_2)_3-C_6H_4-SO_3\ Na$
NUCLEOSIL® 100-5 SA		6.5% C	100 Å	5 µm	**712240.10**	**712240.100**
NUCLEOSIL® 100-10 SA		6.5% C	100 Å	10 µm	**712250.10**	**712250.100**

NUCLEOSIL® standard silica for HPLC

Phase	Endcapped	Carbon content	Pore size	Particle size	Pack of 10 g	Pack of 100 g
Anion exchanger, strongly basic (SAX)					$-(CH_2)_3-C_6H_4-CH_2-N^+(CH_3)_3Cl^-$	
NUCLEOSIL® 100-5 SB		10 % C	100 Å	5 µm	**712260.10**	**712260.100**
NUCLEOSIL® 100-10 SB		10 % C	100 Å	10 µm	**712270.10**	**712270.100**
Unmodified silica					**SiOH**	
NUCLEOSIL® 50-3			50 Å	3 µm	**712000.10**	**712000.100**
NUCLEOSIL® 50-5			50 Å	5 µm	**712010.10**	**712010.100**
NUCLEOSIL® 50-7			50 Å	7 µm	**712020.10**	**712020.100**
NUCLEOSIL® 50-10			50 Å	10 µm	**712030.10**	**712030.100**
NUCLEOSIL® 100-3			100 Å	3 µm	**712360.10**	**712360.100**
NUCLEOSIL® 100-5			100 Å	5 µm	**712040.10**	**712040.100**
NUCLEOSIL® 100-7			100 Å	7 µm	**712050.10**	**712050.100**
NUCLEOSIL® 100-10			100 Å	10 µm	**712060.10**	**712060.100**
NUCLEOSIL® 120-3			120 Å	3 µm	**712390.10**	**712390.100**
NUCLEOSIL® 120-5			120 Å	5 µm	**712400.10**	**712400.100**
NUCLEOSIL® 120-7			120 Å	7 µm	**712410.10**	**712410.100**
NUCLEOSIL® 120-10			120 Å	10 µm	**712420.10**	**712420.100**
NUCLEOSIL® 300-5			300 Å	5 µm	**712430.10**	**712430.100**
NUCLEOSIL® 300-7			300 Å	7 µm	**712440.10**	**712440.100**
NUCLEOSIL® 300-10			300 Å	10 µm	**712450.10**	**712450.100**
NUCLEOSIL® 500-5			500 Å	5 µm	**712680.10**	**712680.100**
NUCLEOSIL® 500-7			500 Å	7 µm	**712690.10**	**712690.100**
NUCLEOSIL® 500-10			500 Å	10 µm	**712700.10**	**712700.100**
NUCLEOSIL® 1000-5			1000 Å	5 µm	**712710.10**	**712710.100**
NUCLEOSIL® 1000-7			1000 Å	7 µm	**712720.10**	**712720.100**
NUCLEOSIL® 1000-10			1000 Å	10 µm	**712730.10**	**712730.100**
NUCLEOSIL® 4000-5			4000 Å	5 µm	**712850.10**	**712850.100**
NUCLEOSIL® 4000-7			4000 Å	7 µm	**712860.10**	**712860.100**
NUCLEOSIL® 4000-10			4000 Å	10 µm	**712870.10**	**712870.100**

POLYGOSIL® bulk packings

- Irregular silica for analytical applications
- pH stability 2–8

Physical properties of unmodified POLYGOSIL® materials

Phase	Pore size	Pore volume	Surface (BET)	Density	Pressure stability
POLYGOSIL® 60	60 Å	0.75 mL/g	350 m^2/g	0.45 g/mL	600 bar
POLYGOSIL® 100	100 Å	1 mL/g	280 m^2/g	0.35 g/mL	400 bar
POLYGOSIL® 300	300 Å	0.8 mL/g	100 m^2/g	0.45 g/mL	400 bar
POLYGOSIL® 1000	1000 Å	0.8 mL/g	25 m^2/g	0.45 g/mL	300 bar

Modification of POLYGOSIL® follows the same processes as for NUCLEOSIL® silica.

POLYGOSIL® irregular silica for HPLC

Ordering information

Phase	Endcapped	Carbon content	Pore size	Particle size	Pack of 10 g	Pack of 100 g
Octadecyl phases						**$-(CH_2)_{17}-CH_3$**
POLYGOSIL® 60-5 C_{18}	yes	12% C	60 Å	5 µm	**711330.10**	**711330.100**
POLYGOSIL® 60-7 C_{18}	yes	12% C	60 Å	7 µm	**711340.10**	**711340.100**
POLYGOSIL® 60-10 C_{18}	yes	12% C	60 Å	10 µm	**711350.10**	**711350.100**
POLYGOSIL® 100-5 C_{18}	yes	14% C	100 Å	5 µm	**711560.10**	**711560.100**
POLYGOSIL® 100-7 C_{18}	yes	14% C	100 Å	7 µm	**711570.10**	**711570.100**
POLYGOSIL® 100-10 C_{18}	yes	14% C	100 Å	10 µm	**711580.10**	**711580.100**
POLYGOSIL® 300-7 C_{18}	yes	4% C	300 Å	7 µm	**711710.10**	**711710.100**
POLYGOSIL® 1000-7 C_{18}	yes	~ 1% C	1000 Å	7 µm	**711992.10**	**711992.100**
Octyl phases						**$-(CH_2)_7-CH_3$**
POLYGOSIL® 60-5 C_8	no	7% C	60 Å	5 µm	**711300.10**	**711300.100**
POLYGOSIL® 60-7 C_8	no	7% C	60 Å	7 µm	**711310.10**	**711310.100**
POLYGOSIL® 60-10 C_8	no	7% C	60 Å	10 µm	**711320.10**	**711320.100**
Butyl phases						**$-(CH_2)_3-CH_3$**
POLYGOSIL® 300-7 C_4	yes	~ 1% C	300 Å	7 µm	**711680.10**	**711680.100**
POLYGOSIL® 1000-7 C_4	yes	< 1% C	1000 Å	7 µm	**711991.10**	**711991.100**
Cyano phases (nitrile)						**$-(CH_2)_3-CN$**
POLYGOSIL® 60-5 CN		~ 5% C	60 Å	5 µm	**711380.10**	**711380.100**
POLYGOSIL® 60-10 CN		~ 5% C	60 Å	10 µm	**711390.10**	**711390.100**
Nitro phases						**$-(CH_2)_3-C_6H_4-NO_2$**
POLYGOSIL® 60-5 NO_2		~ 4.5% C	60 Å	5 µm	**711400.10**	**711400.100**
POLYGOSIL® 60-10 NO_2		~ 4.5% C	60 Å	10 µm	**711410.10**	**711410.100**
Unmodified silica						**SiOH**
POLYGOSIL® 60-5			60 Å	5 µm	**711010.10**	**711010.100**
POLYGOSIL® 60-7			60 Å	7 µm	**711280.10**	**711280.100**
POLYGOSIL® 60-10			60 Å	10 µm	**711020.10**	**711020.100**
POLYGOSIL® 100-5			100 Å	5 µm	**711510.10**	**711510.100**
POLYGOSIL® 100-7			100 Å	7 µm	**711520.10**	**711520.100**
POLYGOSIL® 100-10			100 Å	10 µm	**711530.10**	**711530.100**
POLYGOSIL® 300-7			300 Å	7 µm	**711600.10**	**711600.100**
POLYGOSIL® 1000-7			1000 Å	7 µm	**711890.10**	**711890.100**
Amino phases						**$-(CH_2)_3-NH_2$**
POLYGOSIL® 60-5 NH_2		~ 3% C	60 Å	5 µm	**711360.10**	**711360.100**
POLYGOSIL® 60-10 NH_2		~ 3% C	60 Å	10 µm	**711370.10**	**711370.100**
Dimethylamino phases						**$-(CH_2)_3-N(CH_3)_2$**
POLYGOSIL® 60-5 $N(CH_3)_2$		~ 3.5% C	60 Å	5 µm	**711420.10**	**711420.100**
POLYGOSIL® 60-10 $N(CH_3)_2$		~ 3.5% C	60 Å	10 µm	**711430.10**	**711430.100**

POLYGOPREP bulk packings

- Irregular silica for preparative applications
- pH stability 2–8

Physical properties of unmodified POLYGOPREP materials

Phase	Pore size	Pore volume	Surface (BET)	Density	Pressure stability
POLYGOPREP 60	60 Å	0.75 mL/g	350 m^2/g	0.45 g/mL	600 bar
POLYGOPREP 100	100 Å	1 mL/g	280 m^2/g	0.35 g/mL	400 bar
POLYGOPREP 300	300 Å	0.8 mL/g	100 m^2/g	0.45 g/mL	400 bar
POLYGOPREP 1000	1000 Å	0.8 mL/g	35 m^2/g	0.45 g/mL	300 bar

Modification of POLYGOPREP follows the same processes as for NUCLEOSIL® silica.

Ordering information

Phase	Endcapped	Carbon content	Pore size	Particle size	Pack of 100 g	Pack of 1 kg
Octadecyl phases						$-(CH_2)_{17}-CH_3$
POLYGOPREP 60-12 C_{18}	no*	12 % C	60 Å	10–15 µm	**711009.100**	**711009.1000**
POLYGOPREP 60-20 C_{18}	no*	12 % C	60 Å	15–25 µm	**711031.100**	**711031.1000**
POLYGOPREP 60-30 C_{18}	no*	12 % C	60 Å	25–40 µm	**711480.100**	**711480.1000**
POLYGOPREP 60-50 C_{18}	no*	12 % C	60 Å	40–63 µm	**711500.100**	**711500.1000**
POLYGOPREP 60-80 C_{18}	no*	12 % C	60 Å	63–100 µm	**711011.100**	**711011.1000**
POLYGOPREP 60-130 C_{18}	no*	12 % C	60 Å	63–200 µm	**711590.100**	**711590.1000**
POLYGOPREP 100-12 C_{18}	no*	14 % C	100 Å	10–15 µm	**711018.100**	**711018.1000**
POLYGOPREP 100-20 C_{18}	no*	14 % C	100 Å	15–25 µm	**711019.100**	**711019.1000**
POLYGOPREP 100-30 C_{18}	no*	14 % C	100 Å	25–40 µm	**711032.100**	**711032.1000**
POLYGOPREP 100-50 C_{18}	no*	14 % C	100 Å	40–63 µm	**711021.100**	**711021.1000**
POLYGOPREP 300-12 C_{18}	yes	4 % C	300 Å	10–15 µm	**711024.100**	**711024.1000**
POLYGOPREP 300-20 C_{18}	yes	4 % C	300 Å	15–25 µm	**711025.100**	**711025.1000**
POLYGOPREP 300-30 C_{18}	yes	4 % C	300 Å	25–40 µm	**711720.100**	**711720.1000**
POLYGOPREP 300-50 C_{18}	yes	4 % C	300 Å	40–63 µm	**711730.100**	**711730.1000**
POLYGOPREP 1000-30 C_{18}	yes	~ 1 % C	1000 Å	25–40 µm	**711028.100**	**711028.1000**
POLYGOPREP 1000-50 C_{18}	yes	~ 1 % C	1000 Å	40–63 µm	**711029.100**	**711029.1000**
Octyl phases						$-(CH_2)_7-CH_3$
POLYGOPREP 60-12 C_8	no*	7 % C	60 Å	10–15 µm	**711007.100**	**711007.1000**
POLYGOPREP 60-20 C_8	no*	7 % C	60 Å	15–25 µm	**711008.100**	**711008.1000**
POLYGOPREP 60-30 C_8	no*	7 % C	60 Å	25–40 µm	**711470.100**	**711470.1000**
POLYGOPREP 60-50 C_8	no*	7 % C	60 Å	40–63 µm	**711490.100**	**711490.1000**
Butyl phases						$-(CH_2)_3-CH_3$
POLYGOPREP 300-12 C_4	yes	~ 1 % C	300 Å	10–15 µm	**711022.100**	**711022.1000**
POLYGOPREP 300-20 C_4	yes	~ 1 % C	300 Å	15–25 µm	**711023.100**	**711023.1000**
POLYGOPREP 300-30 C_4	yes	~ 1 % C	300 Å	25–40 µm	**711690.100**	**711690.1000**
POLYGOPREP 300-50 C_4	yes	~ 1 % C	300 Å	40–63 µm	**711700.100**	**711700.1000**
POLYGOPREP 1000-30 C_4	yes	< 1 % C	1000 Å	25–40 µm	**711026.100**	**711026.1000**
POLYGOPREP 1000-50 C_4	yes	< 1 % C	1000 Å	40–63 µm	**711027.100**	**711027.1000**
* On request, these POLYGOPREP RP phases can be endcapped at surcharge.						
Cyano phases (nitrile)						$-(CH_2)_3-CN$
POLYGOPREP 60-12 CN		~ 4.5 % C	60 Å	10–15 µm	**711015.100**	**711015.1000**
POLYGOPREP 60-20 CN		~ 4.5 % C	60 Å	15–25 µm	**711016.100**	**711016.1000**
POLYGOPREP 60-30 CN		~ 4.5 % C	60 Å	25–40 µm	**711017.100**	**711017.1000**

POLYGOPREP irregular silica for HPLC

Phase	Endcapped	Carbon content	Pore size	Particle size	Pack of 100 g	Pack of 1 kg
Amino phases						**$-(CH_2)_3-NH_2$**
POLYGOPREP 60-12 NH_2		~ 3% C	60 Å	10-15 µm	**711012.100**	**711012.1000**
POLYGOPREP 60-20 NH_2		~ 3% C	60 Å	15-25 µm	**711013.100**	**711013.1000**
POLYGOPREP 60-30 NH_2		~ 3% C	60 Å	25-40 µm	**711014.100**	**711014.1000**

Phase	Pore size	Particle size	Pack of 100 g	Pack of 1 kg	Pack of 5 kg
Unmodified POLYGOPREP silica					**SiOH**
POLYGOPREP 60-12	60 Å	10-15 µm		**711001.1000**	**711001.5000**
POLYGOPREP 60-20	60 Å	15-25 µm		**711240.1000**	**711240.5000**
POLYGOPREP 60-30	60 Å	25-40 µm		**711250.1000**	**711250.5000**
POLYGOPREP 60-50	60 Å	40-63 µm		**711260.1000**	**711260.5000**
POLYGOPREP 60-80	60 Å	63-100 µm		**711270.1000**	**711270.5000**
POLYGOPREP 60-130	60 Å	63-200 µm		**711037.1000**	**711037.5000**
POLYGOPREP 100-12	100 Å	10-15 µm		**711002.1000**	**711002.5000**
POLYGOPREP 100-20	100 Å	15-25 µm		**711003.1000**	**711003.5000**
POLYGOPREP 100-30	100 Å	25-40 µm		**711540.1000**	**711540.5000**
POLYGOPREP 100-50	100 Å	40-63 µm		**711550.1000**	**711550.5000**
POLYGOPREP 100-80	100 Å	63-100 µm		**711033.1000**	**711033.5000**
POLYGOPREP 100-130	100 Å	63-200 µm		**711034.1000**	**711034.5000**
POLYGOPREP 300-12	300 Å	10-15 µm	**711004.100**	**711004.1000**	
POLYGOPREP 300-20	300 Å	15-25 µm	**711610.100**	**711610.1000**	
POLYGOPREP 300-30	300 Å	25-40 µm	**711620.100**	**711620.1000**	
POLYGOPREP 300-50	300 Å	40-63 µm	**711630.100**	**711630.1000**	
POLYGOPREP 1000-12	1000 Å	10-15 µm	**711035.100**	**711035.1000**	
POLYGOPREP 1000-20	1000 Å	15-25 µm	**711036.100**	**711036.1000**	
POLYGOPREP 1000-30	1000 Å	25-40 µm	**711005.100**	**711005.1000**	
POLYGOPREP 1000-50	1000 Å	40-63 µm	**711006.100**	**711006.1000**	

Silica adsorbents for low pressure column chromatography

- Silica 60, pore size ~ 60 Å; pore volume ~ 0.75 mL/g; spec. surface BET ~ 500 m^2/g
  highly porous, amorphous silicic acid in the form of hard, opalescent particles, prepared by precipitation of water glass with sulfuric acid
- For higher demands on the performance of column packings we recommend our high-purity irregular POLYGOPREP silicas (see previous page).
- Silica FIA for the fluorescence indicator adsorption procedure for the determination of hydrocarbon groups in the testing of liquid fuels in accordance with DIN 51791 and ASTM D 1319-58T

  The FIA method determines saturated hydrocarbons, olefins and aromatic hydrocarbons of a sample chromatographically by adsorption and desorption in a column filled with FIA silica, in the presence of a fluorescent dye mixture.

Ordering information

Designation	Particle size	1 kg	5 kg	25 kg
Silica 60, 0.015–0.04 mm	–	**815650.1**	**815650.5**	**815650.25**
Silica 60, 0.025–0.04 mm	–	**815300.1**	**815300.5**	**815300.25**
Silica 60, 0.04–0.063 mm	230–400 mesh	**815380.1**	**815380.5**	**815380.25**
Silica 60 M, 0.04–0.063 mm	230–400 mesh	**815381.1**	**815381.5**	**815381.25**
Silica 60, 0.05–0.1 mm	130–270 mesh	**815390.1**	**815390.5**	**815390.25**
Silica 60, 0.05–0.2 mm	70–270 mesh	**815320.1**	**815320.5**	**815320.25**
Silica 60, 0.063–0.2 mm	70–230 mesh	**815330.1**	**815330.5**	**815330.25**
Silica 60, < 0.063 mm	+230 mesh	**815400.1**	**815400.5**	**815400.25**
Silica 60, < 0.08 mm	+190 mesh	**815310.1**	**815310.5**	**815310.25**
Silica 60, 0.1–0.2 mm	70–130 mesh	**815340.1**	**815340.5**	
Silica 60, 0.2–0.5 mm	35–70 mesh	**815350.1**	**815350.5**	**815350.25**
Silica 60, 0.5–1.0 mm	18–35 mesh	**815360.1**	**815360.5**	**815360.25**
Silica FIA fine	0.071–0.16 mm	**815410.1**		
Silica FIA coarse	0.071–0.63 mm	**815430.1**		

Aluminium oxide

- Aluminium oxides produced by dehydration of different aluminium hydroxides, e.g., hydrargillite between 400 and 500 °C
- Activity grade I, particle size 50–200 µm, specific surface (BET) ~ 130 m^2/g

Ordering information

Type	pH	1 kg	5 kg	25 kg
Aluminium oxide 90 basic	pH 9.5 ± 0.3	**815010.1**	**815010.5**	**815010.25**
Aluminium oxide 90 neutral	pH 7 ± 0.5	**815020.1**	**815020.5**	**815020.25**
Aluminium oxide 90 acidic	pH 4 ± 0.3	**815030.1**	**815030.5**	**815030.25**

Kieselguhr

- Naturally occurring amorphous silicic acids of fossil origin, also known as diatomaceous earth or diatomite purified for chromatographic applications
- Compared to silica, kieselguhr has a small surface of low activity → application in partition chromatography; impregnated with various substances (paraffin, silicone oil, undecane) it can be used for reversed phase chromatography
- The following grades of kieselguhr are manufactured by Johns-Manville. They are narrowly classified with homogeneous particle size distributions and high purity.

For columns packed with kieselguhr please see CHROMABOND® XTR for liquid-liquid extraction, page 56.

Ordering information

Designation	rel. purification factor	rel. flow rate	1 kg	5 kg
Filter-Cel	100	100	**815510.1**	**815510.5**
Hyflo Super-Cel	58	534	**815530.1**	**815530.5**
Celite 503	42	910	**815540.1**	**815540.5**
Celite 535	35	1269	**815550.1**	**815550.5**
Celite 545	32	1830	**815560.1**	**815560.5**

Adsorbents for column chromatography

Florisil®

- Hard granular magnesia silica gel: MgO 15.5 ± 0.5 % · SiO_2 84.0 ± 0.5 % · Na_2SO_4 ≤ 1.0 %; 60/100 mesh
  Typical applications: sample preparation (see chapter "Solid phase extraction", page 34); clean-up of pesticide residues, separation of chlorinated pesticides, extraction of steroids, sex hormones, antibiotics, lipids etc.

Ordering information

Designation	Particle size	1 kg	5 kg
Florisil® standard 60/100 mesh	0.15/0.25 mm	**815710.1**	**815710.5**

Polyamide

- Polyamide 6 = ε-aminopolycaprolactam
  separation mechanism mainly based on hydrogen bonds
- **Recommended application:** separation of phenolic compounds (e.g., isolation of natural products), carboxylic acids, aromatic nitro compounds

For SPE columns packed with polyamide see CHROMABOND® PA page 34.

Ordering information

Designation	Particle size	1 kg
Polyamide CC 6, < 0.07 mm	< 0.07 mm	**815610.1**
Polyamide CC 6, 0.05–0.16 mm	0.05–0.16 mm	**815620.1**
Polyamide CC 6, 0.10–0.30 mm	0.10–0.30 mm	**815600.1**

Unmodified cellulose

- **Cellulose MN 100:** native fibrous cellulose, standard grade
  average degree of polymerization 620–680, fiber length (85 %) 20–100 µm,
  specific surface acc. to Blaine ~ 6500 cm^2/g; residue on ignition at 850 °C < 10000 ppm,
  < 20 ppm Fe, < 5 ppm Cu, < 7 ppm P, CH_2Cl_2 extract < 0.20 %
- **Cellulose MN 2100:** native fibrous cellulose, purified grade (washed with different eluents)
  average degree of polymerization 620–680, fiber length (85 %) 20–75 µm,
  specific surface acc. to Blaine ~ 5500 cm^2/g
  residue on ignition at 850 °C < 1000 ppm, < 2 ppm Fe, < 1 ppm Cu, < 2 ppm P, CH_2Cl_2 extract < 0.15 %
  Grade MN 2100ff is a defatted cellulose MN 2100 with a CH_2Cl_2 extract < 0.02 %

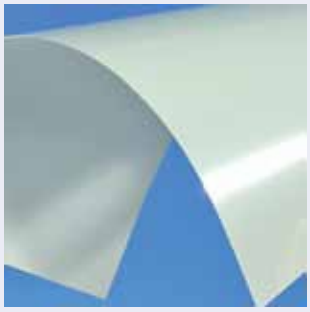
Ordering information

Designation	1 kg	5 kg	25 kg
Cellulose MN 100	**815050.1**	**815050.5**	**815050.25**
Cellulose MN 2100	**815060.1**	**815060.5**	**815060.25**
Cellulose MN 2100ff (cellulose MN 2100 defatted)	**815070.1**		

TLC · Contents

Glass plates

ALUGRAM® aluminium sheets



POLYGRAM® polyester sheets

Basic principles of TLC

Thin layer chromatography (TLC) and high performance thin layer chromatography (HPTLC), also called planar chromatography, are, like all chromatographic techniques, based on a multistage distribution process involving

- Suitable adsorbents (the stationary phase) coated as a thin layer onto a suitable support (e.g., glass plate, polyester or aluminium sheet)
- Solvents or solvent mixtures (the mobile phase or eluent)
- Sample molecules

The principle of TLC is known for more than 100 years [M. W. Beyerinck, Z. Phys. Chem. **3** (1889) 110]. The real break-through as an analytical method, however, came about 50 years ago as a consequence of the pioneering work of Egon Stahl [Thin layer chromatography, 2nd edition, Springer-Verlag Berlin, Reprint 1988].

Today TLC has gained increasing importance as an analytical separation technique, which is probably due to effects of instrumentation and automation [H. Jork, Laborpraxis **2** (1992) 110]. At the same time the applicability of thin layer chromatography was enhanced by development of new adsorbents and supports.

Today MACHEREY-NAGEL offers a versatile range of ready-to-use layers, which are the result of 50 years of continuous research and development.

Features of modern TLC/HPTLC

The success of thin layer chromatography as a highly efficient microanalytical separation method is based on a large number of advantageous properties:

- High sample throughput in a short time
- Suitable for screening tests
- Pilot procedure for HPLC and flash chromatography
- After separation the analytical information can be stored for a longer period of time (the TLC ready-to-use layer acts as storage medium for data)
- Separated substances can be subjected to subsequent analytical procedures (e.g., IR, MS) at a later date
- Rapid and cost-efficient optimization of the separation due to easy change of mobile and stationary phase

For a better understanding of a thin layer chromatographic separation we describe here the basic steps:

- Sample preparation
- Sample application
- Development of a chromatogram, separation techniques
- Evaluation in TLC – visualization of separated substances, qualitative and quantitative determinations

Principle steps of a thin layer chromatographic separation

Sample preparation

For separation the sample must meet several requirements to obtain good results. Since the TLC plate is a disposable product, sample preparation in general is not as demanding as for other chromatographic methods. However, eventually several steps for sample pretreatment may be necessary. These include sampling, mechanical crushing, extraction steps, filtration and sometimes enrichment of interesting components or clean-up, i.e. removal of undesired impurities.

Our TLC micro-sets introduce some simple methods of sample pretreatment. The dyes or dye mixtures of the beginner's set do not require complicated procedures. The advanced sets require the user to carry out some additional steps for preparing a sample, thus introducing the user to techniques often performed in industrial laboratories.

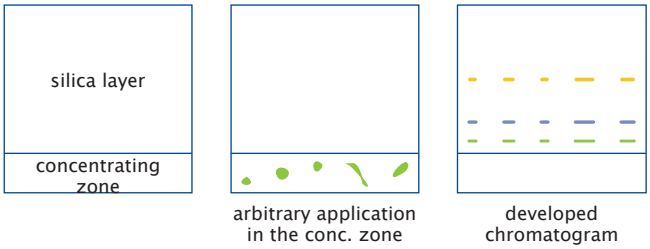
Thorough preparation of samples is an important prerequisite for the success of a TLC separation. For our range of products for more demanding sample pretreatment please see the chapter "SPE" from page 2.

Sample application

The aim of a chromatographic separation determines how the sample should be applied to the TLC plate or sheet. The most frequent technique is application with a glass capillary as spot or short streak.

Application as streak will yield better results especially for instrumental quantification. For both types of application some manual skill is required to obtain reproducible results. Substance zones which are too large from the beginning will cause poor separation since during chromatography they will become even larger and more diffuse.

A valuable aid for manual application especially of large volumes of very dilute samples is the concentrating zone (e.g., SILGUR-25 UV_{254}), which consists of a chromatographically inactive adsorbent (kieselguhr). The substances to be separated are concentrated to a small band in the concentrating zone and the separation starts at the beginning of the chromatographically active adsorbent silica.



Another method for sample concentration is a short pre-elution (few mm) with a solvent, in which all substances have a high R_f value.

If a quantitative evaluation with a TLC scanner is to follow the separation we recommend to use commercially available sample applicators for spotting. These range from simple spotting guides via nanoapplicators to completely automated spotting devices. Application as streak can be performed automatically by spraying of the sample without touching the layer of the TLC plate. Application as band over the whole width of the TLC plate is especially important for preparative TLC.

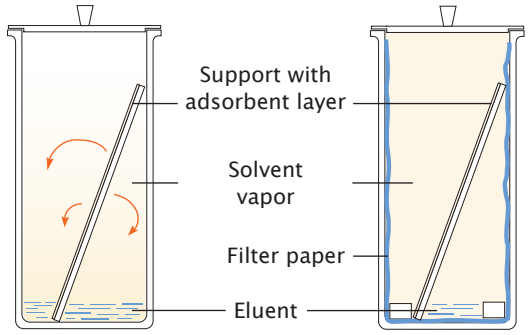
After application allow the solvent of the samples to evaporate completely (about 10 min) or blow with cold or hot air. Development of a chromatogram should never start before the solvent of the applied samples is evaporated completely.

Developing a chromatogram – separation techniques

The most frequently used separation technique is ascending TLC in a trough chamber (standard method, linear development). Usually it is applied as single development. However, multiple development, with or without change of eluent (step technique) can improve separation results. For 2-dimensional development only 1 spot of the sample is applied in one edge of a plate. After chromatography in the first direction the plate is dried, turned by 90° and developed in the 2nd dimension with another eluent. Thus complicated mixtures give 2-dimensional chromatograms taking advantage of the different separating properties of two eluents.

For selection and optimization of the eluent numerous publications are available. A generally applicable standardized optimization method is described by H. Keuker et al. [in "Proceedings of the International Symposium on Instrumental TLC", Brighton, Sussex, UK 1989, 105–114]

It is important to pay attention to the atmosphere in the developing chamber. If reproducible migration distances are required, saturation of the chamber atmosphere with eluent vapor is necessary. For this purpose the developing chamber is lined with well absorbing chromatography paper (e.g., MN 260) and charged with a correspondingly larger volume of eluent.



A) normal saturation, arrows show evaporation of the eluent from the layer

B) Chamber lined with filter paper, saturated with eluent vapor

Another interesting technique is the PMD technique (Programmed Multiple Development) [K. Burger, Fresenius Z. Anal. Chem. **318** (1984) 228–233], which is a true gradient development on silica for TLC. Contrary to the common multiple development every single run is slightly longer than the previous one. Thus broadening of substance zones during chromatography is easily compensated for. Usually, about 10 to 25 development cycles are run, generally with a universal gradient. Since this technique can be automated, you can also find the name AMD (Automated Multiple Development) [K. Burger, Pflanzenschutz-Nachrichten Bayer **41,2** (1988) 173].

It should be noted, that the considerable increase in performance with these techniques also requires a considerable increase in instrumental expense.

Evaluation of a thin layer chromatogram

Evaluation depends on the purpose of the chromatographic analysis. For qualitative determination often localization of substances is sufficient. This can be easily achieved by parallel runs with reference substances.

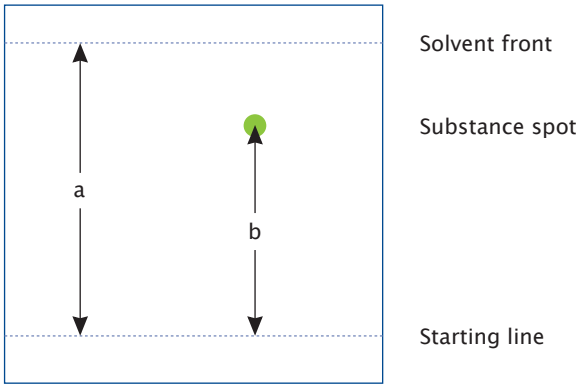
A parameter often used for qualitative evaluation is the R_f value (retention factor) or the 100fold value hR_f. The R_f value is defined as follows:

$$R_f = \frac{\text{distance starting line – middle of spot}}{\text{distance starting line – solvent front}} = \frac{b}{a}$$

i.e. the R_f values are between 0 and 1, best between 0.1 and 0.8 (i.e. 10–80 for hR_f). If reproducible R_f values are to be obtained, it is essential that several parameters such as chamber saturation, composition of solvent mixtures, temperature etc. are strictly controlled.

Quantitative evaluation is possible by suitable calibration measurements. For this purpose either the area of a substance spot is measured or a photometric evaluation is performed directly on the layer. The latter procedure, however, requires a higher instrumental expense.

The following paragraphs describe the most frequently used methods for evaluation in TLC.



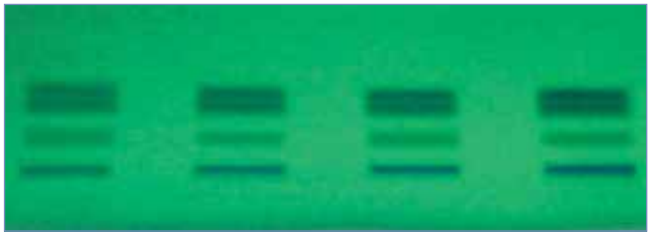
Basic principles of TLC

Qualitative detection

Qualitative evaluation is generally made directly on the TLC plate via characteristic R_f values of substances, i.e. the ratio of distance start – substance zone to distance start – solvent front and specific chemical reactions.

Visualization of separated substances

First of all it is necessary to recognize the position of a substance spot. Only in very few cases the sample is a dye which can be seen with the naked eye. Much more often for unspecific visualization substances can be viewed under UV light, since many substances show a UV absorption. If a fluorescent indicator is added to the layer, all substances absorbing in the respective region of wave length cause a quenching of the fluorescence, i.e. they appear as dark spots on the fluorescent layer. Customary fluorescent indicators are excited at 254 nm or (less frequently) at 366 nm with a mercury lamp. For our program of fluorescent indicators for TLC please see page 234.



Identification of separated substances is possible via the R_f value compared to the pure compound, which is often applied simultaneously on the same plate.

For a number of compounds their native fluorescence can be used for visualization, which is excited by UV light (mostly long-wave UV) (e.g., aflatoxins). This allows not only determination of the R_f value, but often enables a further qualitative assignment.

If these methods do not allow localization or characterization of a substance, post-chromatographic detection methods can be applied, chemical reactions on the TLC plate [H. Jork et al., Dünnschicht-Chromatographie, VCH Verlagsgesellschaft, 1989]. Quite unspecific reactions are iodine adsorption and the charring technique (spraying with sulfuric acid and heat treatment).

More reliable results are possible with specific reagents for spraying or dipping, which form colored or fluorescent compounds with the substances to be detected. Depending on the sensitivity of these reactions they are not only used for group or substance specific characterization (in addition to the R_f value) but also for quantification down to trace levels. As example take the ninhydrin reaction. Formation of a (usually red) zone with this detection method yields the information, that a certain group of substances, e.g., α-amino acids, are present. The R_f value allows further assignment to one or several single compounds. For identification of a substance a combination of different detection methods can be useful. Thus almost all lipids can be converted to products with light green fluorescence by reaction with 2',7'-dichlorofluorescein. Adsorption of iodine vapor enables a differentiation between saturated and unsaturated lipids or lipids containing nitrogen. And finally the R_f value is a third means of identification.

Here are some general remarks concerning spraying: use all spray reagents under a fume hood. The developed, dried TLC plate or sheet is placed on a sheet of filter paper for spraying. Usually it is sufficient to fill the sprayer with about 5–10 mL solution. Spray from a distance of about 15 cm with the aid of a rubber ball or – if available – with pressurized air. It is always better to spray a layer twice very thinly and evenly (with intermediate drying), than to saturate the layer with excessive spray reagent. In the latter case spots tend to become diffuse. After visualization mark outlines of zones with a lead pencil, because some spots tend to fade after a while.

Especially for quantitative evaluation short dipping of the layer in the respective reagent solution is recommended. For this purpose automatic instruments are commercially available, which allow reproducible dipping.

When a substance is localized on the TLC plate (e.g., under UV), but not yet identified, TLC scanners allow recording of UV spectra of individual substance zones directly on the layer, or the zone is removed by scratching or cutting (for sheets), eluted and further analyzed, e.g., by FT-IR, RAMAN, NMR or mass spectroscopy.

Quantitative evaluation

Often TLC is considered to be only a semiquantitative analytical procedure. This is true for visual evaluation of spots, since the eye can only compare but not measure absolute values. If, however, a direct optical evaluation („in situ" measurement) is performed on the TLC plate with a thin layer scanner, after measurement of calibration functions exact quantitative results are possible. Commercial scanners offer many features such as evaluation in absorption and fluorescence, unattended programmed scanning of lanes, multi-wave length measurement, background correction, selectable base line for integration, recording of spectra, evaluation of circular or anti-circular chromatograms with very high ease of operation. In addition to manual operation control by a computer is possible with respective data collection and storage. Usually wavelengths from 200 to 700 nm are available (visible and UV), e.g., all post-chromatographic (and of course all pre-chromatographic) visualization procedures are evaluated with the proper wavelength, which is determined with the instrument. Time requirements for all these possibilities are extremely low. Interlaboratory experiments with standard deviations of 2 % show how excellent results are obtainable [Planar Chromatography, Vol. 1, ed. R. E. Kaiser, Dr. Alfred Hüthig Verlag, Heidelberg, 1986].

Overview of MN ready-to-use layers for TLC

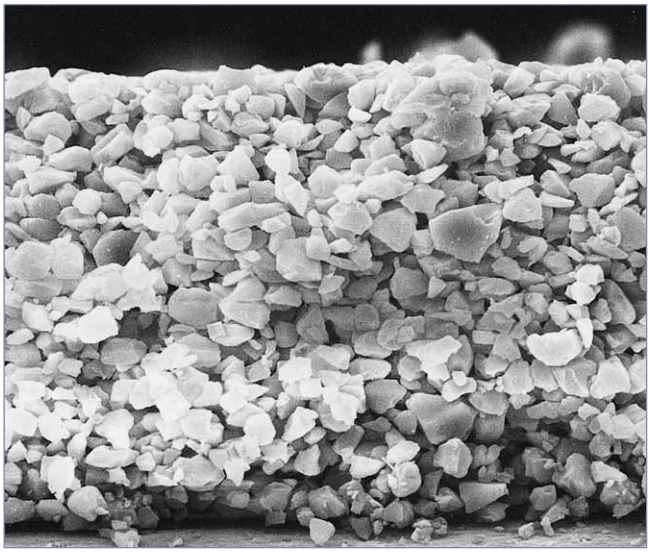
Advantages of MN plates and sheets for TLC

- **Continuous high quality**
  guaranteed by stringent production control including standardized lot tests, surface checks for roughness or cracks as well as hardness and adherence checks
- **Comprehensive range of phases for TLC / HPTLC**
  there is no universal TLC plate which meets all possible types of analyses. Our versatile range of TLC ready-to-use layers covers many different types of applications.
- **Immediately ready for chromatographic separation**
  coatings or impregnations are not necessary
- **Homogeneous, smooth, well adhering layers**
  an important criterion especially for reproducible quantitative evaluation

Adsorbents for MN plates and sheets for TLC

- **Classical adsorbents**
  for ~80% of all TLC separations silica 60 (mean pore diameter 60 Å = 6 nm) is used. Other classical adsorbents are aluminium oxide, cellulose, kieselguhr, ion exchangers and polyamide.
- **Special phases**
  reversed phases, mainly C18 (octadecyl) modified silica, but also cyano, amino, diol and RP-2 modified silica. Special layers for specific separations, like our CHIRALPLATE for enantiomer separation, complete the versatile range of TLC plates.
- **Particle size distribution** and **thickness of layer** are chosen to fit the given type of application (e.g., HPTLC, standard or preparative separations).
- Most MN ready-to-use layers are available with or without fluorescent indicator.

Electron microscope photograph of a cross section through a glass plate with silica layer (magnification x 500)



Electron microscope photograph of a cross section through an aluminium sheet with silica layer (magnification x 500)

Supports for ready to use layers for TLC

	Glass plates	POLYGRAM®	ALUGRAM® / ALUGRAM® Xtra
Physical properties of support materials			
Material	Glass	Polyester	Aluminium
Thickness (approx.)	1.3 mm	0.2 mm	0.15 mm
Weight, packaging and storage requirements	high	low	low
Torsional strength	ideal	low	relatively high
Temperature stability	high	max. 185 °C	high
Susceptible to breakage	yes	no	no
Can be cut with scissors	no	yes	yes
Chemical resistance of support materials			
against solvents	high	high	high
against mineral acids and conc. ammonia	high	high	low
Stability of the binder system of NP plates in water			
suitability for aqueous detection reagents	depending on phase	very suitable	ALUGRAM®: limited suitability; ALUGRAM® Xtra: very suitable

Summary of MN ready-to-use layers for TLC

Phase	Support*	Layer	Page
Standard silica			
ADAMANT	G	Silica 60, improved binder system, optimized particle size distribution	213
SIL G	G P A Ax	Silica 60, standard grade, particle size 5–17 µm	215
DURASIL	G	Silica 60, special binder system	215
SILGUR	G Ax	Silica 60 with kieselguhr concentrating zone	216
Unmodified silica for HPTLC			
Nano-SILGUR	G Ax	Nano silica 60 with kieselguhr concentrating zone	216
Nano-ADAMANT	G	Nano silica 60, improved binder system, optimized particle size distribution	217
Nano-SIL	G A Ax	Nano silica 60, standard grade, particle size 2–10 µm	218
Nano-DURASIL	G	Nano silica 60, special binder system	218
Modified silica for HPTLC			
Nano-SIL C18-50 / Nano-SIL C18-100	G	Nano silica with partial or complete C18 modification	219
RP-18 W/UV_{254}	G A	Nano silica with partial octadecyl modification, wettable with water	220
RP-2/UV_{254}	G A	Silanized silica = dimethyl-modified nano silica 60	220
Nano-SIL CN	G A	Cyano-modified nano silica	221
Nano-SIL NH_2	G A	Amino-modified nano silica	222
Nano-SIL DIOL	G	Diol-modified nano silica	223
Aluminium oxide			
Alox-25 / Alox N	G P A	Aluminium oxide	224
Cellulose, unmodified and modified			
CEL 300	G P A	Native fibrous cellulose MN 300	225
CEL 400	G P	Microcrystalline cellulose MN 400 (AVICEL®)	225
CEL 300 PEI	P	Polyethyleneimine-impregnated cellulose ion exchanger	226
CEL 300 AC	P	Acetylated cellulose MN 300	226
Layers for special separations			
POLYAMIDE-6	P	Perlon = ε-aminopolycaprolactame	226
CHIRALPLATE	G	RP silica with Cu^{2+} ions and chiral reagent, for enantiomer separation of amino acids	226
SIL N-HR	P	High purity silica 60, special binder system, higher gypsum content	227
SIL G-25 HR	G	High purity silica 60 with gypsum, recommended for aflatoxin analysis	227
SIL G-25 Tenside	G	Silica G with ammonium sulfate for separation of surfactants	228
Nano-SIL PAH	G	Nano silica with special impregnation for PAH analysis	228
IONEX-25 SA-Na	P	Mixed layer of strongly acidic cation exchanger and silica	228
IONEX-25 SB-AC	P	Mixed layer of strongly basic anion exchanger and silica	228
Alox/CEL-AC-Mix	G	Mixed layer of aluminium oxide and acetylated cellulose	229
SILCEL-Mix	G	Mixed layer of cellulose and silica	229

* **G** = glass plates **P** = POLYGRAM® polyester sheets
A = ALUGRAM® aluminium sheets **Ax** = ALUGRAM® Xtra aluminium sheets

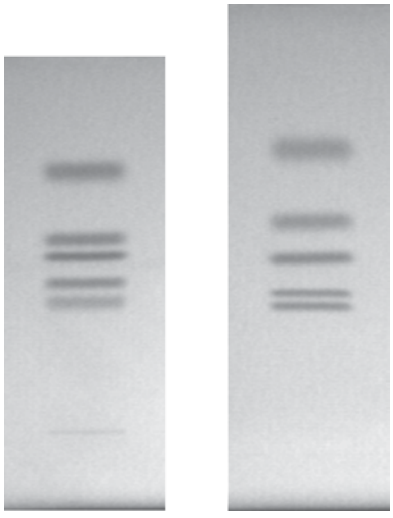
ADAMANT

unmodified standard silica layers

- Silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 mL/g, particle size 5–17 µm
  - **Outstanding hardness** and **abrasion resistance** due to an optimized binder system
  - **Increased separation efficiency** due to an optimized particle size distribution
  - **High suitability for trace analyses** resulting from a UV indicator with increased brilliance and a low-noise background of the layer

Separation of steroids

Layers: ADAMANT UV_{254}, SIL G/UV_{254}
Eluent: chloroform – methanol (97:3, v/v)
Developing time: 10 min
Sample: 0.1 % solution in $CHCl_3$
Detection: UV



ADAMANT UV_{254} SIL G/UV_{254}

R_f	ADAMANT	SIL G
Cortisone	0.37	0.27
Corticosterone	0.43	0.30
Testosterone	0.50	0.39
Deoxycorticosterone	0.55	0.46
Progesterone	0.73	0.62
Migration distance	5.0 cm	5.7 cm

MN Appl. No. 402930

Separation of barbiturates

Layer: ADAMANT UV_{254}
Eluent: chloroform – acetone (95:5, v/v)
Migration distance: 73 mm in 20 min
Sample volume: 1 µL
Detection: UV

Substance	R_f
Thiamylal (0.5 %)	0.69
Thiopental (1.0 %)	0.65
Hexobarbital (5.0 %)	0.41
Pentobarbital (1.0 %)	0.26
Phenobarbital (1.0 %)	0.18

MN Appl. No. 402950

For more applications of ADAMANT ready-to-use layers, check our application database at ***www.mn-net.com/apps***.

Ordering information

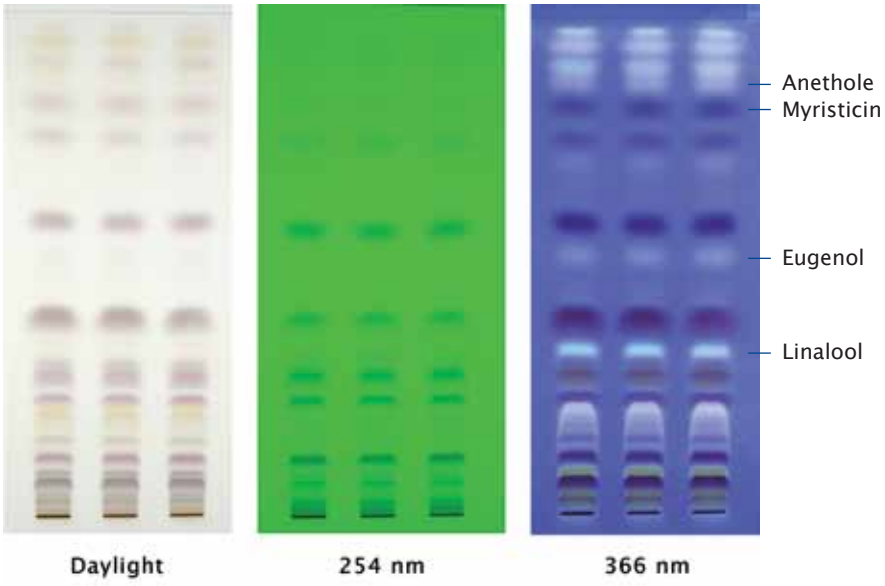
Plate size [cm]	2.5 x 7.5	5 x 10		5 x 20	10 x 10	10 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Pack of [plates]	100	50	200	100	25	50	25		
Glass plates									
ADAMANT		**821040**	**821040.200**		**821050**		**821060**	0.25 mm	–
ADAMANT UV_{254}	**821005**	**821010**	**821010.200**	**821015**	**821020**	**821025**	**821030**	0.25 mm	UV_{254}

Standard silica layers for TLC

ALUGRAM® Xtra SIL G — unmodified standard silica layers on aluminium

- Silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 mL/g, particle size 5–17 µm; standard grade
  - Outstanding wettability for precise colorization results, even with 100% aqueous detection reagents
  - Excellent separation efficiency and reproducibility from lot to lot
  - Easy and reliable cutting due to an optimized binder system, no flaking of silica
- Binder: highly polymeric product, which is stable in almost all organic solvents and resistant towards aggressive visualization reagents; also completely stable in purely aqueous eluents

Separation of nutmeg ingredients



Sample:	shake 1.0 g freshly powdered drug for 3 min with 4 mL methanol and filter; apply 10 µL
Layer:	ALUGRAM® Xtra SIL G UV_{254}
Eluent:	toluene – ethyl acetate (95:5, v/v)
Migration distance:	15 cm
Detection:	254 nm: underivatized daylight and 366 nm: spray with 5% ethanolic sulfuric acid, 1% vanillic acid and heat to 105 °C

The chromatograms show the following zones with increasing R_f values: linalool (bluish grey), eugenol (yellowish brown), myristicin (reddish brown), and anethole (pink-violet). Other colored zones may appear.

MN Appl. No. 403590

Ordering information

Plate size [cm]	2.5 x 7.5	4 x 8	5 x 7.5	5 x 10	5 x 20	10 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Pack of [plates]	200	50	20	50	50	20	25		
ALUGRAM® Xtra aluminium sheets									
SIL G			**818230.20**	**818261**	**818232**		**818233**	0.20 mm	–
SIL G/UV_{254}	**818329**	**818331**	**818330.20**	**818360**	**818332**	**818362**	**818333**	0.20 mm	UV_{254}

Standard silica layers for TLC

SIL G — unmodified standard silica layers

- Silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 mL/g, particle size 5–17 µm; standard grade
- Thickness of layer for analytical plates 0.25 mm, for **preparative plates** 0.5 and 1 mm; for 2 mm preparative layers a slightly coarser material is used
- Indicators: manganese activated zinc silicate with green fluorescence for short-wave UV (254 nm); special inorganic fluorescent pigment with blue fluorescence for long-wave UV (366 nm)
- Binders: highly polymeric products, which are stable in almost all organic solvents and resistant towards aggressive visualization reagents; binder system for POLYGRAM® sheets (as for ALUGRAM® Xtra sheets) is also completely stable in purely aqueous eluents

Ordering information

Glass plates

Plate size [cm]	2.5 x 7.5	5 x 10		5 x 20	10 x 10	10 x 20	20 x 20	Thickness of layer
Pack of [plates]	100	50	200	100	25	50	25	
SIL G-25		**809017**	**809017.200**	**809011**		**809012**	**809013**	0.25 mm
SIL G-25 UV_{254}	**809028.100**	**809027**	**809027.200**	**809021**	**809020**	**809022**	**809023**	0.25 mm
SIL G-25 $UV_{254+366}$				**809121**		**809122**	**809123**	0.25 mm
Pack of [plates]	(preparative TLC)						20	
SIL G-50							**809051**	0.50 mm
SIL G-50 UV_{254}							**809053**	0.50 mm
Pack of [plates]	(preparative TLC)						15	
SIL G-100							**809061**	1.00 mm
SIL G-100 UV_{254}							**809063**	1.00 mm
Pack of [plates]	(preparative TLC)						12	
SIL G-200							**809073**	2.00 mm
SIL G-200 UV_{254}							**809083**	2.00 mm

POLYGRAM® polyester sheets

Plate size [cm]	2.5 x 7.5	4 x 8	5 x 20	20 x 20	40 x 20	
Pack of [plates]	200	50	50	25	25	
SIL G	**805902**	**805032**	**805012**	**805013**	**805014**	0.20 mm
SIL G/UV_{254}	**805901**	**805021**	**805022**	**805023**	**805024**	0.20 mm
SIL G/UV_{254}			Roll 500 x 20 cm		**805017**	0.20 mm

ALUGRAM® aluminium sheets

Plate size [cm]	2.5 x 7.5	4 x 8	5 x 7.5	5 x 10	5 x 20	10 x 20	20 x 20	
Pack of [plates]	200	50	20	50	50	20	25	
SIL G			**818030.20**	**818161**	**818032**	**818163**	**818033**	0.20 mm
SIL G/UV_{254}	**818129**	**818131**	**818130.20**	**818160**	**818132**	**818162**	**818133**	0.20 mm

DURASIL — unmodified standard silica layers

- Silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 mL/g, particle size 5–17 µm
- Hard, water-resistant and wettable layers due to a special binder system

Ordering information

Plate size [cm]	5 x 10		5 x 20	10 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Pack of [plates]	50	200	100	50	25		
Glass plates							
DURASIL-25				**812003**	**812004**	0.25 mm	-
DURASIL-25 UV_{254}	**812005**	**812005.200**	**812006**	**812007**	**812008**	0.25 mm	UV_{254}

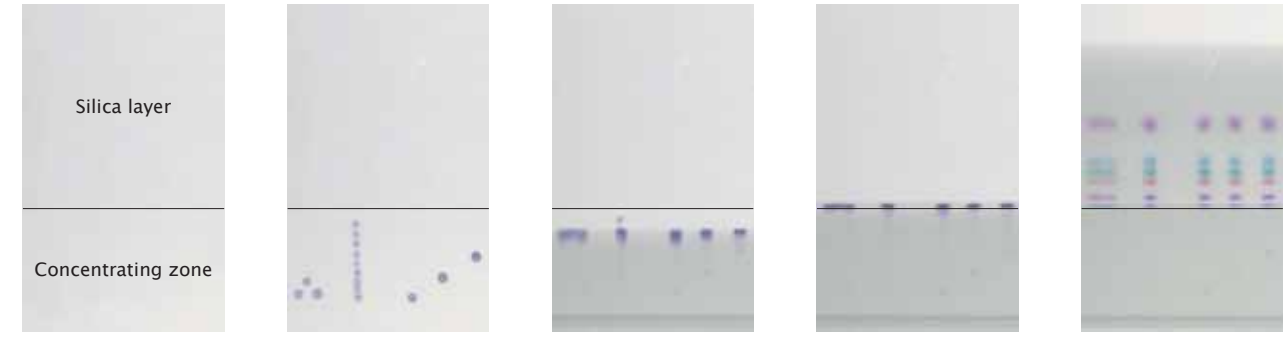
Silica layers with concentrating zone

SILGUR — unmodified standard silica layers with concentrating zone

- Silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 mL/g, particle size 5–17 µm
- **Kieselguhr zone for rapid sample application:** because kieselguhr is completely inert towards a large number of compounds, the samples always form a narrow band at the interface of the two adsorbents, irrespective of shape, size or position of the spots in the concentrating zone (see page 208). Separation then takes place in the silica layer.
  Available as glass plate and as ALUGRAM® Xtra aluminium sheet with or without fluorescent indicator (for advantages of ALUGRAM® Xtra see page 214)

Ordering information

Plate size [cm]	10 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Glass plates				
Pack of [plates]	50	25		
SILGUR-25	**810012**	**810013**	0.25 mm	–
SILGUR-25 UV_{254}	**810022**	**810023**	0.25 mm	UV_{254}
ALUGRAM® Xtra aluminium sheets · *NEW!*				
Pack of [plates]	20	25		
SILGUR	**818412**	**818413**	0.20 mm	–
SILGUR UV_{254}	**818422**	**818423**	0.20 mm	UV_{254}



ALUGRAM® Xtra SILGUR | arbitrary application in the concentrating zone | applied substances are concentrated | applied substances at the phase boundary | developed chromatogram

Nano-SILGUR — unmodified HPTLC silica layers with concentrating zone

- Nano silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 mL/g, **particle size 2–10 µm**
- Narrow fractionation of the silica for sharper separations, shorter developing times, shorter migration distances, lower amount of samples and an increased detection sensitivity compared to SILGUR plates
- Kieselguhr zone for rapid sample application (see SILGUR above)

Ordering information

	Plate size 10 x 10 cm, pack of 25 plates	Thickness of layer	Fluorescent indicator
Glass plates			
Nano-SILGUR-20	**811032**	0.20 mm	–
Nano-SILGUR-20 UV_{254}	**811042**	0.20 mm	UV_{254}
ALUGRAM® Xtra aluminium sheets · *NEW!*			
Nano-SILGUR	**818432**	0.20 mm	–
Nano-SILGUR UV_{254}	**818442**	0.20 mm	UV_{254}

Nano-ADAMANT

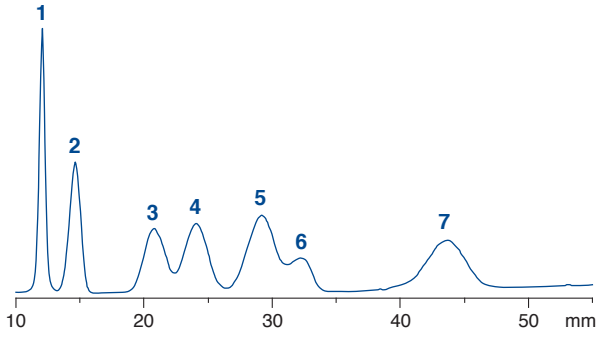
unmodified HPTLC silica layers

- Nano silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 mL/g, **particle size 2–10 µm**
  - **Outstanding hardness** and **abrasion resistance** due to an optimized binder system
  - **Increased separation efficiency** due to an optimized particle size distribution
  - **High suitability for trace analyses** resulting from a UV indicator with increased brilliance and a low-noise background of the layer
- Narrow fractionation of the silica particles allows theoretical plate heights, which are one order of magnitude smaller than on standard silica layers with the advantage of sharper separations, shorter developing times, shorter migration distances, lower amount of samples, and increased detection sensitivity with equal selectivity.

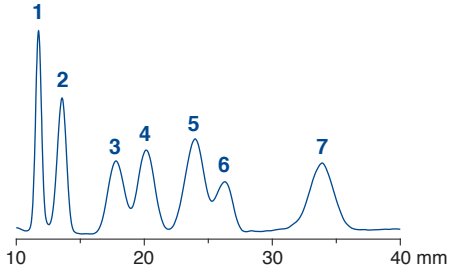
Comparison of ADAMANT and Nano-ADAMANT plates for separation of anthraquinone dyes

Layers: A) ADAMANT, B) Nano-ADAMANT
Sample: 1 µL, about 0.1 %
Eluent: toluene – cyclohexane (4:3, v/v)
Migration time: A) 30 min, B) 15 min

Peaks:
1. Blue 3
2. Violet 2
3. Red
4. Green
5. Blue 1
6. Greenish blue
7. Violet 1



A



B

Ordering information

Plate size [cm] Pack of [plates[	10 x 10 25	10 x 20 50	Thickness of layer	Fluorescent indicator
Glass plates				
Nano-ADAMANT	**821140**	**821150**	0.20 mm	–
Nano-ADAMANT UV_{254}	**821110**	**821120**	0.20 mm	UV_{254}

Nano silica layers for HPTLC

Nano-SIL

unmodified HPTLC silica layers

- Nano silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 mL/g, **particle size 2–10 µm**
  indicator: manganese activated zinc silicate with green fluorescence for short-wave UV (254 nm)
  binder: highly polymeric product, which is stable in almost all organic solvents and resistant towards aggressive visualization reagents
- Narrow fractionation of the silica particles allows sharper separations, shorter developing times, shorter migration distances, smaller samples and an increased detection sensitivity compared to SIL G plates.
- Available as glass plate and as ALUGRAM® Xtra aluminium sheet with or without fluorescent indicator (advantages of ALUGRAM® Xtra see page 214)

Ordering information

Plate size [cm] / Pack of [plates]	5 x 5 / 100	5 x 20 / 50	10 x 10 / 25	10 x 20 / 50	20 x 20 / 25	Thickness of layer	Fluorescent indicator
Glass plates							
Nano-SIL-20	**811011**		**811012**	**811013**		0.20 mm	–
Nano-SIL-20 UV_{254}	**811021**		**811022**	**811023**		0.20 mm	UV_{254}
ALUGRAM® Xtra aluminium sheets · *NEW!*							
Nano-SIL G		**818240**			**818241**	0.20 mm	–
Nano-SIL G/UV_{254}		**818342**			**818343**	0.20 mm	UV_{254}
ALUGRAM® aluminium sheets							
Nano-SIL G					**818141**	0.20 mm	–
Nano-SIL G/UV_{254}					**818143**	0.20 mm	UV_{254}

Nano-DURASIL

unmodified HPTLC silica layers

- Nano silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 mL/g, particle size 2–10 µm
  indicator: manganese activated zinc silicate with green fluorescence for short-wave UV (254 nm)
  hard, water-resistant and wettable layers due to a special binder system
- Narrow fractionation of the silica particles allows sharper separations, shorter developing times, shorter migration distances, smaller samples and an increased detection sensitivity compared to DURASIL plates
  different selectivity compared to ADAMANT and SIL-G plates
  no reversed phase tendency, more polar than Nano-SIL

Ordering information

Plate size [cm] / Pack of [plates]	10 x 10 / 25	10 x 20 / 50	Thickness of layer	Fluorescent indicator
Glass plates				
Nano-DURASIL-20	**812010**	**812011**	0.20 mm	–
Nano-DURASIL-20 UV_{254}	**812013**	**812014**	0.20 mm	UV_{254}

Nano-SIL C18

octadecyl-modified HPTLC silica layers

- Base material:
  - Nano silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 mL/g, **particle size 2–10 µm,** pH stability 2–10
  - Indicator: acid-resistant product with a pale blue fluorescence for short-wave UV (254 nm); UV-absorbing substances appear as dark-blue to black spots on a light-blue background
- Partial (50%) or complete (100%) octadecyl modification, carbon content 7.5 and 14%, respectively
- Order of polarity: silica > DIOL > NH_2 > CN > RP-2 > **C18-50** > RP-18 W > **C18-100**
- Reversed phase separation mode with eluents from anhydrous solvents to mixtures with high concentrations of water (see table and figure below)
- **Recommended application:**
  Alkaloids, amino acids, preservatives, optical brighteners, barbiturates, polycyclic aromatic hydrocarbons (PAH), drugs, peptides, flavonoids, phenols, indole derivatives, steroids

Ordering information

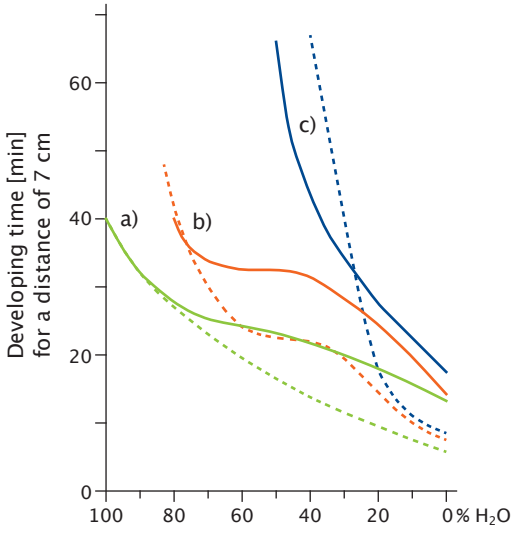
Plate size [cm] Pack of [plates]		10 x 10 25	Thickness of layer	Fluorescent indicator
Glass plates				
Nano-SIL C18-50	} 50% silanized	**811054**	0.20 mm	–
Nano-SIL C18-50 UV_{254}		**811064**	0.20 mm	UV_{254}
Nano-SIL C18-100	} 100% silanized	**811052**	0.20 mm	–
Nano-SIL C18-100 UV_{254}		**811062**	0.20 mm	UV_{254}

Migration of C18-50 and C18-100 silica layers as compared to RP-18 W plates

Eluent	v/v	Migration distances [mm/15 min] C18-50	C18-100	RP-18 W
Methanol – H_2O	2:1	57	45	44
	1:1	52	21	40
	1:2	50	0	43
	1:3	40	0	45
	1:4	30	0	46
	0:1	0	0	54
Acetonitrile – H_2O	2:1	62	46	66
	1:1	52	30	54
	1:2	51	27	46
	1:3	48	15	44
	1:9	20	0	42
Trichloromethane		68	64	71

For numerous separations with MN RP plates please visit our on-line application data base at ***www.mn-net.com/apps***.

Elution properties of MN RP plates in mixtures of methanol – water and acetonitrile – water



a) RP-18 W, b) Nano-SIL C18-50, c) Nano-SIL C18-100
all plates with UV indicator
methanol – water; acetonitrile – water

Modified RP silica layers for TLC and HPTLC

RP-18 W/UV_{254} — octadecyl-modified HPTLC silica layers

- Base material:
  - Nano silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 mL/g, particle size 2–10 µm; for **preparative plates** (1 mm thickness of layer) standard silica 60, particle size 5–17 µm pH stability 2–10
  - Indicator: acid-resistant product with a pale blue fluorescence for short-wave UV (254 nm); UV-absorbing substances appear as dark-blue to black spots on a light-blue background
- Partial octadecyl (C18) modification, wettable with water, carbon content 14%
- Order of polarity: silica > DIOL > NH_2 > CN > RP-2 > C18-50 > **RP-18 W** > C18-100
- NP or RP separation with eluents from anhydrous solvents to mixtures with high concentrations of water (see table and figure on previous page); relative polarity of the eluent determines the polarity of the layer
- **Recommended application:** aminophenols, barbiturates, preservatives, nucleobases, polycyclic aromatic hydrocarbons, steroids, tetracyclines, plasticizers (phthalates)

Ordering information

Plate size [cm]	4 x 8	5 x 10	5 x 20	10 x 10	10 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Glass plates								
Pack of [plates]			50	25	50	25		
RP-18 W/UV_{254}			**811073**	**811075**	**811072**	**811071**	0.25 mm	UV_{254}
Pack of [plates]	(preparative TLC)					15		
RP-18 W/UV_{254}						**811074**	1.00 mm	UV_{254}
ALUGRAM® aluminium sheets								
Pack of [plates]	50	50	50	25		25		
RP-18 W/UV_{254}	**818144**	**818152**	**818145**	**818147**		**818146**	0.15 mm	UV_{254}

RP-2/UV_{254} — "silanized silica" = dimethyl-modified standard silica layers

- Base material:
  - Silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 mL/g, particle size 5–17 µm, pH stability 2–10
  - Indicator: acid-resistant product with a pale blue fluorescence for short-wave UV (254 nm); UV-absorbing substances appear as dark-blue to black spots on a light-blue background
- Silanized silica with dimethyl modification, carbon content 4%
- Order of polarity: silica > DIOL > NH_2 > CN > **RP-2** > C18-50 > RP-18 W > C18-100
- Normal phase or reversed phase separation modes with purely organic, organic – aqueous or purely aqueous eluents
- **Recommended application:** active plant constituents, steroids

Ordering information

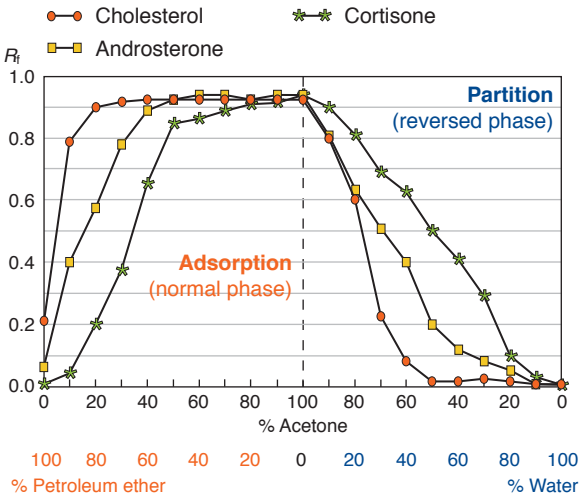
Plate size [cm]	10 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Pack of [plates]	50	25		
Glass plates				
RP-2/UV_{254}	**811081**	**811082**	0.25 mm	UV_{254}
ALUGRAM® aluminium sheets				
RP-2/UV_{254}		**818171**	0.15 mm	UV_{254}

Nano-SIL CN

cyano-modified HPTLC silica layers

- Base material:
  - Nano silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 mL/g, **particle size 2–10 µm,** pH stability 2–8
  - Indicator: acid-resistant product with a pale blue fluorescence for short-wave UV (254 nm); UV-absorbing substances appear as dark-blue to black spots on a light-blue background
- Cyanopropyl modification, carbon content 5.5%
- Order of polarity: silica > DIOL > NH_2 > **CN** > RP-2 > C18-50 > RP-18 W > C18-100
- Available as glass plates or ALUGRAM® aluminium sheets
- NP or RP separation modes depending on the polarity of the developing solvent (see figure below)
- **Recommended application:** steroid hormones, phenols, preservatives

R_f values of different steroids as a function of eluent composition



Layer: Nano-SIL CN/UV
Polarity of the eluent governs the type of separation mechanism:

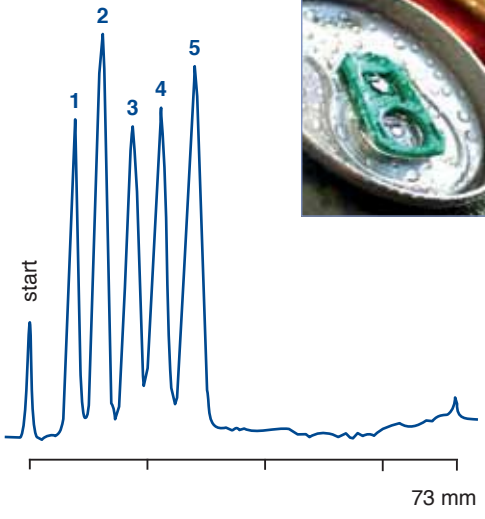
Eluent system petroleum ether (PE) – acetone (NP mode)
the higher the concentration of PE, the stronger are the adsorptive interactions of the steroids with the stationary phase

Eluent system acetone – water (RP mode)
the sequence of elution of the steroids is reversed, the most nonpolar compounds are most strongly retained

Separation of preservatives

Layer:	Nano-SIL CN/UV
Sample volume:	400 nL
Eluent:	ethanol – water – glacial acetic acid (20:80:0.2) with 0.1 mol/L tetraethylammonium chloride
Migration distance:	7.3 cm in 30 min
Detection:	TLC scanner, UV 254 nm

Peaks:
1. Propyl *p*-hydroxybenzoate
2. Ethyl *p*-hydroxybenzoate
3. Methyl *p*-hydroxybenzoate
4. Benzoic acid
5. Sorbic acid



MN Appl. No. 401440

Ordering information

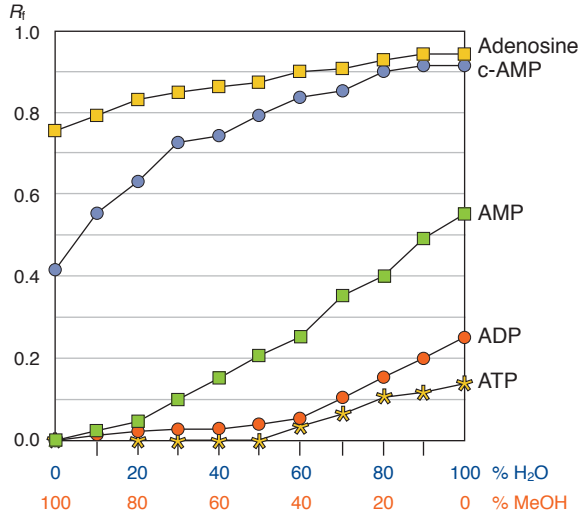
Plate size [cm] Pack of [plates]	4 x 8 50	10 x 10 25	10 x 20 25	Thickness of layer	Fluorescent indicator
Glass plates					
Nano-SIL CN/UV		**811115**	**811116**	0.20 mm	UV_{254}
ALUGRAM® aluminium sheets					
Nano-SIL CN/UV	**818184**			0.15 mm	UV_{254}

Modified silica layers for HPTLC

Nano-SIL NH_2 — amino-modified HPTLC silica layers

- Base material:
  - Nano silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 mL/g, particle size 2–10 µm, pH stability 2–8
  - Indicator: acid-resistant product with a pale blue fluorescence for short-wave UV (254 nm); UV-absorbing substances appear as dark-blue to black spots on a light-blue background
- Aminopropyl modification, carbon content 3.5 %
- Order of polarity: silica > DIOL > **NH_2** > CN > RP-2 > C18-50 > RP-18 W > C18-100
- Available with or without fluorescent indicator, as glass plates or ALUGRAM® aluminium sheets
- Layer can be wetted equally well with pure water as with organic solvents
- **Recommended application:**
  Vitamins, sugars, steroids, purine derivatives, xanthines, phenols, nucleotides and pesticides

Influence of eluent composition on the separation of nucleotides

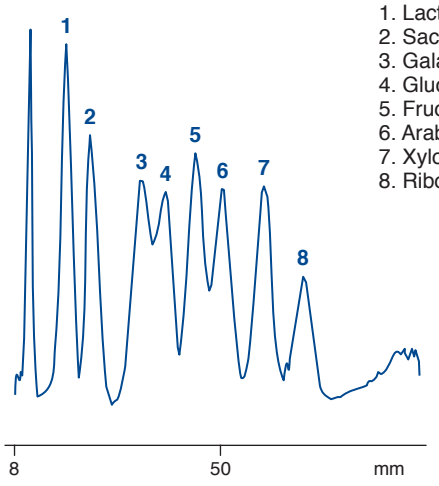


Layer: Nano-SIL NH_2/UV
Eluent: MeOH – H_2O according to fig. + 0.18 mol/L NaCl
Migration distance: 7 cm

c-AMP, AMP: adenosine monophosphate
ADP: adenosine diphosphate
ATP: adenosine triphosphate

Separation of sugars

Layer: Nano-SIL NH_2/UV
Eluent: ethyl acetate – pyridine – water – glacial acetic acid (60:30:10:5, v/v/v/v)
Migration distance: 8 cm in 45 min, double development
Sample volume: 0.5 µL
Detection: dry layer at 160 °C for 5 min, TLC scanner, UV 254 nm



Peaks (0.1 % each):
1. Lactose
2. Saccharose
3. Galactose
4. Glucose
5. Fructose
6. Arabinose
7. Xylose
8. Ribose

MN Appl. No. 401590

Ordering information

Plate size [cm] Pack of [plates]	4 x 8 50	10 x 10 25	10 x 20 25	Thickness of layer	Fluorescent indicator
Glass plates					
Nano-SIL NH_2/UV		**811111**	**811112**	0.20 mm	UV_{254}
ALUGRAM® aluminium sheets					
Nano-SIL NH_2/UV	**818182**			0.15 mm	UV_{254}

Nano-SIL DIOL

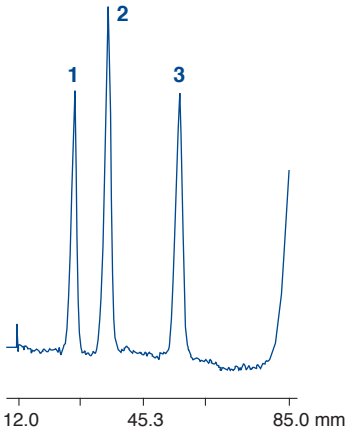
diol-modified HPTLC silica layers

- Base material:
  - Nano silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 mL/g, **particle size 2–10 µm,** pH stability 2–8
  - Indicator: acid-resistant product with a pale blue fluorescence for short-wave UV (254 nm); UV-absorbing substances appear as dark-blue to black spots on a light-blue background
- Diol modification, carbon content 5.5 %
- Order of polarity: silica > **DIOL** > NH_2 > CN > RP-2 > C18-50 > RP-18 W > C18-100
- Available as glass plates or ALUGRAM® aluminium sheets
- Layer can be wetted equally well by pure water as by organic solvents
- **Recommended application:**
  Steroids, pesticides and plant constituents; for critical separations an alternative to silica, since it is less sensitive to the water content of the environment; leads to more reproducible results compared to silica

Separation of herbicides

Layer: Nano-SIL DIOL/UV
Sample volume: 2 µL
Eluent: petroleum ether (40–60 °C) – acetone (80:20, v/v)
Migration distance: 7 cm
Detection: TLC scanner, 238 nm

Peaks:
(0.07 % each in methanol)
1. Metoxuron
2. Monuron
3. Metobromuron



MN Appl. No. 402340

Ordering information

	Plate size 10 x 10 cm, pack of 25 plates	Thickness of layer	Fluorescent indicator
Glass plates			
Nano-SIL DIOL/UV	**811120**	0.20 mm	UV_{254}

HPTLC method development kits

- For selection of the optimum HPTLC plate for a given separation

Ordering information

Description	REF
Glass plates: 3 plates 10 x 10 cm (scored to 5 x 10 cm) each of Nano-SIL C18-100/UV_{254}, RP-18 W/UV_{254}, RP-2/UV_{254}, Nano-SIL CN/UV, Nano-SIL NH_2/UV, Nano-SIL DIOL/UV	**811001**
ALUGRAM® aluminium sheets: 5 sheets 4 x 8 cm each of RP-18 W/UV_{254}, RP-2/UV_{254}, Nano-SIL CN/UV, Nano-SIL NH_2/UV, Nano-SIL DIOL/UV	**818001**

Aluminium oxide layers for TLC

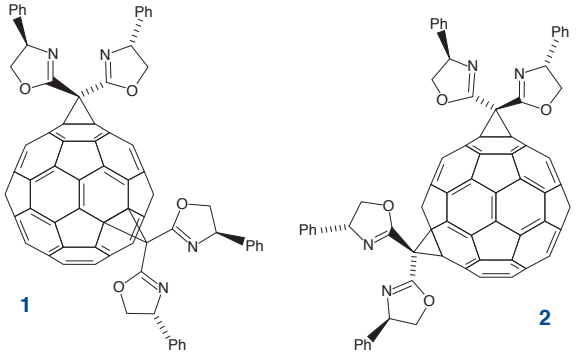
Alox — aluminium oxide layers for TLC

- Aluminium oxide, specific surface (BET) ~ 200 m^2/g, mean pore size 60 Å; inert organic binder
  Indicator manganese-activated zinc silicate
- **Recommended application:**
  Terpenes, alkaloids, steroids, aliphatic and aromatic compounds
  We recommend to activate aluminium oxide layers before use by heating 10 minutes at 120 °C.

Separation of bisadducts of fullerenes

F. Djojo, A. Hirsch, Chem. Eur. J. **4** (1998), 344–356
Layer: ALUGRAM® Alox N/UV_{254}
Eluent: toluene – ethyl acetate (95:5, v/v)
Detection: UV, 254 nm

Compound	R_f values
Bis[bis(4-phenyloxazolin)methane]fullerene 1	0.14
Bis[bis(4-phenyloxazolin)methane]fullerene 2	0.26

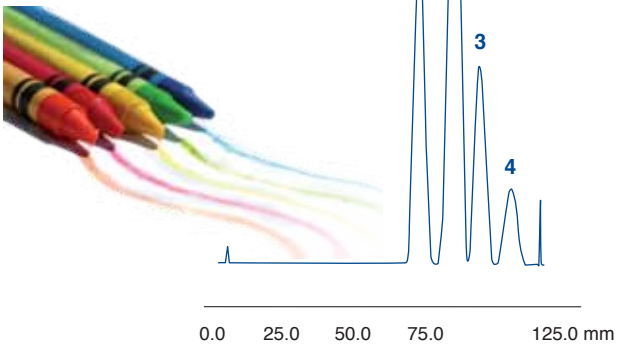


MN Appl. No. 401930

Separation of lipophilic dyes

Layer: Alox-25 UV_{254}
Sample volume: 1000 nL
Eluent: toluene – cyclohexane (2:1, v/v)
Migration distance: 10.8 cm in 15 min
Detection: TLC scanner, UV 254 nm

Peaks:
1. Indophenol
2. Sudan red G
3. Sudan blue II
4. Butter yellow



MN Appl. No. 403010

Ordering information

Plate size [cm]	4 x 8	5 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Glass plates					
Pack of [plates]		100	25		
Alox-25 UV_{254}		**807021**	**807023**	0.25 mm	UV_{254}
Pack of [plates]	(preparative TLC)		15		
Alox-100 UV_{254}			**807033**	1.00 mm	UV_{254}
POLYGRAM® polyester sheets					
Pack of [plates]	50	50	25		
Alox N/UV_{254}	**802021**	**802022**	**802023**	0.20 mm	UV_{254}
ALUGRAM® aluminium sheets					
Pack of [plates]		50	25		
Alox N/UV_{254}		**818024**	**818023**	0.20 mm	UV_{254}

Cellulose MN 300 — native fibrous cellulose layers for TLC

- Fiber length (95 %) 2–20 µm, average degree of polymerization 400–500, specific surface acc. to Blaine 15000 cm^2/g
  ≤ 20 ppm Fe, 6 ppm Cu, 7 ppm P; CH_2Cl_2 extract ≤ 0.25 %; residue on ignition at 850 °C ≤ 1500 ppm
- **Recommended application:**
  Partition chromatography of polar substances such as amino acids, carboxylic acids or carbohydrates

Ordering information

Plate size [cm]	4 x 8	5 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Glass plates					
Pack of [plates]			25		
CEL 300-10			**808013**	0.10 mm	–
CEL 300-10 UV_{254}			**808023**	0.10 mm	UV_{254}
CEL 300-25			**808033**	0.25 mm	–
CEL 300-25 UV_{254}			**808043**	0.25 mm	UV_{254}
Pack of [plates]	(preparative TLC)		20		
CEL 300-50			**808053**	0.50 mm	–
CEL 300-50 UV_{254}			**808063**	0.50 mm	UV_{254}
POLYGRAM® polyester sheets					
Pack of [plates]	50	50	25		
CEL 300	**801011**		**801013**	0.10 mm	–
CEL 300 UV_{254}		**801022**	**801023**	0.10 mm	UV_{254}
ALUGRAM® aluminium sheets					
Pack of [plates]	50	50	25		
CEL 300	**818155**		**818153**	0.10 mm	–
CEL 300 UV_{254}		**818157**	**818156**	0.10 mm	UV_{254}

Cellulose MN 400 (AVICEL®) — microcrystalline cellulose layers for TLC

- Prepared by hydrolysis of high purity cellulose with HCl; average degree of polymerization 40–200
- **Recommended application:**
  Carboxylic acids, lower alcohols, urea and purine derivatives

Ordering information

Plate size [cm]	10 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Pack of [plates]	50	25		
Glass plates				
CEL 400-10	**808072**	**808073**	0.10 mm	–
POLYGRAM® polyester sheets				
CEL 400		**801113**	0.10 mm	–
CEL 400 UV_{254}		**801123**	0.10 mm	UV_{254}

Cellulose layers for TLC

Cellulose MN 300 PEI — PEI-impregnated cellulose ion exchange layers

- Fibrous cellulose impregnated with polyethyleneimine
- **Recommended application:** analysis of nucleic acids, and of mutagenic substances with the ^{32}P postlabelling procedure (see application 402260 at ***www.mn-net.com/apps***)

Ordering information

Plate size [cm] Pack of [plates]	20 x 20 25	Thickness of layer	Fluorescent indicator
POLYGRAM® polyester sheets			
CEL 300 PEI	**801053**	0.10 mm	–
CEL 300 PEI/UV_{254}	**801063**	0.10 mm	UV_{254}

Acetylated cellulose MN 300

- Fibrous cellulose with 10% content of acetylated cellulose for reversed phase chromatography

Ordering information

Plate size [cm] Pack of [plates]	Acetyl content	20 x 20 25	Thickness of layer	Fluorescent indicator
POLYGRAM® polyester sheets				
CEL 300 AC-10%	10%	**801033**	0.10 mm	–

Polyamide-6 — ε-aminopolycaprolactame layers for TLC

- Polyamide 6 = Nylon 6 = perlon = ε-aminopolycaprolactame

  Separation mechanism based on hydrogen bonds to amide groups of the polymer matrix as well as on ionic, dipole and electron donor-acceptor interactions
- **Recommended application:**
  Natural compounds, phenols, carboxylic acids, aromatic nitro compounds and especially amino acids

Ordering information

Plate size [cm] Pack of [plates]	5 x 20 50	20 x 20 25	Thickness of layer	Fluorescent indicator
POLYGRAM® polyester sheets				
POLYAMIDE-6	**803012**	**803013**	0.10 mm	–
POLYAMIDE-6 UV_{254}	**803022**	**803023**	0.10 mm	UV_{254}

CHIRALPLATE — special layer for TLC enantiomer separation

- Reversed phase nano silica impregnated with Cu^{2+} ions and a chiral selector (a proline derivative, DP 31 43 726 and EP 0 143 147)

  Separation based on ligand exchange, i.e. formation of ternary mixed-ligand complexes with the Cu(II) ions; differences in the stability of the diastereomeric complexes cause chromatographic separation
- **Recommended application:** enantiomer separation of amino acids, *N*-methylamino acids, *N*-formylamino acids, α-alkylamino acids, thiazolidine derivatives, dipeptides, lactones, α-hydroxycarboxylic acids

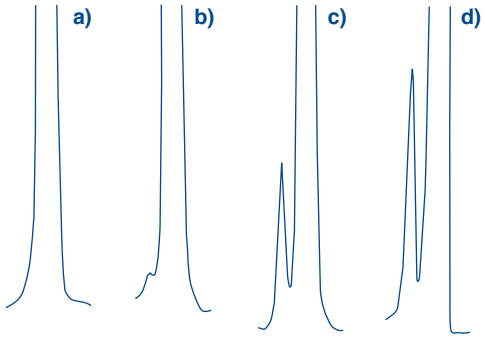
A review on the application of CHIRALPLATE has been given by K. Günther [J. Chromatogr. **448** (1988) 11–30].

Enantiomer separation of amino acids

Quantitative determination (remission location curves) of TLC-separated enantiomers of *tert.*-leucine:

Layer: CHIRALPLATE
Eluent: methanol – water (10:80, v/v)
Detection: dip in 0.3 % ninhydrin solution
quantification with scanner, 520 nm

a) L-*tert.*-leucine
b) L-*tert.*-leucine + 0.1 % D-*tert.*-leucine
c) L-*tert.*-leucine + 1 % D-*tert.*-leucine
d) external reference sample



Ordering information

Plate size [cm]	5 x 20	10 x 10	10 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Glass plates						
Pack of [plates]			4			
CHIRALPLATE			**811056**		0.25 mm	UV_{254}
Pack of [plates]	50	25	25	25		
CHIRALPLATE	**811057**	**811059**	**811055**	**811058**	0.25 mm	UV_{254}

SIL N-HR — unmodified standard silica layers

- **High purity silica 60,** specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 mL/g, particle size 5–17 µm
  Different binder system compared to SIL G results in different separation characteristics
- A special feature of the POLYGRAM® SIL N-HR is a **higher gypsum content.**

Ordering information

Plate size [cm]	5 x 20	20 x 20	Thickness of layer	Fluorescent indicator
Pack of [plates]	50	25		
POLYGRAM® polyester sheets				
SIL N-HR/UV_{254}	**804022**	**804023**	0.20 mm	UV_{254}

SIL G-25 HR — special layer for aflatoxin separation

- High purity silica 60 with gypsum and a very small quantity of a polymeric organic binder softer than the standard silica layer, i.e. spots can be scratched and the layer absorbs faster
- **Recommended application:** aflatoxins

Ordering information

Plate size [cm]	20 x 20	Thickness of layer	Fluorescent indicator
Pack of [plates]	25		
Glass plates			
SIL G-25 HR	**809033**	0.25 mm	–
SIL G-25 HR/UV_{254}	**809043**	0.25 mm	UV_{254}

Layers for special TLC separations

SIL G-25 Tenside

special layer for separation of surfactants

- Silica G impregnated with ammonium sulfate
  Recommended for the separation of detergents, alkanesulfonates, polyglycols etc.

Ordering information

	Plate size 20 x 20 cm, pack of 25 plates	Thickness of layer	Fluorescent indicator
Glass plates			
SIL G-25 Tenside	**810063**	0.25 mm	-

Nano-SIL PAH

special HPTLC silica layer for PAH analysis

- Base material: nano silica 60, specific surface (BET) ~ 500 m^2/g, mean pore size 60 Å, specific pore volume 0.75 mL/g, particle size 2–10 µm; impregnated with caffeine, an electron acceptor for PAH analysis based on charge-transfer complexes
  Recommended application: 6 PAHs according to German drinking water specifications (TVO) in accordance with German standard DIN 38407 part 7 (see application 402400 at ***www.mn-net.com/apps***)

Ordering information

	Plate size 10 x 20 cm, pack of 50 plates	Thickness of layer	Fluorescent indicator
Glass plates			
Nano-SIL PAH	**811051**	0.20 mm	-

IONEX

special mixed layers of silica with ion exchange resins

- **IONEX-25 SA-Na:** mixture of silica and a strongly acidic cation exchanger coated to polyester sheets
- **IONEX-25 SB-AC:** mixture of silica and a strongly basic anion exchanger coated to polyester sheets
  Both layers contain an inert organic binder
- **Recommended application:**
  Amino acids, e.g., in protein and peptide hydrolyzates, in seeds and fodder, in biological fluids; for racemate separation in peptide syntheses, for the separation of nucleic acid hydrolyzates, aminosugars, amino acids, antibiotics, inorganic phosphates, cations and other compounds with ionic groups

Ordering information

		Plate size [cm] Pack of	20 x 20 25	Thickness of layer	Fluorescent indicator
POLYGRAM® polyester sheets					
IONEX-25 SA-Na	strongly acidic cation exchanger		**806013**	0.20 mm	-
IONEX-25 SB-AC	strongly basic anion exchanger		**806023**	0.20 mm	-

Mixed layers for TLC

- **Alox/CEL-AC-Mix-25:** mixed layer of aluminium oxide G and acetylated cellulose
  recommended for separation of PAH (see application 401040 at ***www.mn-net.com/apps***)
- **SILCEL-Mix-25:** mixed layer of cellulose and silica
  recommended for separation of preservatives and other antimicrobial compounds (see application 401420 at ***www.mn-net.com/apps***)

Ordering information

Plate size [cm] Pack of [plates]	20 x 20 25	Thickness of layer	Fluorescent indicator
Glass plates			
Alox/CEL-AC-Mix-25	**810053**	0.25 mm	–
SILCEL-Mix-25 UV_{254}	**810043**	0.25 mm	UV_{254}

Chromatography papers

- Paper chromatography is the oldest chromatographic technique
  separation due to partition of the analytes between special paper grades and the mobile phase, which penetrates the paper by capillary action
  ascending, descending and circular techniques are possible.

- *Please note:* always treat chromatography papers with care:
  never touch them with fingers, because this will contaminate the surface
  do not bend them sharply, because this will decrease the capillary action (preferably store them flat)

  Chromatography papers possess a preferred direction of the fibers with higher absorption properties (with our sheets 58 x 60 cm, the longer edge). We recommend to use them in the direction of higher absorption.

Ordering information

Code	Weight [g/m²]	Thickness [mm]	Description	Flow rate	Size [cm]	Pack of	REF
MN 214	140	0.28	smooth	90–100 mm/30 min	58 x 60	100 sheets	**817001**
MN 218	180	0.36	smooth	90–100 mm/30 min	58 x 60	100 sheets	**817002**
MN 260	90	0.20	smooth	120–130 mm/30 min	58 x 60	100 sheets	**817003**
MN 261	90	0.18	smooth	90–100 mm/30 min	58 x 60	100 sheets	**817004**
MN 827	270	0.70	soft carton	130–140 mm/10 min	58 x 60	100 sheets	**817005**
MN 866	650	1.70	soft carton	100–120 mm/10 min	38 x 38	100 sheets	**817006**
MN 866	650	1.70	soft carton	100–120 mm/10 min	80 x 80	100 sheets	**817007**
MN 214 ff	140	0.28	MN 214 defatted *	90–100 mm/30 min	56 x 58	100 sheets	**817008**

* This paper is extracted with organic solvents

For further papers, filters and membranes, feel free to ask for our catalog "Filtration"

Introductory kits for TLC

TLC micro-sets — introductory kits for science education

- **Beginner's set**
  features separations with simple developing solvents; samples are colored thus eliminating the need for visualization. All equipment needed is contained in the set.
- **Advanced sets**
  require some experience and skill from the user: some of the samples have to be pretreated before separation, and for identification of substances spray reagents have to be used
- **TLC wine set**
  chromatographic rapid test for evaluating the conversion of malic acid to lactic acid in wine (2nd fermentation), i.e. the optimum time for bottling of a wine

TLC micro-set A for beginners

This kit contains all chemicals and accessories for the following separations:

- ✓ Separation of the fat-soluble (lipophilic) dye mixture 1: butter yellow, indophenol, sudan blue II, sudan red G
- ✓ Separation of a mixture of anthraquinone dyes (test dye mixture 2): blue 1, blue 3, green, green blue, red, violet 1, violet 2
- ✓ Separation of a mixture of food dyes (test dye mixture 3): brilliant black BN (E151), fast red E, erythrosine (E127), yellow orange S (sunset yellow CFC, E110), naphthol red S, ponceau 4 R (E124), tartrazine (E102)
- ✓ Separation of dyes from felt tip pens

Contents of TLC micro-set A for beginners

1	manual
3	developing chambers
50	glass capillaries 1 µL
1	spotting guide
2	felt tip pens
1	measuring cylinder 10 mL
50	polyester sheets 4 x 8 cm each of POLYGRAM® SIL G/UV$_{254}$, Alox N/UV$_{254}$ and CEL 300
8 mL	each of test dye mixture 1 (4 lipophilic dyes), test dyes sudan red G, and sudan blue II
8 mL	each of test dye mixture 2 (7 anthraquinone dyes), test dyes blue 1 and violet 2
8 mL	each of test dye mixture 3 (7 food dyes), test dyes yellow orange S, and brilliant black BN
100 mL	each of toluene, toluene – cyclohexane (2:1, v/v) ethanol, 2.5 % sodium citrate solution 25 % ammonia solution – 2-propanol (5:3, v/v)

TLC micro-set M

This kit is prerequisite for the separations with kits F1 to F3. In addition, it serves as basic equipment for the individual study of further thin layer chromatographic experiments.

Contents of TLC micro-set M (materials kit)

2 x 50 glass capillaries 1 µL
2 spotting guides
1 rubber cap for capillaries
1 measuring cylinder 10 mL
1 beaker 25 mL
2 developing chambers
1 glass laboratory sprayer with rubber bulb
1 plastic syringe 1 mL, 20 sheets filter paper MN 713 (15 x 21 cm)
50 polyester sheets 4 x 8 cm each of POLYGRAM® SIL G/UV$_{254}$, Alox N/UV$_{254}$ and CEL 300

Ordering information

Designation	Pack of	REF
TLC micro-set A for beginners	1 kit	**814000**
Replacement parts for TLC micro-set A		
Test dye mixture 1*, solution of 4 lipophilic dyes in toluene (components see above)	8 mL	**814001**
Test dye mixture 2*, solution of 7 anthraquinone dyes in toluene – cyclohexane (2:2, v/v) (components see above)	8 mL	**814002**
Test dye mixture 3, aqueous solution of 7 food dyes (components see above)	8 mL	**814003**
Collection of 4 individual components of test dye mixture 1*	4 x 8 mL	**814011**
Collection of 7 individual components of test dye mixture 2*	7 x 8 mL	**814012**
Collection of 7 individual components of test dye mixture 3	7 x 8 mL	**814013**
Sodium citrate, 2.5 g in 100 mL bottles to fill up with distilled water	2.5 g	**814029**
TLC micro-set M (materials kit)	1 kit	**814100**

* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see MSDS.

Introductory kits for TLC

TLC micro-set F1

This kit contains all chemicals required for the separation of

- ✓ amino acids (test mixture, consisting of alanine, arginine, tryptophan and valine)
- ✓ amino acids in urine
- ✓ the heavy metal cations copper(II) and manganese(II)

Contents of TLC micro-set F1
1 manual; 50 glass capillaries 1 µL
50 polyester sheets 4 x 8 cm each of POLYGRAM® SIL G/UV$_{254}$ and CEL 300
100 mL each of *n*-butanol, ninhydrin spray reagent (0.2 % in ethanol), acetone, 25 % ammonia solution, rubeanic acid spray reagent
50 mL each of 50 % acetic acid, 18 % hydrochloric acid
8 mL each of the amino acid test mixture (see left), tryptophan and arginine reference solutions
8 mL each of the heavy metal cation test mixture (see left), Mn^{2+}, and Cu^{2+} reference solutions

TLC micro-set F2

This kit contains all chemicals required

- ✓ for analysis of edible fats
- ✓ for analysis of fats and cholesterol in blood

Contents of TLC micro-set F2
1 manual; 50 glass capillaries 1 µL
50 polyester sheets 4 x 8 cm POLYGRAM® SIL G/UV$_{254}$
5 disposable pipettes 25 µL,
5 sample vials N 11 (1.5 mL) with PE caps and seals,
3 sample vials 30 mL (for butter, margarine and edible oil)
100 mL each of cyclohexane and molybdatophosphoric acid spray reagent
2 x 50 mL acetone with calibrated pipette, 25 mL butan-2-one
8 mL cholesterol reference solution

TLC micro-set F3

This kit contains all chemicals required

- ✓ for separation of analgetics (pain relievers)
- ✓ for drug analysis as shown for cinchona bark

Contents of TLC micro-set F3
1 manual, 50 glass capillaries 1 µL
50 polyester sheets 4 x 8 cm POLYGRAM® SIL G/UV$_{254}$
5 Aspirin® tablets, 5 Thomapyrin® tablets
20 folded filters MN 615 1/4, 11 cm diameter, 3 sample vials 8 mL (for Aspirin® sample, Thomapyrin® sample, cinchona bark extract), 5 g cinchona bark
100 mL each of ethanol, 2-propanol, toluene – diethyl ether (55:35, v/v), spray reagent for caffeine and spray reagent according to Dragendorff-Munier, 50 mL each of iron(III) chloride solution and potassium hexacyanoferrate(III) solution, 30 mL ethyl acetate, 25 mL each of 12.5 % ammonia solution and diethylamine
8 mL each of caffeine, paracetamol, quinine reference solutions

All experiments with TLC micro-sets F1 – F3 require the materials kit (see previous page).

Introductory kits for TLC

Ordering information

Designation	Pack of	REF
TLC micro-set F1*	1 kit	**814200**
Refill reagents for TLC micro-set F1		
Amino acid test mixtures (components see previous page)	8 mL	**814201**
Collection of 4 individual components of the amino acid test mixture	4 x 8 mL	**814202**
Cation test mixture (components see previous page)	8 mL	**814204**
Collection of 2 individual components of the cation test mixture (Cu^{2+}, Mn^{2+})	2 x 8 mL	**814205**
TLC micro-set F2*	1 kit	**814300**
Refill reagents for TLC micro-set F2		
Cholesterol reference solution*	8 mL	**814301**
TLC micro-set F3*	1 kit	**814400**
Refill reagents for TLC micro-set F3		
Quinine reference solution*	8 mL	**814405**
Paracetamol reference solution*	8 mL	**814406**
Caffeine reference solution*	8 mL	**814407**
Refill packs TLC sheets for all TLC micro-sets		
TLC polyester sheets POLYGRAM® SIL G/UV_{254}, 4 x 8 cm	4 x 50	**814025**
TLC polyester sheets POLYGRAM® Alox N/UV_{254}, 4 x 8 cm	4 x 50	**814026**
TLC polyester sheets POLYGRAM® CEL 300, 4 x 8 cm	4 x 50	**814027**
TLC polyester sheets POLYGRAM® 4 x 8 cm: 100 x SIL G/UV_{254}; 50 x Alox N/UV_{254}; 50 x CEL 300	1 set	**814028**

* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see MSDS.

TLC wine set

This kit contains all chemicals and equipment required for determination of malic, lactic, and tartaric acid in wine (evaluation of the conversion of malic to lactic acid, 2nd fermentation)

Contents of the TLC wine set
detailed instruction leaflet
50 polyester sheets 4 x 8 cm POLYGRAM® CEL 300
cation exchanger, eluent, reference substances
developing chamber, capillaries, spotting guide

Ordering information

Designation	Pack of	REF
TLC wine set		
*	1 set	**814500**

* This product contains harmful substances which must be specially labeled as hazardous. For detailed information please see MSDS.

Accessories for TLC

TLC accessories

Designation	Pack of	REF
Simultaneous developing chamber for TLC, 20 x 20 cm, for up to 5 plates	1	**814019**
Simultaneous developing chamber for TLC, 10 x 10 cm, for up to 2 plates	1	**814018**
Developing chambers for TLC micro-sets	4	**814021**
Glass laboratory sprayer with rubber bulb	1	**814101**
Glass capillaries 1 µL	3 x 50	**814022**
Rubber caps for capillaries	2	**814102**
Plastic syringe, 1 mL content with graduation	1	**814104**
Spotting guides	2	**814023**
Measuring cylinders, glass, 10 mL content	2	**814024**
MN ALUGRAM® scissors, ground blade, black handle	1	**818666**
Filter paper MN 713, 15 x 21 cm	100	**814103**
Folded filters MN 615 1/4, 11 cm diameter	100	**531011**
Chromatography paper MN 260, 7.5 x 17 cm (for chamber saturation)	100	**814030**

818666

814019

814018

Visualization reagents

- Small selection of frequently used spray reagents for postchromatographic detection reactions in TLC suited for spraying or dipping TLC plates
  A detailed description of many more detection procedures for TLC is available on request.

Ordering information

Spray reagent	Solvent	Detection of	Pack of	REF
Aniline phthalate	2-propanol – ethanol (1:1)	reducing sugars, oxohalic acids	100 mL	**814919**
Bromocresol green	2-propanol	organic acids	100 mL	**814920**
Reagent for caffeine	water – acetone	caffeine	100 mL	**814401**
2',7'-Dichlorofluorescein	2-propanol	lipids (saturated, unsaturated)	100 mL	**814921**
4-(Dimethylamino)-benzaldehyde	2-propanol	terpenes, sugars, steroids	100 mL	**814922**
according to Dragendorff-Munier	water	alkaloids and other nitrogen compounds	100 mL	**814402**
Iron(III) chloride	water	acetylsalicylic acid, paracetamol	100 mL	**814403**
Potassium hexacyanoferrate(III)	water		100 mL	**814404**
Molybdatophosphoric acid	ethanol	lipids, sterols, steroids, reducing compounds	100 mL	**814302**
Ninhydrin	ethanol	amino acids, amines and amino sugars	100 mL	**814203**
Rhodamin B	ethanol	lipids	100 mL	**814923**
Rubeanic acid	ethanol	heavy metal cations	100 mL	**814206**

These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see MSDS.

Silica

adsorbents for TLC

Pore size 60 Å, pore volume 0.75 mL/g, specific surface (BET) ~ 500 m^2/g, pH 7 for a 10% aqueous suspension

- **Silica G:** standard grade, particle size 2–20 µm, Fe < 0.02%, Cl < 0.02%, 13% gypsum as binder, supplied with or without fluorescence indicator UV_{254}
- **Silica N:** standard grade, particle size 2–20 µm, Fe < 0.02%, Cl < 0.02%, no binder, supplied with or without fluorescence indicator UV_{254}
- **Silica G-HR:** high purity grade, particle size 3–20 µm, Fe < 0.002%, Cl < 0.008%, gypsum as binder, supplied without fluorescence indicator
- **Silica P:** preparative grade, particle size 5–50 µm, Fe < 0.02%, Cl < 0.02%, organic binder, supplied with fluorescence indicator UV_{254}
- **Silica P with gypsum:** preparative grade, particle size 5–50 µm, Fe < 0.02%, Cl < 0.02%, gypsum as binder, supplied with fluorescence indicator UV_{254}

Ordering information

Designation	Fluorescent indicator	1 kg	5 kg
Silica G	–	**816310.1**	**816310.5**
Silica G/UV_{254}	UV_{254}	**816320.1**	**816320.5**
Silica N	–	**816330.1**	**816330.5**
Silica N/UV_{254}	UV_{254}	**816340.1**	**816340.5**
Silica G-HR	–	**816410.1**	**816410.5**
Silica P/UV_{254}	UV_{254}	**816380.1**	**816380.5**
Silica P/UV_{254} with gypsum	UV_{254}	**816400.1**	**816400.5**

Polyamide

adsorbents for TLC

- Polyamide 6 = nylon 6 = perlon = ε-aminopolycaprolactame

Ordering information

Designation	Fluorescent indicator	1 kg
Polyamide TLC 6	–	**816610.1**
Polyamide TLC 6 UV_{254}	UV_{254}	**816620.1**

Cellulose MN 301

native fibrous cellulose

- Native fibrous cellulose, standard grade; fiber length (95%) 2–20 µm, average degree of polymerization 400–500, specific surface acc. to Blaine 15000 cm^2/g
  ≤ 20 ppm Fe, 6 ppm Cu, 7 ppm P, CH_2Cl_2 extract ≤ 0.25%, residue on ignition at 850 °C ≤ 1500 ppm

Ordering information

Designation	Fluorescent indicator	1 kg	5 kg
Cellulose MN 301	–	**816250.1**	**816250.5**

Fluorescent indicators

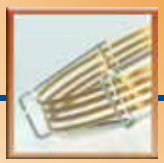
- UV indicators with efficient radiation for short-wave as well as long-wave UV ranges

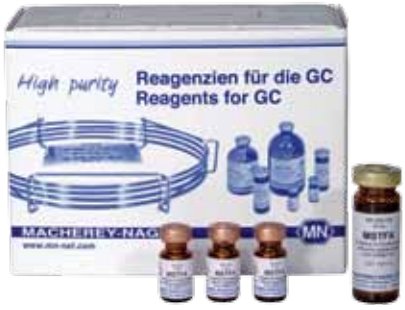
  UV_{254}: manganese activated zinc silicate with absorption maximum at 254 nm; green fluorescence; relatively susceptible towards acids; thus its fluorescence can be completely quenched by acidic solvents

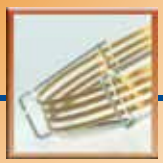
  UV_{366}: inorganic fluorescent pigment with absorption maximum at 366 nm; blue fluorescence

Ordering information

	Composition	Absorption maximum	Color of fluorescence	Pack of 100 g
Fluorescent indicator UV_{254}	manganese-activated zinc silicate	254 nm	green	**816710.01**
Fluorescent indicator UV_{366}	inorganic fluorescent pigment	366 nm	blue	**816720.01**

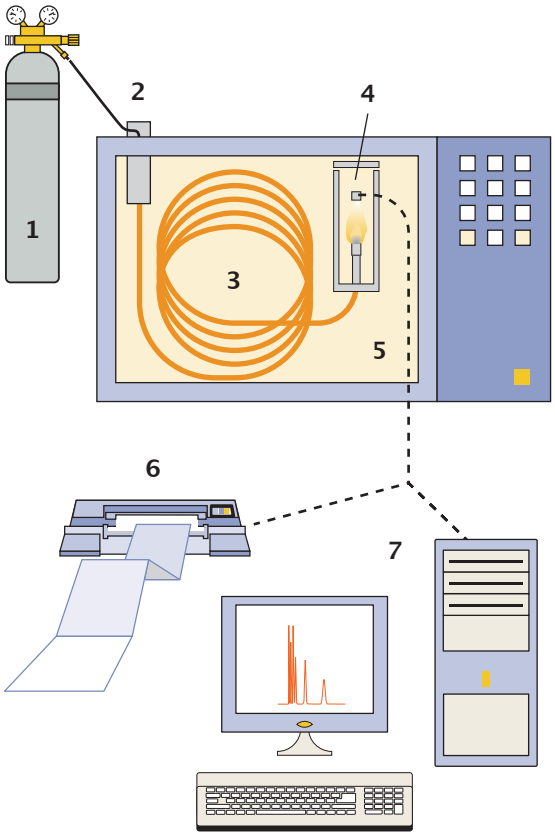






Basic principles of capillary GC

The GC system



1–5 Configuration of a gas chromatograph:

1. **Gas supply:** carrier gas and – if necessary – detector gases
2. **Sample injector:**
   During *direct injection*, the sample is applied to the column without touching any other parts made from glass or metal (on-column injection).
   During *indirect injection*, the sample is brought into an evaporator and is then transferred onto the column either completely, or partially (split technique).
   Both techniques allow working at low temperatures, high temperatures and the use of temperature programming.
3. **Capillary column:** the heart of the GC system
4. **Detector:** indicates a substance by generating an electrical signal (response). Some detectors are specific for certain classes of substances or for certain elements (e.g., PND).
5. Temperature-controlled oven

6 and/or 7 serve for evaluation of the separation

6. **Recorder** for analogue plotting of chromatograms
7. **Data station** for a digital evaluation of chromatograms

The separation process

Chromatographic separation is achieved through continuous distribution of each sample component between the mobile and the stationary phase:

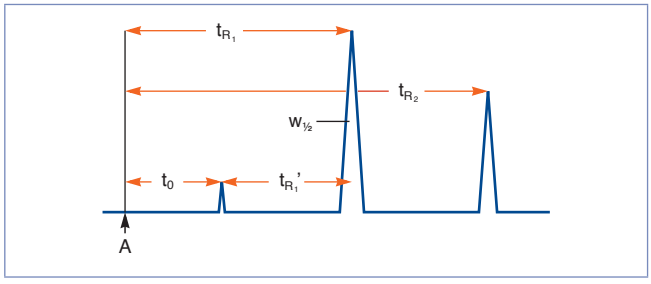
In GC, the **mobile phase** is always a gas, either He, N_2, Ar, or H_2.

The **stationary phase** is often a viscous, gum-like liquid adhered to the inner wall of a capillary column (WCOT = Wall Coated Open Tubular).

Transport of the components occurs exclusively in the mobile phase, while separation only takes place in the stationary phase. The quality of a separation (resolution) depends on the residence time of the components within the stationary phase and on the rate of interactions. The type of interaction between component and phase (selectivity) is determined by the functional groups of the stationary phase. The polarity of the phase is a function of its substituents.

The chromatogram

A chromatogram consists of a base line and a number of peaks. The area of a peak allows quantitative determinations:



A: starting point of a chromatogram = time of injection of a dissolved solute

A component can be identified by its retention time (qualitative determination):

$$t_{R_i} = t_0 + t_{R_i}'$$

t_0: dead time = residence time of a solute in the mobile phase (time required by a component to migrate through the chromatographic system without any interaction with the stationary phase)

t_{R_i}: retention time = time interval between peak i and the point of injection

t_{R_i}': net retention time = difference between total retention time and dead time t_0. It indicates how long a substance stays in the stationary phase.

Other terms characterizing a separation:

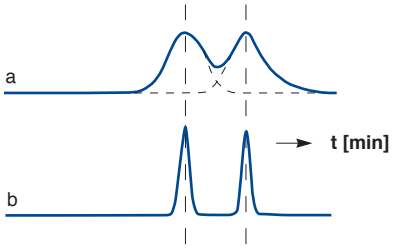
k': retention factor: a measure for the position of a sample peak in the chromatogram. The retention factor is specific for a given compound and constant under constant conditions.

$$k'_i = \frac{t_{R_i} - t_0}{t_0}$$

α: relative retention, also called separation factor or selectivity coefficient, is the ratio of two capacity factors. The reference substance is always in the denominator.

$$\alpha = \frac{k'_2}{k'_1}$$

The relative retention does not provide any information on the quality of a separation. For equal values of α two very broad peaks may overlap (as shown in a), or may be completely resolved (as in b), if they are accordingly narrow.



$w_{1/2}$: peak width at half height

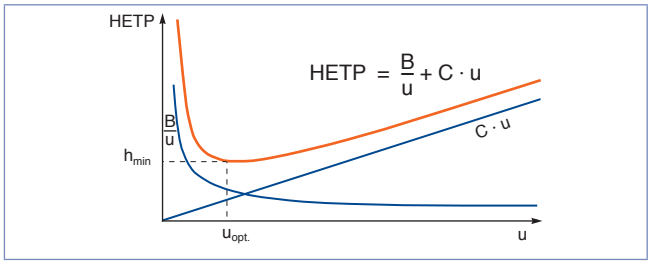
R: resolution: a measure for the quality of a separation, taking $w_{1/2}$ into account according to

$$R = \frac{t_{R_2} - t_{R_1}}{(w_{1/2})_2 + (w_{1/2})_1}$$

N_{th}: number of theoretical plates: characterizes the quality of a column (should be determined for k' > 5). The height equivalent to a theoretical plate (h, HETP) is calculated by dividing the length L of the column by the number of theoretical plates Nth. The smaller this value the more efficient the column.

$$N_{th} = 5.54 \cdot \left(\frac{t_{R_i}}{w_{1/2}}\right)^2 \qquad h = HETP = \frac{L}{N_{th}}$$

The Golay equation shows how the plate height h depends on the flow velocity u:



B molecular axial diffusion; B is a function of the diffusion coefficient of the component in the respective carrier gas

C resistance to mass transfer

In practice often higher velocities than $u_{opt.}$ are chosen, if separation efficiency is sufficient. Higher carrier velocities mean shorter retention times.

Parameters characterizing a capillary column

OPTIMA® 5,	1.0 µm film	30 m x	0.32 mm ID
A	B	C	D

A. Stationary phase

Different chemical structures of stationary phases are responsible for the type of interaction (selectivity) between the phase and the analytes. The stationary phase also limits the temperature range for chromatography. For a detailed summary of MN phases for GC please see the following chapter.

B. Film thickness

ranges from 0.1 to 5.0 µm. The standard film thickness is 0.25 µm. Thin films (0.1–0.2 µm) are very well suited for high-boiling, temperature-sensitive or almost contemporaneously eluting substances. Increasing the film thickness will increase the capacity, the retention for low-boiling substances and the inertness of the column. This is especially helpful for samples with a broad range of concentrations, or the separation of volatile polar substances.

A better coverage of the column wall by a thicker film and a reduced column surface due to a shorter columns have a positive impact on the separation of very active substrates, that may cause noticeable tailing when they come in contact with non-coated spots of the column wall.

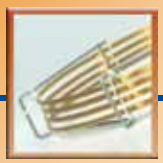
Thick films, however, always mean more stationary phase in the column, hence increased column bleeding. Therefore, maximum operating temperatures for thick-film columns are reduced. In addition, thick-film columns may have a lesser separating capacity.

C. Column length

The separating efficiency (better the number of plates N) of a column is directly proportional to its length. Most routine separations are carried out on 25 or 30 m columns, while more complex samples may require 50 or 60 m. 10 m columns are common for Fast GC (see page 267).

D. Inner diameter (ID)

The lower the ID, the higher is the theoretically possible number of plates per meter;
0.1–0.2 mm ID: for high resolution and short retention times at low carrier gas flow
0.25 mm ID: for analyses of complex mixtures
0.32 mm ID: for routine analyses with short retention times, but increased capacity
0.53 mm ID: for rapid separations with inert surface and highest capacity



Summary of MN phases for GC

MN offers more than 40 different phases for gas chromatography, from very nonpolar to polar columns.

Nonpolar stationary phases (e.g., 100% dimethylpolysiloxane phases) separate by volatility (i.e. boiling point) only. Typical analytes are linear hydrocarbons (*n*-alkanes).

Polar phases offer additional interactions that may improve a separation. When the polarity is increased, e.g., by introducing phenyl and / or cyanopropyl groups, differences in dipole moment and charge transfer effects, e.g., in 5–50% diphenylpolysiloxane phases, gain more and more influence on the separation. Typical analytes are hydrocarbons containing oxygen, sulfur, nitrogen, phosphorus or halogens, as well as unsaturated, polarizable molecules and aromatics.

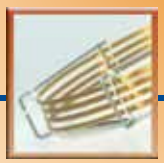
For the separation of components with various abilities to form strong hydrogen bonds, polyethylene glycol phases (WAX) are the best choice. Typical analytes are alcohols and carboxylic acids.

The selectivity of a column has to be optimized for either the critical pair of components, or the main constituent. Always select the least polar column your separation works on. About 70% of all separations can be accomplished on non- to midpolar columns. These columns generally show a high temperature stability.

For GC columns for special separations, please go to page 266.

Phase	Composition	Max. temperature [1]	USP	Similar phases [2]	Page
OPTIMA® 1	100% dimethylpolysiloxane	340 / 360 °C	G1 G2 G38	PERMABOND® SE-30 (page 264), OV-1, DB-1, SE-30, HP-1, SPB™-1, CP-Sil 5 CB, Rtx®-1, 007-1, BP1, MDN-1, AT™-1, ZB-1, OV-101	242
OPTIMA® 1 MS	100% dimethylpolysiloxane	340 / 360 °C	G1 G2 G38	Ultra-1, DB-1MS, HP-1MS, Rxi®-1MS, Rtx®-1MS, Equity™-1, AT™-1MS, VF-1MS, CP-Sil 5 CB MS	243
OPTIMA® 1 MS Accent					244
OPTIMA® 5	5% phenyl – 95% methylpolysiloxane	340 / 360 °C	G27 G36	PERMABOND® SE-52 (page 264), SE-54, SE-52, HP-5, SPB™-5, CP-Sil 8, Rtx®-5, 007-5, BP5, MDN-5, AT™-5, ZB-5	245
OPTIMA® 5 MS	5% diphenyl – 95% dimethylpolysiloxane	340 / 360 °C	G27 G36	DB-5, DB-5MS, HP-5MS, Ultra-2, Equity™-5, CP-Sil 8CB low bleed/MS, Rxi®-5MS, Rtx®-5SIL-MS, Rtx®-5MS, 007-5MS, BPX™5, MDN-5S, AT™-5MS, VF-5MS	246
OPTIMA® 5 MS Accent	silarylene phase with selectivity similar to 5% diphenyl – 95% dimethylpolysiloxane	340 / 360 °C	G27 G36		247
OPTIMA® XLB	silarylene phase, optimized silarylene content for low bleeding	340 / 360 °C	–	DB-XLB, Rxi®-XLB, Rtx®-XLB, MDN-12, VF-XMS	248
OPTIMA® δ-3	phase with autoselectivity [3]	340 / 360 °C	G49	no similar phases	249
OPTIMA® δ-6	phase with autoselectivity [3]	340 / 360 °C	–	no similar phases	250
OPTIMA® 1301	6% cyanopropylphenyl – 94% dimethylpolysiloxane	300 / 320 °C	G43	HP-1301, DB-1301, SPB™-1301, Rtx®-1301, CP-1301, 007-1301	251
OPTIMA® 624	6% cyanopropylphenyl – 94% dimethylpolysiloxane	280 / 300 °C	G43	HP-624, HP-VOC, DB-624, DB-VRX, SPB™-624, CP-624, Rtx®-624, Rtx®-Volatiles, 007-624, BP624, VOCOL	252
OPTIMA® 624 *LB*	as above, low bleed phase	280 / 300 °C	G43		
OPTIMA® 1701	14% cyanopropylphenyl – 86% dimethylpolysiloxane	300 / 320 °C	G46	OV-1701, DB-1701, CP-Sil 19 CB, HP-1701, Rtx®-1701, SPB™-1701, 007-1701, BP10, ZB-1701	253

Summary of MN phases for GC



Phase	Composition	Max. temperature [1]	USP	Similar phases [2]	Page
OPTIMA® 35 MS	silarylene phase with selectivity similar to 35% diphenyl – 65% dimethylpolysiloxane	360 / 370 °C	G28 G32 G42	DB-35 MS, HP-35, SPB™-35, Rxi®-35SIL MS, Rtx-35, 007-35, BPX™-35, MDN-35, AT™-35 MS, ZB-35, OV-11, VF-35 MS	254
OPTIMA® 17	phenylmethylpolysiloxane, 50% phenyl	320 / 340 °C	G3	OV-17, DB-17, HP-50+, HP-17, SPB™-50, SP-2250, Rxi®-17, Rtx®-50, CP-Sil 24 CB, 007-17, ZB-50	255
OPTIMA® 17 MS	silarylene phase with selectivity similar to 50% phenyl – 50% methylpolysiloxane	340 / 360 °C	G3	OV-17, AT™-50, BPX™-50, DB-17, DB-18ms, HP-50+, HP-17, SPB™-50, SPB™-17, SP-2250, Rtx®-50, CP-Sil 24 CB, 007-17, VF-17ms, ZB-50	256
OPTIMA® 210	trifluoropropylmethylpolysiloxane (50% trifluoropropyl)	260 / 280 °C	G6	OV-210, DB-210, Rtx®-200, 007-210	257
OPTIMA® 225	50% cyanopropylmethyl – 50% phenylmethylpolysiloxane	260 / 280 °C	G7 G19	DB-225, HP-225, OV-225, Rtx®-225, CP-Sil 43, 007-225, BP225	258
OPTIMA® 240	33% cyanopropylmethyl – 67% dimethylpolysiloxan	260 / 280 °C	–	no similar phases	259
OPTIMA® WAX	polyethylene glycol 20 000 Da	240 / 250 °C	G16	PERMABOND® CW 20 M (page 265), DB-Wax, Supelcowax, HP-Wax, HP-INNOWAX, Rtx-Wax, CP-Wax 52 CB, Stabilwax, 007-CW, BP20, AT-Wax, ZB-Wax	260
OPTIMA WAXplus®	polyethylene glycol with optimized cross-linking	260 / 270 °C	G16	DB-Wax, Supelcowax, HP-Wax, HP-INNOWAX, Rtx-Wax, CP-Wax 52 CB, Stabilwax, 007-CW, BP20, AT-Wax, ZB-Wax	261
OPTIMA® FFAP	polyethylene glycol 2-nitroterephthalate	240 / 250 °C	G35 G25	PERMABOND® FFAP (page 265), DB-FFAP, HP-FFAP, CP-Wax 58 FFAP CB, 007-FFAP, CP-FFAP CB, Nukol™	262
OPTIMA® FFAPplus	polyethylene glycol 2-nitroterephthalate with optimized cross-linking	250 / 260 °C	G35 G25	DB-FFAP, HP-FFAP, CP-Wax 58 FFAP CB, 007-FFAP, CP-FFAP CB, Nukol™	263

[1] First temperature for isothermal operation, second value for short isotherms in a temperature program
Please note that for columns with 0.53 mm ID and for columns with thicker films temperature limits are generally lower. For details refer to the description of individual phases.

[2] Phases which provide a similar selectivity based on chemical and physical properties

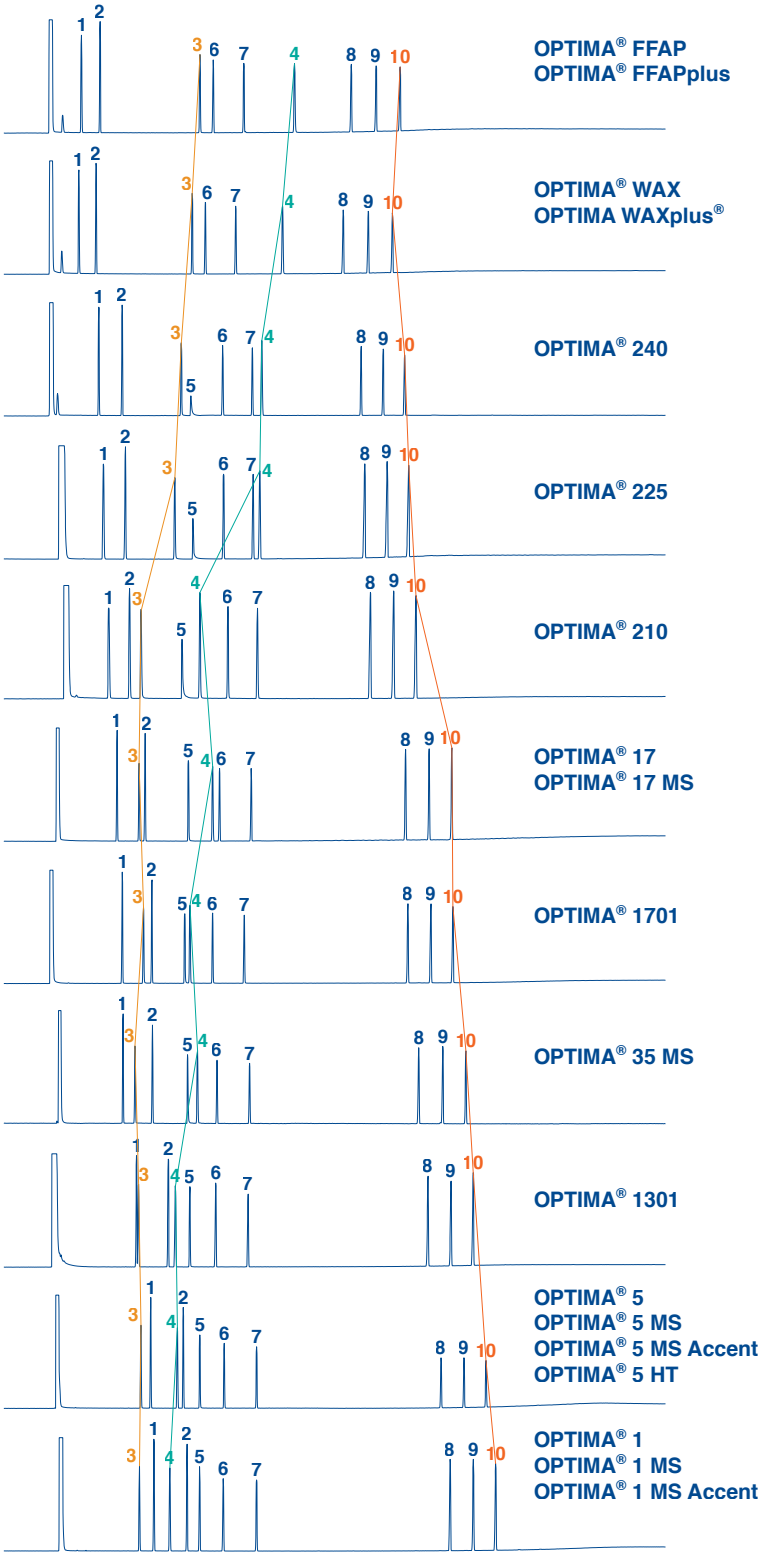
[3] See description on page 241

Each column is individually tested and supplied with test certificate and test chromatogram, but without fittings or ferrules. Columns have fused ends or are sealed with septa, to protect them from atmospheric oxygen. A standard test mixture is included with every column.

On request, all columns can be supplied on a **5 inch (13 cm) cage** for the Agilent GC 6850. To order, please add an E at the end of the REF number (e.g., 726470.30E)

To prolong column life, even at highly contaminated or matrix-containing samples, MN offers the option to add an **integrated guard column**. All capillary columns are available with a 10 m guard column with respective deactivation. To order, please add V1 at the end of the REF number. Guard column combinations with other lengths, IDs or different deactivation are available on request.

Separation properties of OPTIMA® phases

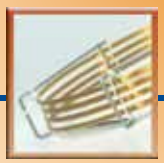


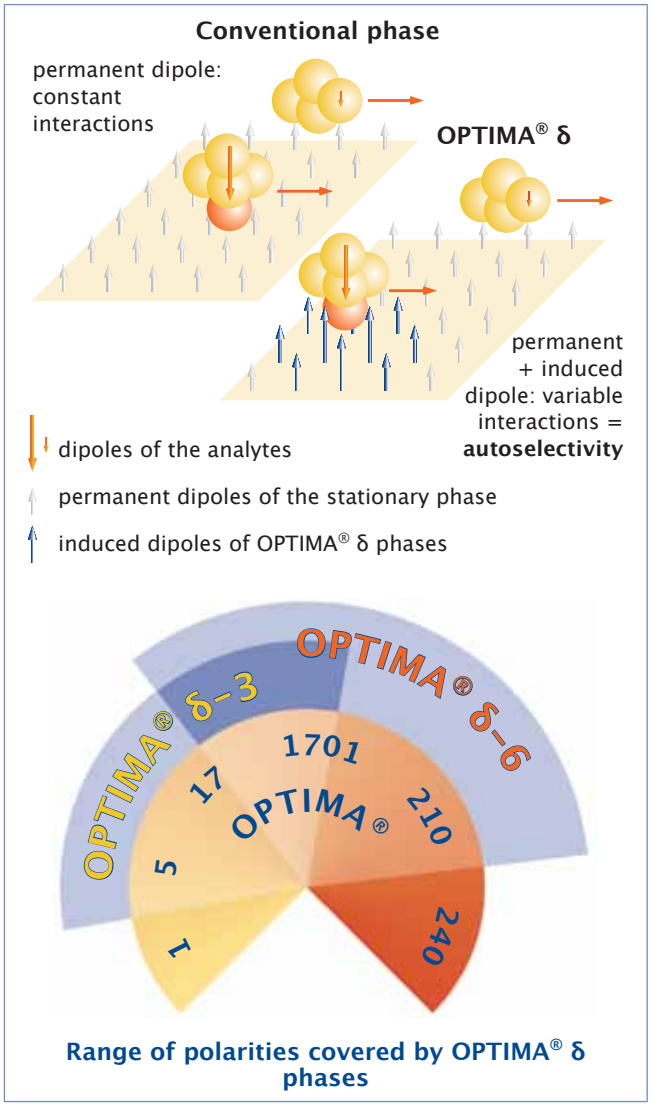
All columns:	0.25 µm film, 30 m x 0.25 mm ID
Sample:	MN OPTIMA® test mixture (REF 722316)
Injection:	1.0 µL, split 15 mL/min
Carrier gas:	0.80 bar He
Temperature:	80 °C → Tmax (isothermal), 8 °C/min (20 min Tmax)
Detector:	FID 260–280 °C

Peaks:

1. Undecane
2. Dodecane
3. Octanol
4. Dimethylaniline
5. Decylamine
6. Methyl decanoate
7. Methyl undecanoate
8. Henicosane
9. Docosane
10. Tricosane

OPTIMA® δ · unique phases with autoselectivity





Range of polarities covered by OPTIMA® δ phases

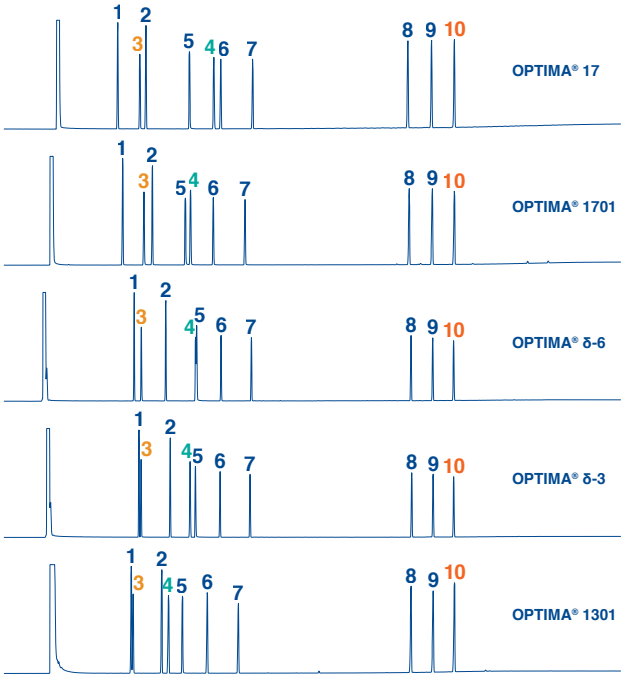
All stationary GC phases can be classified by their polarities. While the selectivity of common GC phases is generally determined by permanent dipole-dipole interactions, OPTIMA® δ-3 and OPTIMA® δ-6 show an additional feature. Large, polarizable groups in the polymer chain of the stationary phase enable the analyte to induce a further dipole moment that increases with the polarity of said analyte. We call this phenomenon "Autoselectivity", because the column adjusts itself to the polarity of the analyte. The implemented polymers consist of cross-linked polysiloxanes with a defined composition and an extremely narrow distribution of molecular weight.

OPTIMA® δ phases cover broad ranges of polarities. Compared with conventional phases, OPTIMA® δ-3 polarity ranges from approximately the nonpolar OPTIMA® 5 to the midpolar OPTIMA® 1701, while for OPTIMA® δ-6 the polarity covers a range from about the midpolar OPTIMA® 17 to the polar OPTIMA® 210.

OPTIMA® δ phases show high temperature limits (340 / 360 °C), as well as low bleed levels, which makes them ideal for the use with mass selective (MSD) or phosphorus/nitrogen detectors (PND) in the field of environmental trace analysis.

Isomeric phenols, such as chloro- and nitrophenols, are difficult to analyze with standard GC phases (e.g., OPTIMA® 5 or OPTIMA® 17) because of co-elutions. The autoselective OPTIMA® δ-3 is able to separate all 22 phenols due to stronger interactions occurring with more polar molecules, because polar analytes induce a dipole moment in the phase of the OPTIMA® δ-3 (see chromatogram page 249).

Separation characteristics of OPTIMA® δ phases

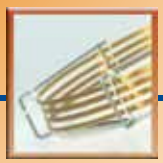


For conditions and peaks see opposite page

Key features of OPTIMA® δ phases:

- Wide range of application due to autoselectivity
- Outstanding thermal stability similar to nonpolar phases
- Low bleed levels
- Medium polar without CN groups

For ordering information of OPTIMA® δ phases see pages 249-250.

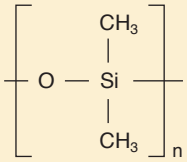


OPTIMA® high performance capillary columns

OPTIMA® 1

100 % dimethylpolysiloxane

- Nonpolar phase



Similar phases: PERMABOND® SE-30 (page 264), OV-1, DB-1, SE-30, HP-1, SPB-1, CP-Sil 5 CB, Rtx-1, 007-1, BP1, MDN-1, AT-1, ZB-1, OV-101

- **USP G1 / G2 / G38**

Columns with 0.1–0.32 mm ID and films < 3 µm: max. temperature for isothermal operation 340 °C, max. temperature for short isotherms in a temperature program 360 °C
0.53 mm ID columns with films < 3 µm: max. temperatures 320 and 340 °C, resp.
Thick film columns with films ≥ 3 µm: max. temperatures 300 and 320 °C, resp.

- Separation of components according to boiling points

Thick film columns ≥ 3 µm film are especially recommended for solvent analysis.

Ordering information

Length →	10 m	12 m	15 m	20 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)								
0.10 µm film	**726024.10**			**726024.20**				
0.40 µm film				**726025.20**				
0.2 mm ID (0.4 mm OD)								
0.10 µm film					**726832.25**			
0.20 µm film		**726834.12**			**726834.25**		**726834.50**	
0.35 µm film		**726837.12**			**726837.25**		**726837.50**	
0.50 µm film							**726839.50**	
0.25 mm ID (0.4 mm OD)								
0.10 µm film	**726038.10**		**726038.15**		**726038.25**	**726038.30**		**726038.60**
0.25 µm film	**726050.10**		**726050.15**		**726050.25**	**726050.30**	**726050.50**	**726050.60**
0.50 µm film	**726081.10**				**726081.25**	**726081.30**	**726081.50**	**726081.60**
1.00 µm film					**726802.25**	**726802.30**	**726802.50**	**726802.60**
0.32 mm ID (0.5 mm OD)								
0.10 µm film	**726301.10**				**726301.25**	**726301.30**	**726301.50**	**726301.60**
0.25 µm film	**726302.10**		**726302.15**		**726302.25**	**726302.30**	**726302.50**	**726302.60**
0.35 µm film					**726821.25**	**726821.30**	**726821.50**	**726821.60**
0.50 µm film	**726304.10**				**726304.25**	**726304.30**	**726304.50**	**726304.60**
1.00 µm film	**726323.10**		**726323.15**		**726323.25**	**726323.30**	**726323.50**	**726323.60**
3.00 µm film					**726805.25**	**726805.30**	**726805.50**	**726805.60**
5.00 µm film	**726931.10**				**726931.25**	**726931.30**	**726931.50**	
0.53 mm ID (0.8 mm OD)								
0.50 µm film			**726519.15**		**726519.25**	**726519.30**		
1.00 µm film	**726529.10**		**726529.15**		**726529.25**	**726529.30**		
2.00 µm film	**726521.10**				**726521.25**	**726521.30**	**726521.50**	
5.00 µm film	**726926.10**				**726926.25**	**726926.30**	**726926.50**	

In addition to this standard program we will be happy to supply columns custom-made to your specifications.

Each column is individually tested and supplied with test certificate and test chromatogram, but without fittings or ferrules. Columns have fused ends or are sealed with septa, to protect them from atmospheric oxygen. A standard test mixture is included with every column.

On request, all columns can be supplied on a **5 inch (13 cm) cage** for the Agilent GC 6850. To order, please add an E at the end of the REF number (e.g., 726470.30E)

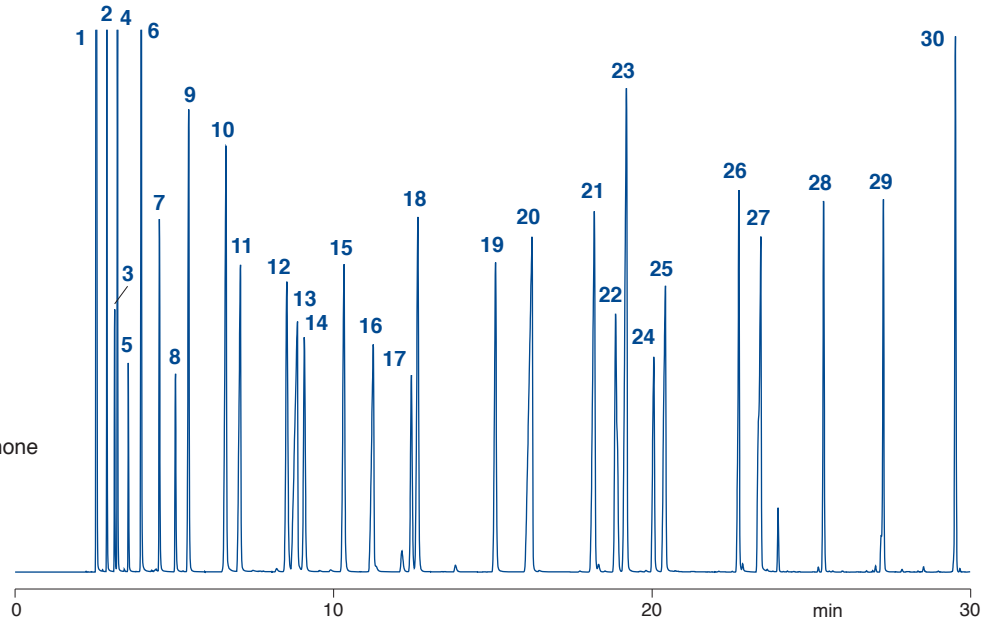
To prolong column life, even at highly contaminated or matrix-containing samples, MN offers the option to add an **integrated guard column**. All capillary columns are available with a 10 m guard column with respective deactivation. To order, please add V1 at the end of the REF number. Guard column combinations with other lengths, IDs or different deactivation are available on request.

Solvent analysis

Column: OPTIMA® 1, 1.0 µm film, 60 m x 0.32 mm ID
Sample: solvent mixture, courtesy of J. Lutz, Alcan Rorschach, Switzerland
Injection: 0.4 µL, split 1:60
Carrier gas: H_2, 120 kPa
Temperature: 50 °C (9 min) → 90 °C, 4 °C/min → 280 °C (2 min), 14 °C/min
Detector: FID 300 °C

Peaks:

1. Methanol
2. Ethanol
3. Acetone
4. 2-Propanol
5. Methyl acetate
6. *n*-Propanol
7. Methyl ethyl ketone
8. Ethyl acetate
9. Isobutanol
10. *n*-Butanol
11. 1-Methoxy-2-propanol
12. Isooctane
13. Ethyl glycol
14. Isoheptane
15. Methyl isobutyl ketone
16. 1-Ethoxy-2-propanol
17. Toluene
18. Isobutyl acetate
19. Butyl acetate
20. 4-Hydroxy-4-methyl-2-pentanone
21. 1-Methoxy-2-propyl acetate
22. Xylene
23. Cyclohexanone
24. Ethyl glycol acetate
25. Butyl glycol
26. Heptanol
27. Ethyl diglycol
28. Butyl diglycol
29. Butyl glycol acetate
30. Butyl diglycol acetate

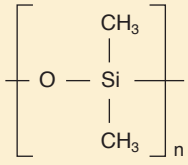


MN Appl. No. 201390

OPTIMA® 1 MS

100 % dimethylpolysiloxane

- Selectivity identical to OPTIMA® 1



Similar phases: Ultra-1, DB-1MS, HP-1MS, Rxi-1MS, Rtx-1MS, Equity-1, AT-1MS, VF-1MS, CP-Sil 5 CB MS

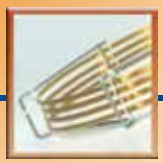
- Max. temperature for isothermal operation 340 °C, max. temperature for short isotherms in a temperature program 360 °C
- Phase with low bleeding

  Suited for GC/MS and ECD applications and general analyses at trace level
- **USP G1 / G2 / G38**

Ordering information

Length →	12 m	15 m	25 m	30 m	50 m	60 m
0.2 mm ID (0.4 mm OD)						
0.20 µm film			**726201.25**		**726201.50**	
0.35 µm film	**726203.12**					
0.25 mm ID (0.4 mm OD)						
0.25 µm film		**726205.15**		**726205.30**		**726205.60**
0.32 mm ID (0.5 mm OD)						
0.25 µm film				**726202.30**		**726202.60**

In addition to this standard program we will be happy to supply columns custom-made to your specifications.

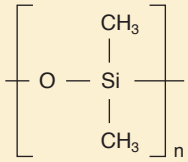


OPTIMA® high performance capillary columns

OPTIMA® 1 MS Accent

100 % dimethylpolysiloxane

- Selectivity identical to OPTIMA® 1



Increased sensitivity due to an unmatched low background level

- **USP G1 / G2 / G38**

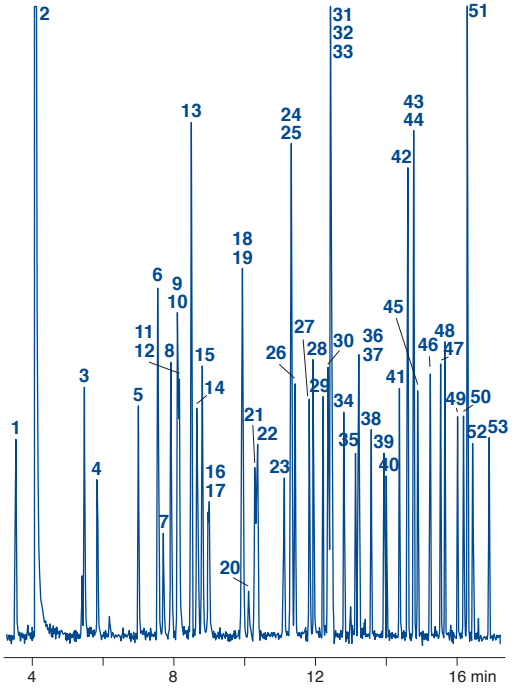
- Max. temperature for isothermal operation 340 °C, max. temperature for short isotherms in a temperature program 360 °C
- Lowest column bleed, nonpolar phase, ideal for ion trap and quadrupole MS detectors
  perfect inertness for basic compounds
  solvent rinsing for removal of impurities applicable
- Recommended application: all-round phase for environmental analyses, trace analyses, EPA methods, pesticides, PCB, food and drug analyses
- Similar phases: Ultra-1, DB-1 MS, HP-1 MS, Rxi-1 MS, Rtx-1 MS, Equity-1, AT-1 MS, VF-1 MS, CP-Sil 5 CB MS

EPA 8140 / 8141 / 8141 A Organophosphorus pesticides

Column:	OPTIMA® 1 MS Accent, 0.50 µm film, 30 m x 0.32 mm ID
Sample:	0.2 µg/mL in hexane, 8140/8141 OP pesticides calibration mix A and 8141 OP pesticides calibration mix B; IS triphenyl phosphate and tributyl phosphate
Injection:	250 °C, splitless (hold 1 min)
Carrier gas:	He, 1 mL/min, constant pressure
Temperature:	100 °C → 180 °C, 10 °C/min (2 min) → 300 °C, 18 °C/min (3 min)
Detector:	FPD (Flame Photometric Detector), 280 °C

Peaks:
1. Dichlorvos, 2. Hexamethylphosphoramide, 3. Mevinphos, 4. Trichlorfon, 5. TEPP, 6. Thionazin, 7. Demeton-O, 8. Ethoprop 9. Tributyl phosphate (IS), 10. Dicrotophos, 11. Monocrotophos, 12. Naled, 13. Sulfotepp, 14. Phorate, 15. Dimethoate, 16. Demeton-S, 17. Dioxathion, 18. Terbufos, 19. Fonophos, 20. Phosphamidon isomer, 21. Diazinon, 22. Disulfoton, 23. Phosphamidon, 24. Dichlorofenthion, 25. Parathion-methyl, 26. Chlorpyrifos methyl, 27. Ronnel, 28. Fenitrothion, 29. Malathion, 30. Fenthion, 31. Aspon, 32. Parathion-ethyl, 33. Chlorpyrifos, 34. Trichloronate, 35. Chlorfenvinphos, 36. Merphos, 37. Crotoxyphos, 38. Stirofos, 39. Tokuthion, 40. Merphos oxidation product, 41. Fensulfothion, 42. Famphur, 43. Ethion, 44. Bolstar, 45. Carbophenothion, 46. Triphenyl phosphate (IS), 47. Phosmet, 48. EPN, 49. Azinphos-methyl, 50. Leptophos, 51. Tri-*o*-cresyl phosphate, 52. Azinphos-ethyl, 53. Coumaphos

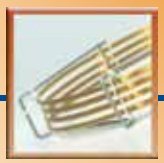
MN Appl. No. 213030



Ordering information

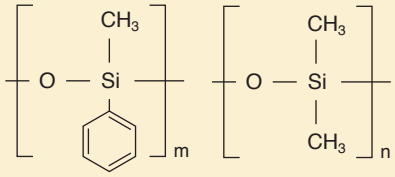
Length →	15 m	25 m	30 m	50 m	60 m
0.2 mm ID (0.4 mm OD)					
0.20 µm film		**725801.25**		**725801.50**	
0.25 mm ID (0.4 mm OD)					
0.25 µm film	**725805.15**		**725805.30**		**725805.60**
0.50 µm film			**725806.30**		**725806.60**
0.32 mm ID (0.5 mm OD)					
0.25 µm film			**725802.30**		**725802.60**
0.50 µm film			**725807.30**		**725807.60**

Each column is individually tested and supplied with test certificate and test chromatogram, but without fittings or ferrules. Columns have fused ends or are sealed with septa, to protect them from atmospheric oxygen. A standard test mixture is included with every column.



OPTIMA® 5

- Nonpolar phase



Similar phases: PERMABOND® SE-52 (page 264), SE-54, SE-52, DB-5, HP-5, SPB-5, CP-Sil 8, Rtx-5, 007-5, BP5, MDN-5, AT-5, ZB-5

5 % phenyl – 95 % methylpolysiloxane

Columns with 0.1–0.32 mm ID and films < 3 µm:
max. temperature for isothermal operation 340 °C,
max. temperature for short isotherms in a temperature program 360 °C
0.53 mm ID columns with films < 3 µm:
max. temperatures 320 and 340 °C, resp.
Thick film columns with films ≥ 3 µm:
max. temperatures 300 and 320 °C, resp.

- Standard phase with large range of application
- **USP G27 / G36**

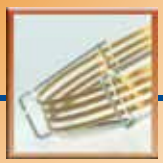
Ordering information

Length →	10 m	15 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)						
0.10 µm film	**726846.10**					
0.20 mm ID (0.4 mm OD)						
0.10 µm film			**726854.25**			
0.20 µm film			**726857.25**		**726857.50**	
0.35 µm film			**726860.25**		**726860.50**	
0.50 µm film			**726863.25**		**726863.50**	
0.25 mm ID (0.4 mm OD)						
0.10 µm film			**726911.25**	**726911.30**	**726911.50**	**726911.60**
0.25 µm film	**726056.10**	**726056.15**	**726056.25**	**726056.30**	**726056.50**	**726056.60**
0.35 µm film			**726623.25**	**726623.30**	**726623.50**	**726623.60**
0.50 µm film			**726099.25**	**726099.30**	**726099.50**	**726099.60**
1.00 µm film			**726807.25**	**726807.30**	**726807.50**	**726807.60**
0.32 mm ID (0.5 mm OD)						
0.10 µm film	**726313.10**	**726313.15**	**726313.25**	**726313.30**	**726313.50**	**726313.60**
0.25 µm film		**726314.15**	**726314.25**	**726314.30**	**726314.50**	**726314.60**
0.35 µm film			**726628.25**	**726628.30**	**726628.50**	**726628.60**
0.50 µm film			**726316.25**	**726316.30**	**726316.50**	**726316.60**
1.00 µm film		**726325.15**	**726325.25**	**726325.30**	**726325.50**	**726325.60**
3.00 µm film			**726809.25**	**726809.30**	**726809.50**	**726809.60**
5.00 µm film		**726934.15**	**726934.25**	**726934.30**	**726934.50**	
0.53 mm ID (0.8 mm OD)						
0.50 µm film	**726523.10**		**726523.25**	**726523.30**		
1.00 µm film	**726541.10**	**726541.15**	**726541.25**	**726541.30**		
2.00 µm film	**726525.10**		**726525.25**	**726525.30**	**726525.50**	**726525.60**
5.00 µm film	**726916.10**		**726916.25**	**726916.30**	**726916.50**	

In addition to this standard program we will be happy to supply columns custom-made to your specifications.

On request, all columns can be supplied on a **5 inch (13 cm) cage** for the Agilent GC 6850. To order, please add an E at the end of the REF number (e.g., 726470.30E)

To prolong column life, even at highly contaminated or matrix-containing samples, MN offers the option to add an **integrated guard column**. All capillary columns are available with a 10 m guard column with respective deactivation. To order, please add V1 at the end of the REF number. Guard column combinations with other lengths, IDs or different deactivation are available on request.

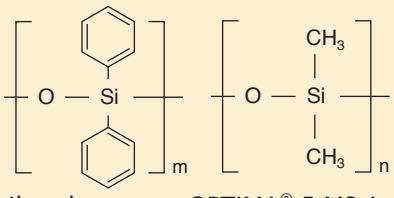


OPTIMA® high performance capillary columns

OPTIMA® 5 MS

5 % diphenyl – 95 % dimethylpolysiloxane

- Selectivity identical to OPTIMA® 5



Similar phases see OPTIMA® 5 MS Accent page 247

- Max. temperature for isothermal operation 340 °C, max. temperature for short isotherms in a temperature program 360 °C
- Phase with low bleeding
- Suited for GC/MS and ECD applications and general analyses at trace level
- Perfect inertness for basic compounds
- **USP G27 / G36**

Analysis of various phenols

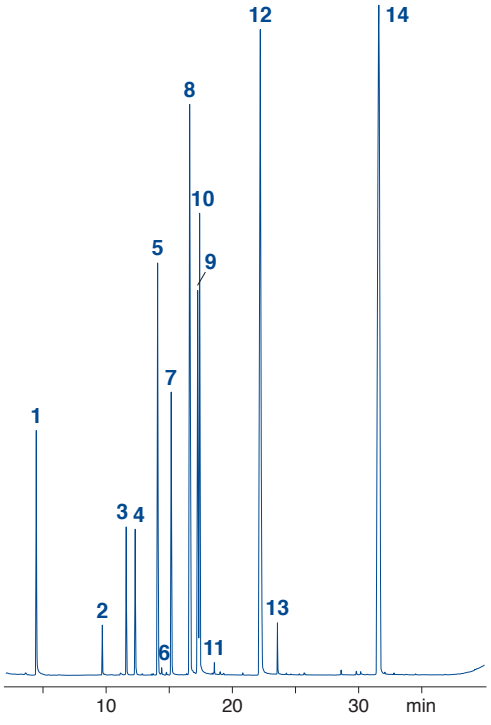
Column: OPTIMA® 5 MS, 30 m x 0.25 mm ID, 0.25 µm film
Sample: 5 ppm of each compound except *N-i*-propylaniline (9.4 ppm)
Method: SPME
Temperature: 40 °C (2 min) → 240 °C, 6 °C/min → 320 °C, 20 °C/min
Detector: MSD

Peaks:

1. Toluene-D_8
2. Phenol
3. 2-Methylphenol (*o*-Cresol)
4. Nitrobenzene-D_5
5. *N-i*-Propylaniline
6. 2,4-Dichlorophenol
7. 4-Chlorophenol
8. 4-Bromo-2-chlorophenol
9. 3-Bromophenol
10. 4-Chloro-3-methylphenol
11. 2,4-Dibromophenol
12. 2-Hydroxybiphenyl
13. 2-Cyclohexylphenol
14. Hexafluorobisphenol A

Courtesy of Riedel-de-Haën, Seelze, Germany

MN Appl. No. 210110



Ordering information

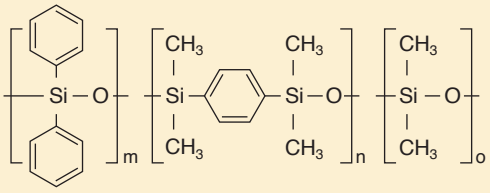
Length →	12 m	15 m	25 m	30 m	50 m	60 m
0.2 mm ID (0.4 mm OD)						
0.20 µm film	**726210.12**		**726210.25**		**726210.50**	
0.35 µm film	**726215.12**		**726215.25**		**726215.50**	
0.25 mm ID (0.4 mm OD)						
0.25 µm film		**726220.15**		**726220.30**		**726220.60**
0.50 µm film				**726225.30**		**726225.60**
1.00 µm film				**726226.30**		**7262267.60**
0.32 mm ID (0.5 mm OD)						
0.25 µm film				**726211.30**		
0.50 µm film				**726213.30**		
1.00 µm film			**726212.25**		**726212.50**	**726212.60**

In addition to this standard program we will be happy to supply columns custom-made to your specifications.

OPTIMA® 5 MS Accent

silarylene phase

Chemically bonded, cross-linked silarylene phase with polarity similar to a 5% diphenyl – 95% dimethylpolysiloxane phase



Increased sensitivity due to an unmatched low background level

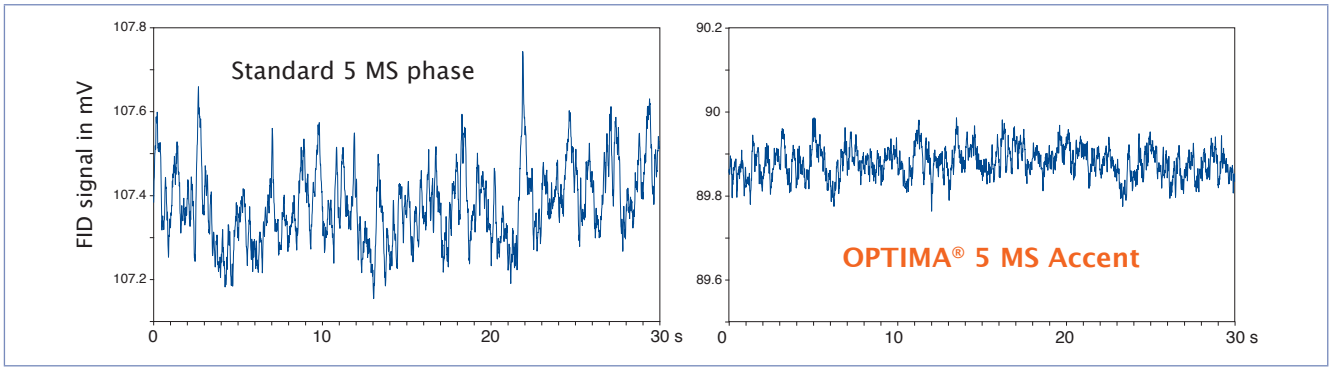
- **USP G27 / G36**

- Max. temperature for isothermal operation 340 °C, max. temperature for short isotherms in a temperature program 360 °C,
  Columns with films > 0.5 µm: max. temperatures 320 and 340 °C, respectively
- **Lowest column bleed,** nonpolar phase, ideal for ion trap and quadrupole MS detectors
- Solvent rinsing for removal of impurities applicable
- Recommended application: all-round phase for environmental analyses, trace analyses, EPA methods, pesticides, PCB, food and drug analyses
- Similar phases:
  DB-5 MS, HP-5 MS, Ultra-2, Equity-5, CP-Sil 8 CB low bleed/MS, Rxi-5 MS, Rtx-5SIL-MS, Rtx-5 MS, 007-5 MS, BPX5, MDN-5S, AT-5 MS, VF-5 MS

The bleed comparison test of OPTIMA® 5 MS Accent with a conventional 5 MS phase shows the outstanding performance of the silarylene phase.

Background noise at 340 °C

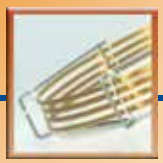
The unmatched low background level of the OPTIMA® 5 MS Accent, which is approximately three times lower compared to a 5 MS brand column, provides significantly increased sensitivity and allows its application in trace analyses particularly of high-boiling compounds.



Ordering information

Length →	12 m	15 m	25 m	30 m	50 m	60 m
0.2 mm ID (0.4 mm OD)						
0.20 µm film			725810.25		725810.50	
0.35 µm film	725815.12				725815.50	
0.25 mm ID (0.4 mm OD)						
0.25 µm film		725820.15		725820.30		725820.60
0.50 µm film				725825.30		725825.60
1.00 µm film				725826.30		725826.60
0.32 mm ID (0.5 mm OD)						
0.25 µm film				725811.30		725811.60
0.50 µm film				725813.30		
1.00 µm film			725812.25			725812.60

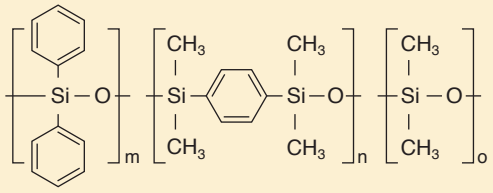
Each column is individually tested and supplied with test certificate and test chromatogram, but without fittings or ferrules. Columns have fused ends or are sealed with septa, to protect them from atmospheric oxygen. A standard test mixture is included with every column.



OPTIMA® high performance capillary columns

OPTIMA® XLB — silarylene phase

Chemically bonded, cross-linked silarylene phase, optimized silarylene content for lowest column bleed

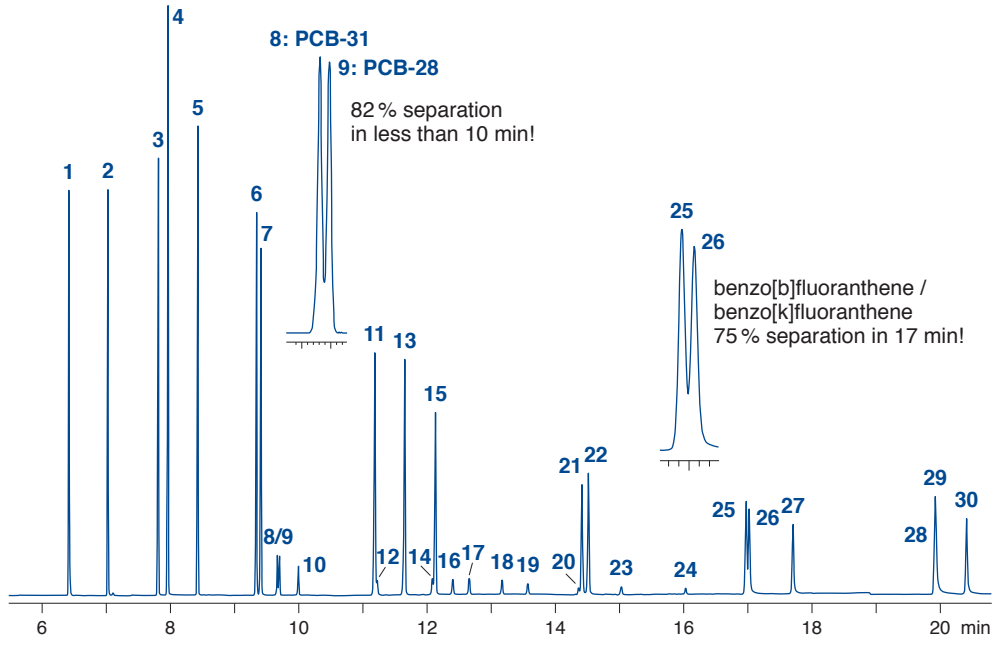


Similar phases: DB-XLB, Rxi-XLB, Rtx-XLB, MDN-12, VF-XMS

- Max. temperature for isothermal operation 340 °C, max. temperature for short isotherms in a temperature program 360 °C,
- **Lowest column bleed,** nonpolar phase, ideal for ion trap and quadrupole MS detectors
- Perfect inertness for basic compounds
- Solvent rinsing for removal of impurities applicable
- Recommended application: ultra low bleed phase, highly selective for environmental and trace analyses, pesticides
- Recommended phase for PCB separations

Rapid separation of PCB and PAH

Column: OPTIMA® XLB, 0.25 µm film, 30 m x 0.25 mm ID
Injection: 1 µL, standard 0.005 ng/µL; 250 °C, pulsed, splitless, pulse 1.38 bar in 1 min
Carrier gas: 60 mL/min He
Temperature: 40 °C (2 min) → 240 °C (2 min), 30 °C/min → 340 °C (5 min), 10 °C/min
Detector: MS source 230 °C, interface 280 °C, quadrupole 150 °C



Peaks:
1. Naphthalene
2. 2-Methylnaphthalene
3. Acenaphthylene
4. Acenaphthene
5. Fluorene
6. Phenanthrene
7. Anthracene
8. PCB-31
9. PCB-28
10. PCB-52
11. Fluoranthene
12. PCB-101
13. Pyrene
14. PCB-77
15. 2-Methylfluoranthene
16. PCB-118
17. PCB-153
18. PCB-138
19. PCB-126
20. PCB-180
21. Benz[a]anthracene
22. Chrysene
23. PCB-169
24. PCB-194
25. Benzo[b]fluoranthene
26. Benzo[k]fluoranthene
27. Benzo[a]pyrene
28. Dibenz[ah]anthracene
29. Indeno[1,2,3-cd]pyrene
30. Benzo[ghi]perylene

Courtesy of Centre d'Analyses de Recherche, Lab. d'Hydrologie, 65400 Illkirch, France

MN Appl. No. 212920

Ordering information

Length →	30 m	60 m
0.25 mm ID (0.4 mm OD)		
0.25 µm film	**725850.30**	**725850.60**

On request, all columns can be supplied on a **5 inch (13 cm) cage** for the Agilent GC 6850. To order, please add an E at the end of the REF number (e.g., 726470.30E)

OPTIMA® δ-3

polysiloxane phase with autoselectivity

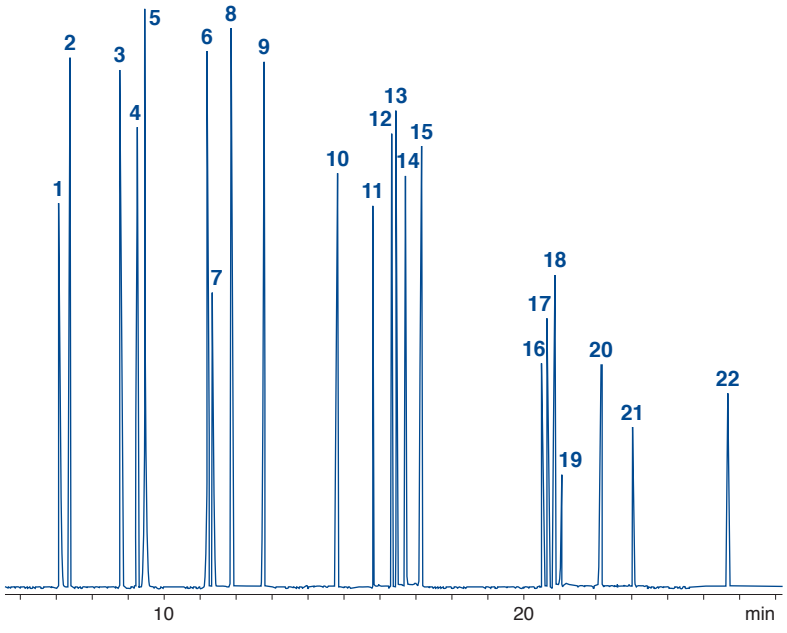
- Medium polar without CN groups
  Analytes determine the polarity of the phase
  Unique from MN, no similar phase
  Ideal for MSD and PND detectors
- **USP G49**

- Max. temperature for isothermal operation 340 °C, max. temperature for short isotherms in a temperature program 360 °C; 0.53 mm ID columns: max. temperatures 320 and 340 °C, resp.
- Autoselectivity resulting in a wide range of polarities from approximately the non-polar OPTIMA® 5 to the midpolar OPTIMA® 1701 (see page 241)

Analysis of isomeric phenols

Column: OPTIMA® δ-3, 0.25 µm film, 60 m x 0.25 mm ID
Injection: 1.0 µL, split 1:80
Carrier gas: He, 1.3 bar
Temperature: 60 °C (3 min) → 320 °C, 6 °C/min
Detector: MSD HP 5971

Peaks:
1. Phenol
2. 2-Chlorophenol
3. 2-Methylphenol
4. 4-Methylphenol
5. 3-Methylphenol
6. 2,4-Dimethylphenol
7. 2-Nitrophenol
8. 2,4-Dichlorophenol
9. 2,6-Dichlorophenol
10. 4-Chloro-3-methylphenol
11. 2,3,5-Trichlorophenol
12. 2,4,6-Trichlorophenol
13. 2,4,5-Trichlorophenol
14. 2,3,4-Trichlorophenol
15. 2,3,6-Trichlorophenol
16. 2,3,5,6-Tetrachlorophenol
17. 2,3,4,5-Tetrachlorophenol
18. 2,3,4,6-Tetrachlorophenol
19. 2,4-Dinitrophenol
20. 3,4,5-Trichlorophenol
21. 2-Methyl-4,6-dinitrophenol
22. 2-Isopropyl-4,6-dinitrophenol

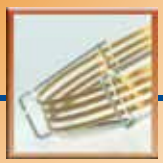


MN Appl. No. 250060

Ordering information

Length →	10 m	20 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)						
0.10 µm film	**726410.10**	**726410.20**				
0.2 mm ID (0.4 mm OD)						
0.20 µm film			**726400.25**		**726400.50**	
0.25 mm ID (0.4 mm OD)						
0.25 µm film				**726420.30**		**726420.60**
0.50 µm film				**726421.30**		
0.32 mm ID (0.5 mm OD)						
0.25 µm film				**726440.30**		**726440.60**
0.35 µm film				**726441.30**		**726441.60**
1.00 µm film				**726442.30**		**726442.60**
0.53 mm ID (0.8 mm OD)						
1.00 µm film				**726443.30**		

In addition to this standard program we will be happy to supply columns custom-made to your specifications.



OPTIMA® δ · unique phases with autoselectivity

OPTIMA® δ-6

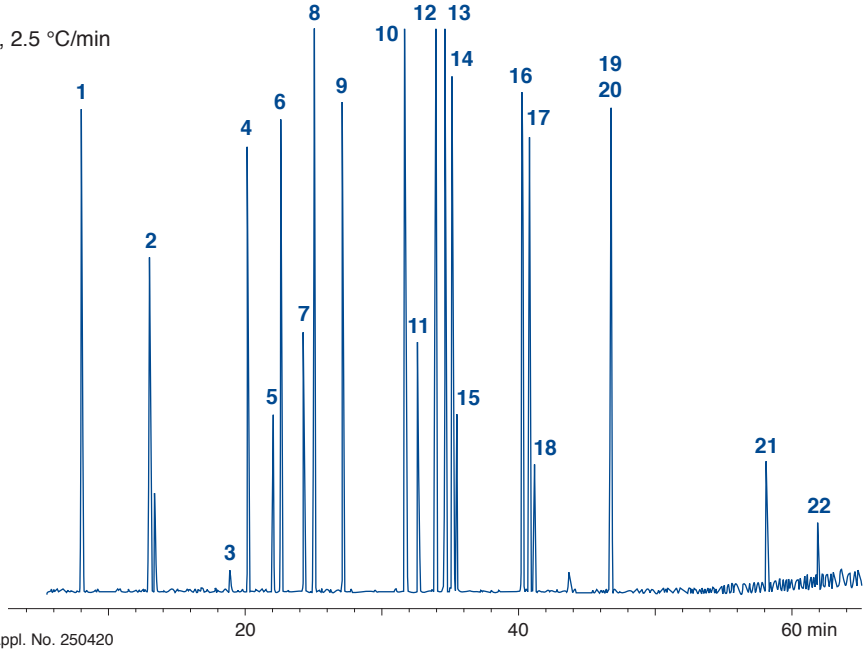
polysiloxane phase with autoselectivity

- Medium polar without CN groups
  Analytes determine the polarity of the phase
  Unique from MN, no similar phase
  Ideal for MSD and PND detectors
- Max. temperature for isothermal operation 340 °C, max. temperature for short isotherms in a temperature program 360 °C; 0.53 mm ID columns: max. temperatures 320 and 340 °C, resp.
- Autoselectivity resulting in a wide range of polarities from approximately the midpolar OPTIMA® 17 to the polar OPTIMA® 210 (see page 241)

Separation of organophosphorus pesticides (EPA 8140 / 8141)

Column: OPTIMA® δ-6, 0.2 µm film, 50 m x 0.2 mm ID
Sample: EPA 8140 OP pesticide calibration mix (Restek), 200 µg/mL each in hexane – acetone (95:5)
Injection: 1 µL, split 1:30
Carrier gas: 2.0 bar He
Temperature: 150 °C → 300 °C (10 min), 2.5 °C/min
Detector: MSD HP 5971

Peaks:
1. Dichlorvos
2. Mevinphos
3. Demeton-S
4. Ethoprop
5. Naled
6. Phorate
7. Demeton-O
8. Diazinon
9. Disulfoton
10. Ronnel
11. Parathion-methyl
12. Chlorpyrifos
13. Trichloronate
14. Fenthion
15. Merphos
16. Stirofos
17. Tokuthion
18. Merphos oxidation product
19. Fensulfothion
20. Bolstar
21. Azinphos-methyl
22. Coumaphos



MN Appl. No. 250420

Ordering information

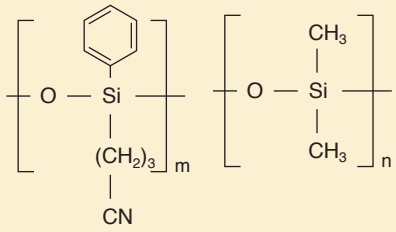
Length →	10 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)					
0.10 µm film	**726490.10**				
0.2 mm ID (0.4 mm OD)					
0.20 µm film		**726465.25**		**726465.50**	
0.25 mm ID (0.4 mm OD)					
0.25 µm film			**726470.30**		**726470.60**
0.32 mm ID (0.5 mm OD)					
0.25 µm film			**726480.30**		**726480.60**
0.35 µm film			**726481.30**		**726481.60**
1.00 µm film			**726482.30**		**726482.60**
0.53 mm ID (0.8 mm OD)					
1.00 µm film			**726483.30**		

In addition to this standard program we will be happy to supply columns custom-made to your specifications.

OPTIMA® 1301

6% cyanopropyl-phenyl – 94% dimethylpolysiloxane

- Medium polar phase



- Max. temperature for isothermal operation 300 °C, max. temperature for short isotherms in a temperature program 320 °C
- Ideal for pesticide analyses

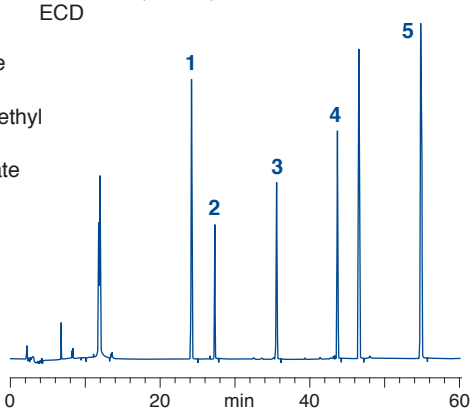
  For corresponding columns with higher film thickness see OPTIMA® 624

  Similar phases: HP-1301, DB-1301, SPB-1301, Rtx-1301, CP-1301, 007-1301
- **USP G43**

Analysis of a pesticide mixture

Column: OPTIMA® 1301, 0.25 µm film, 60 m x 0.25 mm ID
Injection: 3 µL (0.1 ng/µL), 80 °C (1 min) → 250 °C (1 min) pulsed splitless
Carrier gas: He, 54 mL/min
Temperature: 80 °C (2 min) → 190 °C, 20 °C/min (12 min) → 240 °C, 2 °C/min (23 min) → 260 °C, 10 °C/min (20 min)
Detector: ECD

Peaks:
1. Propyzamide
2. Vinclozolin
3. Bromophos-ethyl
4. 2,4-DDT
5. Brompropylate

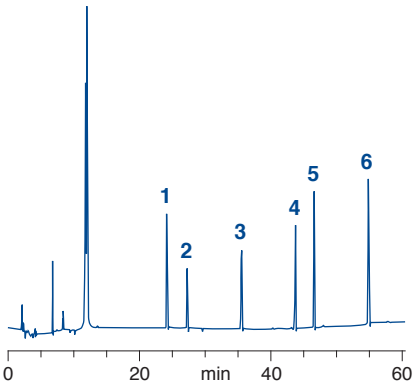


MN Appl. No. 210620

Analysis of a PCB mixture

Column: OPTIMA® 1301, 0.25 µm film, 60 m x 0.25 mm ID
Injection: 3 µL (0.1 ng/µL), 80 °C (1 min) → 250 °C (1 min) pulsed splitless
Carrier gas: He, 54 mL/min
Temperature: 80 °C (2 min) → 190 °C, 20 °C/min (12 min) → 240 °C, 2 °C/min (23 min) → 260 °C, 10 °C/min (20 min)
Detector: ECD

Peaks:
1. PCB-28
2. PCB-52
3. PCB-128
4. PCB-153
5. PCB-138
6. PCB-180



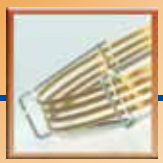
MN Appl. No. 210650

Ordering information

Length →	25 m	30 m	50 m	60 m
0.25 mm ID (0.4 mm OD)				
0.25 µm film	**726771.25**	**726771.30**	**726771.50**	**726771.60**
0.32 mm ID (0.5 mm OD)				
0.25 µm film	**726777.25**	**726777.30**		**726777.60**
1.00 µm film		**726780.30**	**726780.50**	**726780.60**
0.53 mm ID (0.8 mm OD)				
1.00 µm film	**726783.25**			

In addition to this standard program we will be happy to supply columns custom-made to your specifications.

Each column is individually tested and supplied with test certificate and test chromatogram, but without fittings or ferrules. Columns have fused ends or are sealed with septa, to protect them from atmospheric oxygen. A standard test mixture is included with every column.

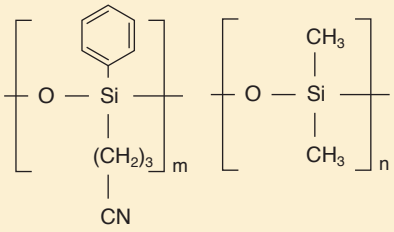


OPTIMA® high performance capillary columns

OPTIMA® 624

6 % cyanopropyl-phenyl – 94 % dimethylpolysiloxane

- Medium polar phase



Similar phases: HP-624, HP-VOC, DB-624, DB-VRX, SPB-624, CP-624, Rtx-624, Rtx-Volatiles, 007-624, BP624, VOCOL

- Max. temperature for isothermal operation 280 °C, max. temperature for short isotherms in a temperature program 300 °C
- Recommended application: environmental analyses

  For corresponding columns with lower film thickness see OPTIMA® 1301
- **USP G43**

OPTIMA® 624 *LB*

6 % cyanopropyl-phenyl – 94 % dimethylpolysiloxane

- Excellent Low Bleed columns for halogenated hydrocarbons, volatiles, aromatic compounds, solvents etc.

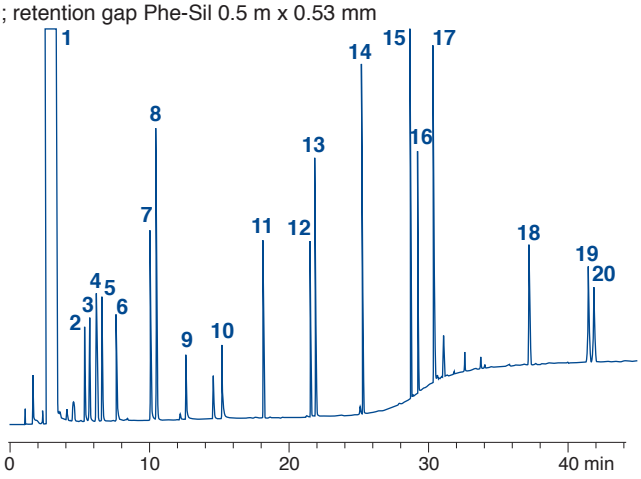
Solvents and semi-volatiles

Column: OPTIMA® 624 *LB*, 1.8 µm film, 30 m x 0.32 mm ID; retention gap Phe-Sil 0.5 m x 0.53 mm
Injection: 1 µL (10 ppm per substance in acetone), cold on-column
Carrier gas: 1.1 bar He
Temperature: 45 °C (3 min) → 150 °C (6 °C/min) → 300 °C (18 °C/min), 20 min 300 °C
Detector: FID 280 °C

Peaks:

1. Acetone
2. Ethyl acetate
3. Tetrahydrofuran
4. Cyclohexane
5. 2-Methyl-2-butanol
6. 1-Butanol
7. Pyridine
8. Toluene
9. Dimethylformamide
10. Dimethylsulfoxide
11. Decane
12. 1-Octanol
13. Acetophenone
14. Butyrophenone
15. Heptanophenone
16. 5-Methoxyindole
17. Dibenzylamine
18. Methyl eicosanoate
19. Methyl *cis*-13-docosenoate
20. Methyl docosanoate

MN Appl. No. 212520



Ordering information

Length →	25 m	30 m	50 m	60 m
OPTIMA® 624				
0.2 mm ID (0.4 mm OD)				
1.10 µm film	726784.25			
0.25 mm ID (0.4 mm OD)				
1.40 µm film	726785.25	726785.30	726785.50	726785.60
0.32 mm ID (0.5 mm OD)				
1.80 µm film	726787.25	726787.30	726787.50	726787.60
0.53 mm ID (0.8 mm OD)				
3.00 µm film	726789.25	726789.30		
OPTIMA® 624 *LB*				
0.32 mm ID (0.5 mm OD)				
1.80 µm film		726786.30	726786.50	

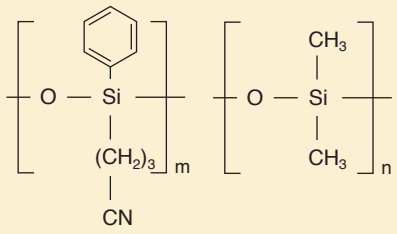
In addition to this standard program we will be happy to supply columns custom-made to your specifications.

On request, all columns can be supplied on a **5 inch (13 cm) cage** for the Agilent GC 6850. To order, please add an E at the end of the REF number (e.g., 726470.30E)

OPTIMA® 1701

14 % cyanopropyl-phenyl – 86 % dimethylpolysiloxane

- Medium polar phase



Similar phases: OV-1701, DB-1701, CP-Sil 19 CB, HP-1701, Rtx-1701, SPB-1701, 007-1701, BP10, ZB-1701

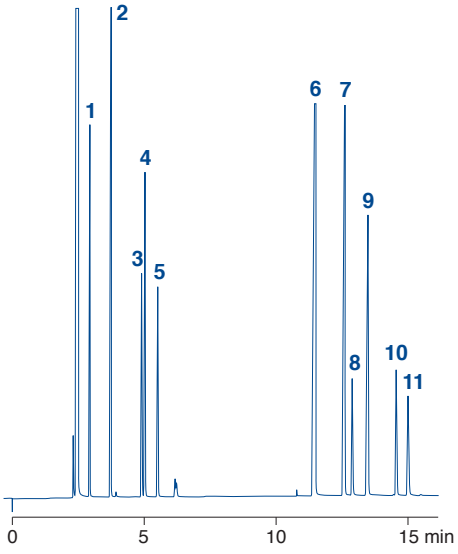
- Max. temperature for isothermal operation 300 °C, max. temperature for short isotherms in a temperature program 320 °C
  0.53 mm ID columns:
  max. temperatures 280 and 300 °C, resp.
- Special selectivity due to high cyanopropyl content
- Reference column for structure identification, e.g., in combination with OPTIMA® 5
- Film thickness ≥ 1 µm for solvent analyses
- **USP G46**

Analysis of aromatic hydrocarbons

Column: OPTIMA® 1701, 0.25 µm film, 25 m x 0.32 mm ID
Injection: 1 µL, split 1:40
Carrier gas: 0.6 bar N_2
Temperature: 60 °C → 120 °C, 4 °C/min
Detector: FID 260 °C

Peaks:
1. Benzene
2. Toluene
3. Ethylbenzene
4. *p*-Xylene
5. *o*-Xylene
6. Phenol
7. 2-Methylphenol
8. 2,6-Dimethylphenol
9. 4-Methylphenol
10. 2,4-Dimethylphenol
11. 2,4,6-Trimethylphenol

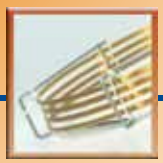
MN Appl. No. 200400



Ordering information

Length →	10 m	15 m	25 m	30 m	50 m	60 m
0.2 mm ID (0.4 mm OD)						
0.20 µm film			726841.25		726841.50	
0.25 mm ID (0.4 mm OD)						
0.25 µm film	726058.10	726058.15	726058.25	726058.30	726058.50	726058.60
0.50 µm film				726064.30		726064.60
1.00 µm film				726965.30		
0.32 mm ID (0.5 mm OD)						
0.25 µm film	726318.10	726318.15	726318.25	726318.30	726318.50	726318.60
0.35 µm film			726824.25	726824.30	726824.50	726824.60
0.50 µm film			726320.25	726320.30	726320.50	726320.60
1.00 µm film			726929.25	726929.30	726929.50	726929.60
0.53 mm ID (0.8 mm OD)						
1.00 µm film	726545.10	726545.15	726545.25	726545.30		
2.00 µm film		726735.15	726735.25	726735.30	726735.50	

In addition to this standard program we will be happy to supply columns custom-made to your specifications.

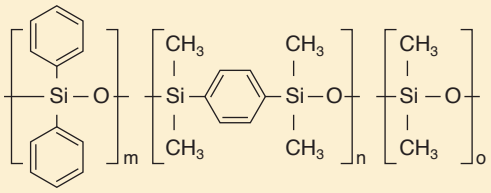


OPTIMA® high performance capillary columns

OPTIMA® 35 MS

silarylene phase

Chemically bonded cross-linked silarylene phase with selectivity similar to 35 % phenyl – 65 % methyl polysiloxane

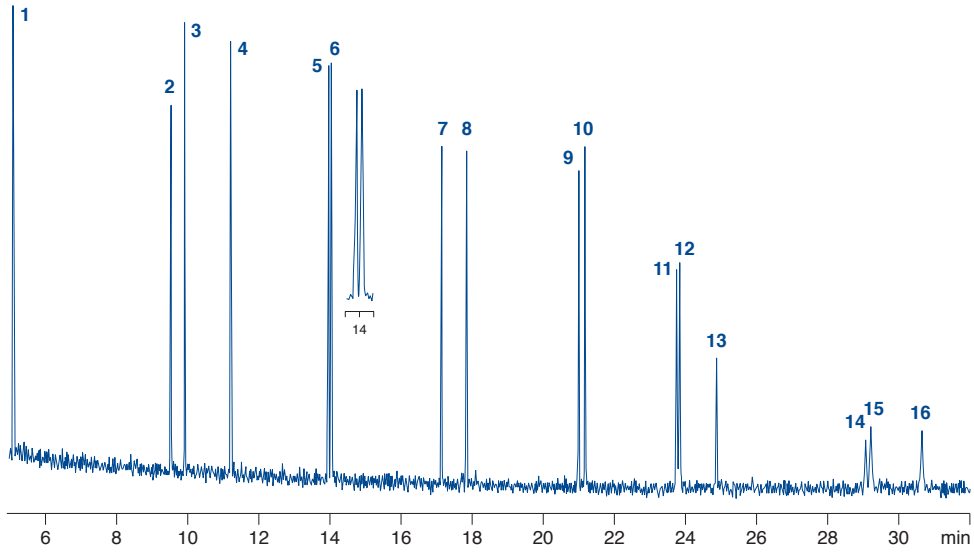


Similar phases: DB-35 MS, HP-35, SPB-35, Rxi-35SIL MS, Rtx-35, 007-35, BPX-35, MDN-35, AT-35 MS, ZB-35, OV-11, VF-35 MS

- Max. temperature for isothermal operation 360 °C, max. temperature for short isotherms in a temperature program 370 °C,
- Very low column bleeding, medium polar phase, recommended for ion-trap detectors
- Optimum column for confirmation of analytical results in combination with a 1 MS or 5 MS
- Polymer without CN groups
- Recommended application: allround phase for environmental analyses, ultra trace analyses, EPA methods, pesticides, PCB, food and drug analyses
- **USP G42**

PAH in accordance with EPA 610

Column: OPTIMA® 35 MS, 0.25 µm film, 30 m x 0.25 mm ID
Injection: 1 µL, split 1:10
Carrier gas: 0.6 bar H_2
Temperature: 100 °C (3 min) → 300 °C (10 min), 6 °C/min
Detector: MSD



Peaks:
1. Naphthalene
2. Acenaphthylene
3. Acenaphthene
4. Fluorene
5. Phenanthrene
6. Anthracene
7. Fluoranthene
8. Pyrene
9. Benz[a]anthracene
10. Chrysene
11. Benzo[b]fluoranthene
12. Benzo[k]fluoranthene
13. Benzo[a]pyrene
14. Indeno[1,2,3-cd]pyrene
15. Dibenz[ah]anthracene
16. Benzo[ghi]perylene

MN Appl. No. 213190

Ordering information

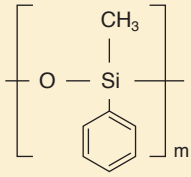
Length →	30 m	60 m
0.25 mm ID (0.4 mm OD)		
0.25 µm film	**726154.30**	**726154.60**
0.32 mm ID (0.5 mm OD)		
0.25 µm film	**726157.30**	**726157.60**

Each column is individually tested and supplied with test certificate and test chromatogram, but without fittings or ferrules. Columns have fused ends or are sealed with septa, to protect them from atmospheric oxygen. A standard test mixture is included with every column.

OPTIMA® 17

phenylmethylpolysiloxane (50% phenyl)

- Medium polar phase

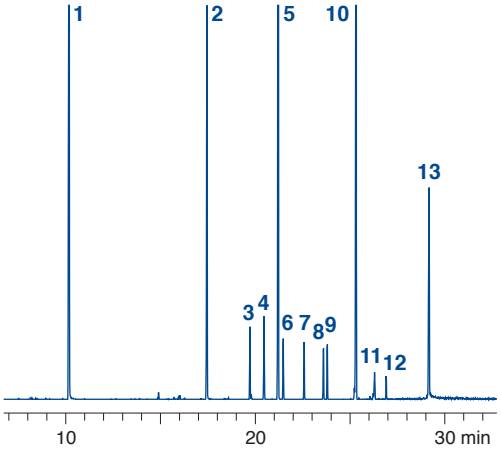


Similar phases: OV-17, DB-17, HP-50+, HP-17, SPB-50, SP-2250, Rxi-17, Rtx-50, CP-Sil 24 CB, 007-17, ZB-50

- Max. temperature for isothermal operation 320 °C, max. temperature for short isotherms in a temperature program 340 °C
  for 0.53 mm ID columns the max. temperatures are 300 and 320 °C, resp.
- Recommended application:
  steroids, pesticides, drug analyses
- **USP G3**

Analysis of pesticides

Column:	OPTIMA® 17, 0.20 µm film, 25 m x 0.2 mm ID
Sample:	pesticides, standard of the cantonal laboratory Schaffhausen (Switzerland), 0.1 mg/mL or 0.01 mg/mL each
Injection:	1.0 µL, 3 s without split
Carrier gas:	He, 25 cm/s
Temperature:	100 °C (3 min), 8 °C/min → 250 °C, 10 °C/min → 320 °C
Detector:	MSD HP 5971



Peaks:
1. Dichlorphos
2. Naled
3. Vinclozolin
4. Chlorthalonil
5. Chlorpyrifos
6. Dichlofluanid
7. Procymidon
8. Captan
9. Folpet
10. Carbophenothion
11. Iprodion
12. Captafol
13. Coumaphos

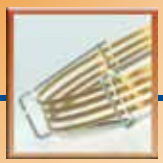
MN Appl. No. 200930

Ordering information

Length →	10 m	12 m	15 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)							
0.10 µm film	**726848.10**						
0.2 mm ID (0.4 mm OD)							
0.20 µm film		**726065.12**		**726065.25**		**726065.50**	
0.50 µm film				**726066.25**		**726066.50**	
0.25 mm ID (0.4 mm OD)							
0.15 µm film				**726742.25**	**726742.30**	**726742.50**	**726742.60**
0.25 µm film			**726022.15**	**726022.25**	**726022.30**	**726022.50**	**726022.60**
0.50 µm film				**726067.25**	**726067.30**	**726067.50**	**726067.60**
0.32 mm ID (0.5 mm OD)							
0.15 µm film					**726755.30**		
0.25 µm film				**726351.25**	**726351.30**	**726351.50**	**726351.60**
0.35 µm film				**726757.25**	**726757.30**	**726757.50**	**726757.60**
0.50 µm film				**726744.25**	**726744.30**	**726744.50**	**726744.60**
0.53 mm ID (0.8 mm OD)							
1.00 µm film	**726747.10**		**726747.15**	**726747.25**	**726747.30**		

In addition to this standard program we will be happy to supply columns custom-made to your specifications.

On request, all columns can be supplied on a **5 inch (13 cm) cage** for the Agilent GC 6850. To order, please add an E at the end of the REF number (e.g., 726470.30E)

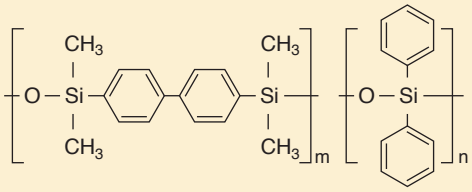


OPTIMA® high performance capillary columns

OPTIMA® 17 MS

silarylene phase

- Medium polar silarylene phase with selectivity analogue to 50% phenyl – 50% methylpolysiloxane



Similar phases: OV-17, AT-50, BPX-50, DB-17, DB-17ms, HP-50+, HP-17, SPB-50, SPB-17, SP-2250, Rtx-50, CP-Sil 24 CB, 007-17, VF-17ms, ZB-50

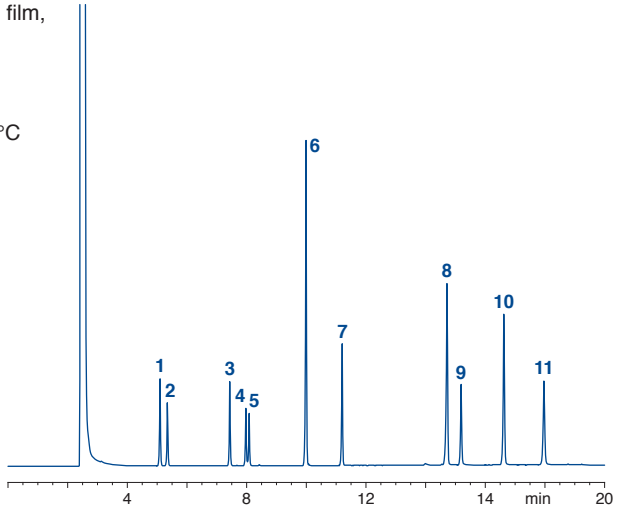
- Max. temperature for isothermal operation 340 °C, max. temperature for short isotherms in a temperature program 360 °C
- Ideal for ion trap detectors
- Optimum reference column in combination with a 1 MS or 5 MS
- No CN groups in the polymer
- Recommended application: all-round phase for environmental analyses, ultra-trace analyses, EPA methods, pesticides, PCBs, food and drug analyses
- **USP G3**

Analysis of phenols

Column:	OPTIMA® 17 MS, 0.25 µm film, 30 m x 0.25 mm ID
Sample:	phenol mix 604
Injection:	1.0 µL, 230 °C, split 1:30
Carrier gas:	He, 0.8 bar
Temperature:	100 °C, 10 °C/min → 250 °C
Detector:	FID 280 °C

Peaks:

1. Phenol
2. 2-Chlorophenol
3. 2,4-Dimethylphenol
4. 2-Nitrophenol
5. 2,4-Dichlorophenol
6. 4-Chloro-3-methylphenol
7. 2,4,6-Trichlorophenol
8. 4-Nitrophenol
9. 2,4-Dinitrophenol
10. 2-Methyl-4,6-dinitrophenol
11. Pentachlorophenol



MN Appl. No. 213600

Ordering information

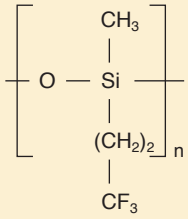
Length →	30 m	60 m
0.25 mm ID (0.4 mm OD)		
0.25 µm film	**726162.30**	**726162.60**
0.32 mm ID (0.5 mm OD)		
0.25 µm film	**726165.30**	**726165.60**

Each column is individually tested and supplied with test certificate and test chromatogram, but without fittings or ferrules. Columns have fused ends or are sealed with septa, to protect them from atmospheric oxygen. A standard test mixture is included with every column.

To prolong column life, even at highly contaminated or matrix-containing samples, MN offers the option to add an **integrated guard column**. All capillary columns are available with a 10 m guard column with respective deactivation. To order, please add V1 at the end of the REF number. Guard column combinations with other lengths, IDs or different deactivation are available on request.

OPTIMA® 210 — trifluoropropyl-methylpolysiloxane (50 % trifluoropropyl)

- Medium polar phase



- Max. temperature for isothermal operation 260 °C, max. temperature for short isotherms in a temperature program 280 °C
- Recommended application: environmental analyses, especially for *o*-, *m*- and *p*-substituted aromatic hydrocarbons
- Close equivalent to **USP G6**

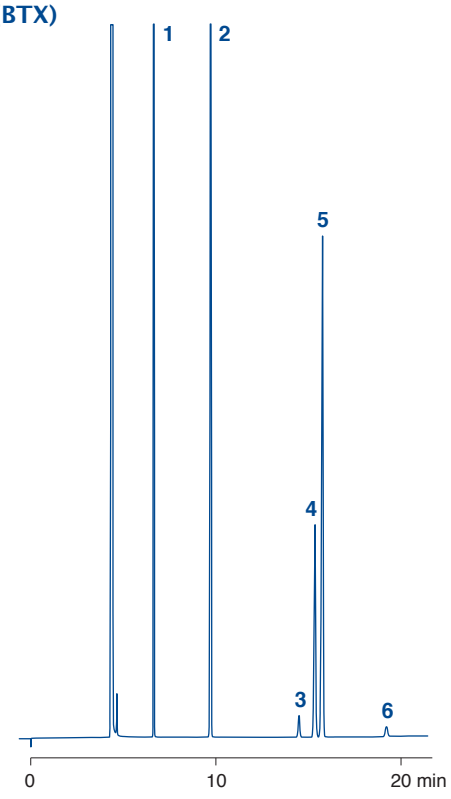
Similar phases: OV-210, DB-210, Rtx-200, 007-210

Aromatic hydrocarbons (BTX)

Column: OPTIMA® 210, 0.5 µm film, 50 m x 0.25 mm ID
Injection: 0.5 µL, split 105 mL/min
Carrier gas: 130 kPa N_2 (1.1 mL/min)
Temperature: 50 °C
Detector: FID 250 °C

Peaks:
1. Benzene
2. Toluene
3. Ethylbenzene
4. *p*-Xylene
5. *m*-Xylene
6. *o*-Xylene

MN Appl. No. 200230

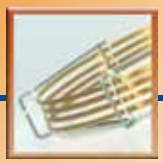


Ordering information

Length →	15 m	25 m	30 m	50 m	60 m
0.25 mm ID (0.4 mm OD)					
0.25 µm film	**726871.15**	**726871.25**	**726871.30**	**726871.50**	**726871.60**
0.50 µm film			**726874.30**	**726874.50**	**726874.60**
0.32 mm ID (0.5 mm OD)					
0.25 µm film	**726877.15**		**726877.30**	**726877.50**	**726877.60**
0.50 µm film		**726880.25**	**726880.30**	**726880.50**	**726880.60**

In addition to this standard program we will be happy to supply columns custom-made to your specifications.

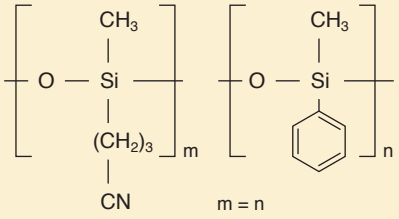
On request, all columns can be supplied on a **5 inch (13 cm) cage** for the Agilent GC 6850. To order, please add an E at the end of the REF number (e.g., 726470.30E)



OPTIMA® high performance capillary columns

OPTIMA® 225 — 50% cyanopropyl-methyl – 50% phenylmethylpolysiloxane

- Medium polar phase



- Max. temperature for isothermal operation 260 °C, max. temperature for short isotherms in a temperature program 280 °C
- Recommended for fatty acid analyses

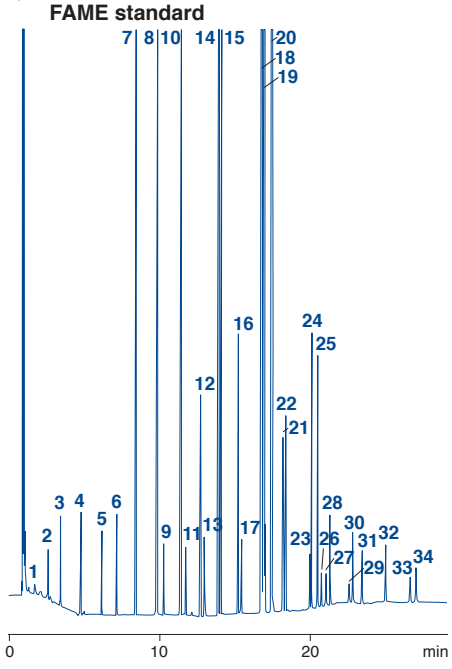
  Similar phases: DB-225, HP-225, OV-225, Rtx-225, CP-Sil 43, 007-225, BP225
- Close equivalent to **USP G7 / G19**

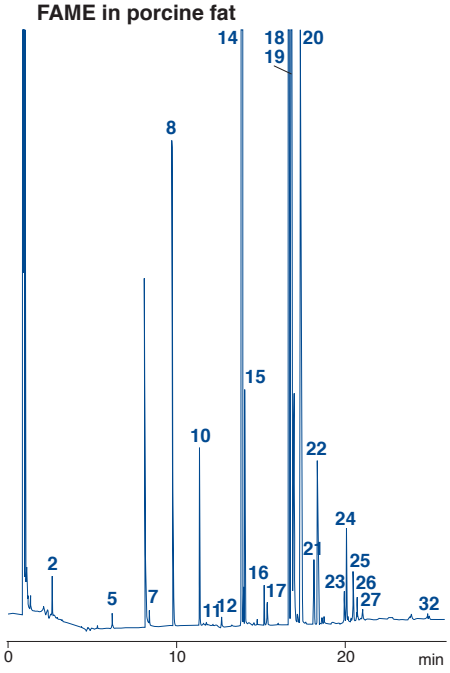
Analysis of FAME in porcine fat

Column: OPTIMA® 225, 0.25 µm film, 25 m x 0.32 mm ID
Injection: 1 µL, split 1:40; carrier gas 60 kPa H_2
Temperature: 50 °C (2 min) → 125 °C, 30 °C/min → 160 °C, 5 °C/min → 180 °C, 20 °C/min → 200 °C, 3 °C/min → 220 °C, 20 °C/min (10 min)
Detector: FID 260 °C

Peaks:

1. C4:0
2. C5:0
3. C6:0
4. C8:0
5. C10:0
6. C11:0
7. C12:0
8. C13:0
9. C13:1
10. C14:0
11. C14:1
12. C15:0
13. C15:1
14. C16:0
15. C16:1
16. C17:0
17. C17:1
18. C18:0
19. C18:1
20. C18:2
21. C18:3
22. C19:0
23. C20:0
24. C20:1
25. C20:2
26. C20:4
27. C20:3
28. C20:5
29. C22:0
30. C22:1
31. C22:2
32. C22:6
33. C24:0
34. C24:1





Courtesy of Dr. Bantleon, Mr. Leusche, Mr. Hagemann, VFG-Labor, Versmold, Germany

MN Appl. No. 210060

Ordering information

Length →	10 m	15 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)						
0.10 µm film	**726080.10**					
0.25 mm ID (0.4 mm OD)						
0.25 µm film		**726118.15**	**726118.25**	**726118.30**	**726118.50**	**726118.60**
0.32 mm ID (0.5 mm OD)						
0.25 µm film			**726352.25**	**726352.30**	**726352.50**	**726352.60**

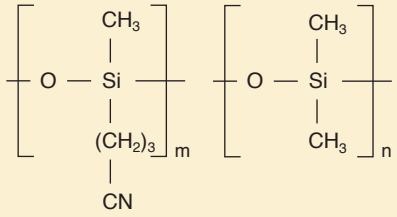
In addition to this standard program we will be happy to supply columns custom-made to your specifications.

On request, all columns can be supplied on a **5 inch (13 cm) cage** for the Agilent GC 6850. To order, please add an E at the end of the REF number (e.g., 726470.30E)

OPTIMA® 240

33 % cyanopropyl-methyl – 67 % dimethylpolysiloxane

- Medium polar phase



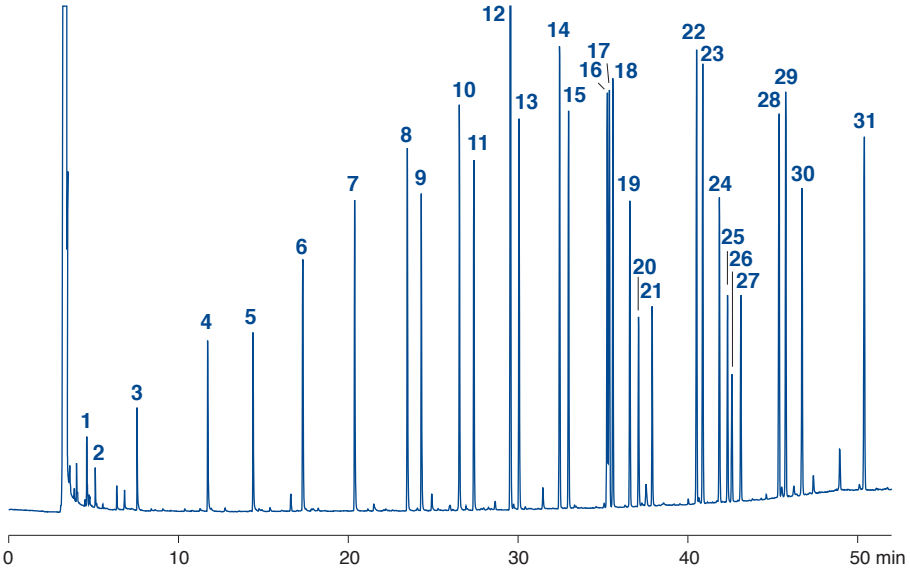
- Max. temperature for isothermal operation 260 °C, max. temperature for short isotherms in a temperature program 280 °C
- Recommended for FAMEs, dioxins
- No similar phases

Fatty acid methyl esters *cis*/*trans* C18:1 (FAME)

Column: OPTIMA® 240, 0.25 µm film, 60 m x 0.25 mm ID
Sample: FAME mixture
Injection: 1.0 µL, split 1:25
Carrier gas: 150 kPa H_2
Temperature: 80 °C → 120 °C, 20 °C/min → 260 °C (10 min), 3 °C/min
Detector: FID 280 °C

Peaks:

1. C4:0
2. C5:0
3. C8:0
4. C10:0
5. C11:0
6. C12:0
7. C13:0
8. C14:0
9. C14:1
10. C15:0
11. C15:1
12. C16:0
13. C16:1
14. C17:0
15. C17:1
16. C18:0
17. *trans*-C18:1
18. *cis*-C18:1
19. C18:2
20. C18:3
21. C18:3
22. C20:0
23. C20:1
24. C20:2
25. C20:3
26. C20:4
27. C20:3
28. C22:0
29. C22:1
30. C22:3
31. C24:1



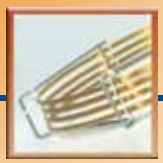
MN Appl. No. 201620

Ordering information

Length →	25 m	30 m	50 m	60 m
0.25 mm ID (0.4 mm OD)				
0.25 µm film		**726089.30**	**726089.50**	**726089.60**
0.50 µm film		**726090.30**		**726090.60**
0.32 mm ID (0.5 mm OD)				
0.25 µm film	**726091.25**	**726091.30**	**726091.50**	**726091.60**
0.35 µm film		**726095.30**		**726095.60**
0.50 µm film		**726096.30**		**726096.60**

In addition to this standard program we will be happy to supply columns custom-made to your specifications.

Each column is individually tested and supplied with test certificate and test chromatogram, but without fittings or ferrules. Columns have fused ends or are sealed with septa, to protect them from atmospheric oxygen. A standard test mixture is included with every column.

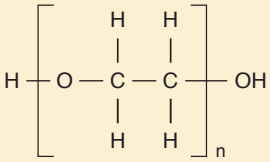


OPTIMA® high performance capillary columns

OPTIMA® WAX

polyethylene glycol 20 000 Da

- Polar phase



Similar phases:
PERMABOND® CW 20 M (page 265), DB-Wax, Supelcowax, HP-Wax, HP-INNOWAX, Rtx-Wax, CP-Wax 52 CB, Stabilwax, 007-CW, BP20, AT-Wax, ZB-Wax

- **USP G16**

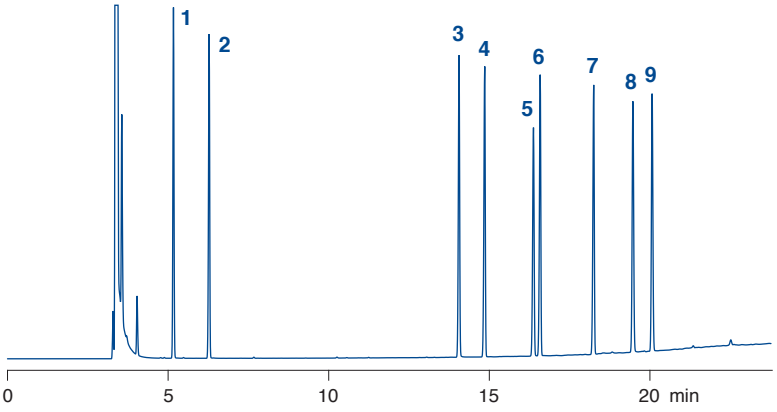
- Columns with 0.25–0.32 mm ID: max. temperature for isothermal operation 240 °C, max. temperature for short isotherms in a temperature program 250 °C; 0.53 mm ID columns: max. temperatures 220 and 240 °C, resp.
- Recommended application: solvent analysis and alcohols, suitable for aqueous solutions

Modified Grob test

Column: OPTIMA® WAX, 0.5 µm film, 50 m x 0.32 mm ID
Injection: 1 µL, split 1:20
Carrier gas: 1.2 bar He
Temperature: 80 °C → 250 °C, 8 °C/min
Detector: FID 250 °C

Peaks:
1. Decane
2. Undecane
3. Octanol
4. Methyl decanoate
5. Dicyclohexylamine
6. Methyl undecanoate
7. Methyl dodecanoate
8. 2,6-Dimethylaniline
9. 2,6-Dimethylphenol

MN Appl. No. 211170



Ordering information

Length →	25 m	30 m	50 m	60 m
0.25 mm ID (0.4 mm OD)				
0.25 µm film	**726600.25**	**726600.30**	**726600.50**	**726600.60**
0.32 mm ID (0.5 mm OD)				
0.25 µm film	**726321.25**	**726321.30**	**726321.50**	**726321.60**
0.50 µm film	**726296.25**	**726296.30**	**726296.50**	**726296.60**
0.53 mm ID (0.8 mm OD)				
1.00 µm film	**726549.25**	**726549.30**		
2.00 µm film		**726548.30**		

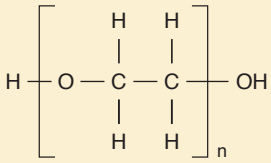
In addition to this standard program we will be happy to supply columns custom-made to your specifications.

On request, all columns can be supplied on a **5 inch (13 cm) cage** for the Agilent GC 6850. To order, please add an E at the end of the REF number (e.g., 726470.30E)

OPTIMA WAXplus®

cross-linked polyethylene glycol

- Polar phase with improved cross-linking for lower column bleed and better temperature stability



NEW!

- **USP G16**

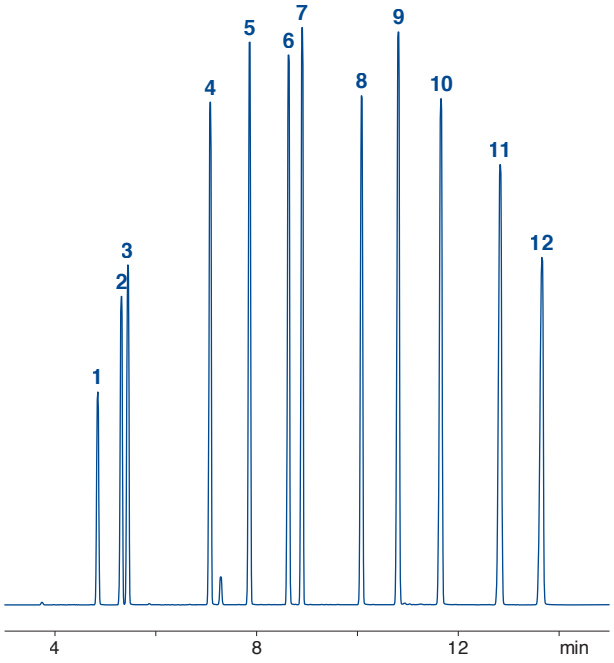
- Max. temperature for isothermal operation 260 °C, max. temperature for short isotherms in a temperature program 270 °C
- Recommended application:
  broad range of application, e.g., for solvents and alcohols, suitable for aqueous solutions

  Similar phases: OPTIMA® WAX (previous page), DB-Wax, Supelcowax, HP-Wax, HP-INNOWAX, Rtx-Wax, CP-Wax 52 CB, Stabilwax, 007-CW, BP20, AT-Wax, ZB-Wax

Alcohols

Columns: OPTIMA WAXplus®, 0.5 µm film, 30 m x 0.25 mm ID
Injection: 0.1 µL, split 1:80
Carrier gas: 1.3 bar He
Temperature: 40 °C → 260 °C, 12 °C/min (15 min)
Detector: FID 260 °C

Peaks:
1. Methanol
2. 2-Propanol
3. Ethanol
4. 1-Propanol
5. 2-Methyl-1-propanol
6. 1-Butanol
7. 4-Methyl-2-pentanol
8. 1-Pentanol
9. 2-Methyl-1-Pentanol
10. 1-Hexanol
11. Cyclohexanol
12. 1-Heptanol



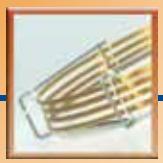
MN Appl. No. 214160

Ordering information

Length →	30 m	60 m
0.25 mm ID (0.4 mm OD)		
0.25 µm film	**726380.30**	**726380.60**
0.50 µm film	**726381.30**	**726381.60**
0.32 mm ID (0.5 mm OD)		
0.25 µm film	**726382.30**	**726382.60**
0.50 µm film	**726383.30**	**726383.60**

In addition to this standard program we will be happy to supply columns custom-made to your specifications.

Each column is individually tested and supplied with test certificate and test chromatogram, but without fittings or ferrules. Columns have fused ends or are sealed with septa, to protect them from atmospheric oxygen. A standard test mixture is included with every column.

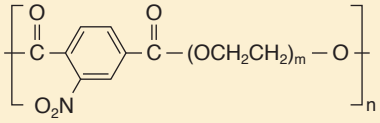


OPTIMA® high performance capillary columns

OPTIMA® FFAP

polyethylene glycol 2-nitroterephthalate

- Polar phase



Similar phases: PERMABOND® FFAP (page 265), DB-FFAP, HP-FFAP, CP-Wax 58 (FFAP) CB, 007-FFAP, CP-FFAP CB, Nukol, BP21

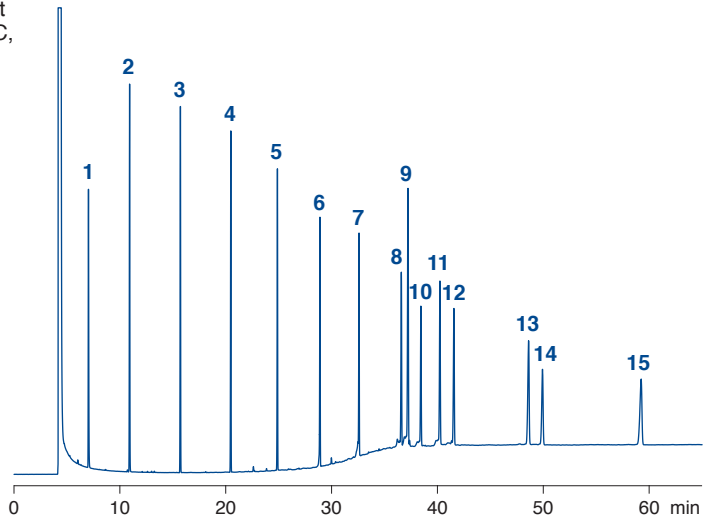
- Columns with 0.10–0.32 mm ID: max. temperature for isothermal operation 240 °C, max. temperature for short isotherms in a temperature program: 250 °C
  0.53 mm ID columns: max. temperatures 220 and 240 °C, resp.
- Recommended application:
  fatty acid methyl esters (FAMEs), free carboxylic acids
- **USP G35** / close equivalent to G25

FAME test

Column: OPTIMA® FFAP, 0.25 µm film, 60 m x 0.32 mm ID
Carrier gas: 1.2 bar He, split
Temperature: 55 °C → 250 °C, 6 °C/min
Injection: 1.0 µL, 220 °C
Detector: FID 220 °C

Peaks:
1. C4
2. C6
3. C8
4. C10
5. C12
6. C14
7. C16
8. C18
9. C18:1 *cis/trans*
10. C18:2
11. C18:3
12. C20
13. C22
14. C22:1
15. C24

MN Appl. No. 211140



Ordering information

Length →	10 m	25 m	30 m	50 m	60 m
0.10 mm ID (0.4 mm OD)					
0.10 µm film	**726180.10**				
0.25 mm ID (0.4 mm OD)					
0.25 µm film		**726116.25**	**726116.30**	**726116.50**	**726116.60**
0.32 mm ID (0.5 mm OD)					
0.25 µm film		**726341.25**	**726341.30**	**726341.50**	**726341.60**
0.50 µm film		**726344.25**	**726344.30**	**726344.50**	
0.53 mm ID (0.8 mm OD)					
0.50 µm film			**726345.30**		
1.00 µm film		**726346.25**			

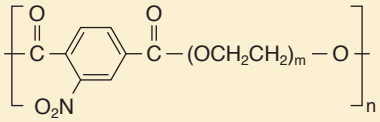
In addition to this standard program we will be happy to supply columns custom-made to your specifications.

To prolong column life, even at highly contaminated or matrix-containing samples, MN offers the option to add an **integrated guard column**. All capillary columns are available with a 10 m guard column with respective deactivation. To order, please add V1 at the end of the REF number. Guard column combinations with other lengths, IDs or different deactivation are available on request.

OPTIMA® FFAPplus

polyethylene glycol 2-nitroterephthalate

- Polar phase



NEW!

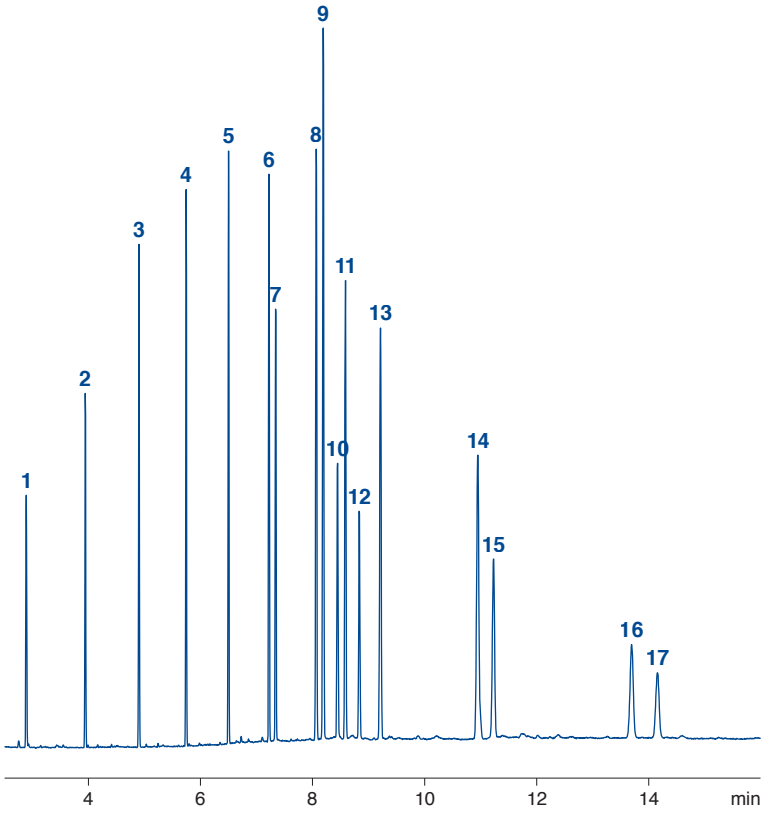
- Max. temperature for isothermal operation 250 °C, max. temperature for short isotherms in a temperature program 260 °C
- Recommended application: FAMEs, free carboxylic acids
- **USP G35** / close equivalent to G25

Similar phases: OPTIMA® FFAP (previous page), DB-FFAP, HP-FFAP, CP-Wax 58 (FFAP) CB, 007-FFAP, CP-FFAP CB, Nukol

FAMEs from biodiesel

Column:	OPTIMA® FFAPplus, 0.25 µm film, 30 m x 0.25 mm ID
Injection:	1 µL, 260 °C, split 1:15
Carrier gas:	40 cm/s He
Temperature:	70 °C (1 min) → 240 °C, 30 °C/min (10 min)
Detector:	MS-EI, ion source 200 °C, interface temperature 250 °C

Peaks:
Methyl esters of:
1. Caproic acid (C6:0)
2. Caprylic acid (C8:0)
3. Capric acid (C10:0)
4. Lauric acid (C12:0)
5. Myristic acid (C14:0)
6. Palmitic acid (C16:0)
7. Palmitoleic acid (C16:1)
8. Stearic acid (C18:0)
9. Oleic acid (C18:1 *cis*)
10. Linoleic acid (C18:2 *cis*)
11. Nonadecanoic acid (C19:0)
12. Linolenic acid (C18:3)
13. Arachidic acid (C20:0)
14. Behenic acid (C22:0)
15. Erucic acid (C22:1 *cis*)
16. Lignoceric acid (C24:0)
17. Nervonic acid (C24:1 *cis*)

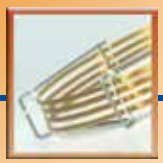


MN Appl. No. 214590

Ordering information

Length →	30 m	60 m
0.25 mm ID (0.4 mm OD)		
0.25 µm film	**726241.30**	**726241.60**
0.50 µm film	**726242.30**	**726242.60**
0.32 mm ID (0.5 mm OD)		
0.25 µm film	**726243.30**	**726243.60**
0.50 µm film	**726246.30**	**726246.60**
In addition to this standard program we will be happy to supply columns custom-made to your specifications.		

On request, all columns can be supplied on a **5 inch (13 cm) cage** for the Agilent GC 6850. To order, please add an E at the end of the REF number (e.g., 726470.30E)

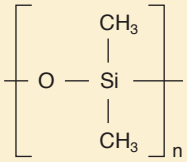


PERMABOND® capillary columns

PERMABOND® SE-30

100 % dimethylpolysiloxane

Nonpolar phase



Max. temperature for isothermal operation 300 °C, max. temperature for short isotherms in a temperature program 320 °C

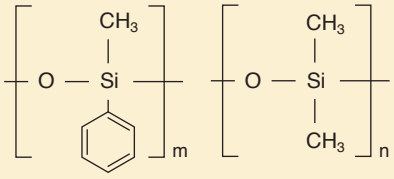
Ordering information

Length →	25 m	50 m
0.25 mm ID (0.4 mm OD)		
0.25 µm film	**723052.25**	**723052.50**
0.32 mm ID (0.5 mm OD)		
0.25 µm film	**723306.25**	
0.50 µm film		**723308.50**
In addition to this standard program we will be happy to supply columns custom-made to your specifications.		

PERMABOND® SE-52

5 % phenyl – 95 % dimethylpolysiloxane

Nonpolar phase

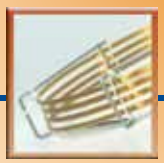


Max. temperature for isothermal operation 300 °C, max. temperature for short isotherms in a temperature program 320 °C

Ordering information

Length →	25 m
0.25 mm ID (0.4 mm OD)	
0.25 µm film	**723054.25**
0.32 mm ID (0.5 mm OD)	
0.25 µm film	**723310.25**
0.50 µm film	**723312.25**
In addition to this standard program we will be happy to supply columns custom-made to your specifications.	

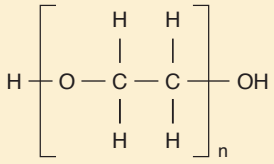
Each column is individually tested and supplied with test certificate and test chromatogram, but without fittings or ferrules. Columns have fused ends or are sealed with septa, to protect them from atmospheric oxygen. A standard test mixture is included with every column.



PERMABOND® CW 20 M

polyethylene glycol 20 000 Da

- Polar phase



Similar phases see OPTIMA® WAX page 260

- 0.1–0.32 mm ID: max. temperature for isothermal operation 220 °C, max. temperature for short isotherms in a temperature program 240 °C
  0.53 mm ID: max. temperatures 200 and 220 °C, resp.
- Recommended for solvent analyses and alcohols
  Suitable for aqueous solutions
- **USP G16**

Ordering information

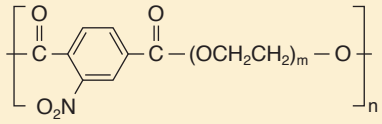
Length →	10 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)					
0.10 µm film	**723064.10**				
0.25 mm ID (0.4 mm OD)					
0.25 µm film	**723060.10**	**723060.25**	**723060.30**	**723060.50**	**723060.60**
0.32 mm ID (0.5 mm OD)					
0.25 µm film	**723321.10**	**723321.25**	**723321.30**	**723321.50**	**723321.60**
0.35 µm film	**723827.10**	**723827.25**		**723827.50**	
0.50 µm film	**723296.10**	**723296.25**	**723296.30**	**723296.50**	**723296.60**
0.53 mm ID (0.8 mm OD)					
0.50 µm film	**723515.10**	**723515.25**			
1.00 µm film	**723549.10**	**723549.25**	**723549.30**		
2.00 µm film	**723517.10**	**723517.25**	**723517.30**		

In addition to this standard program we will be happy to supply columns custom-made to your specifications.

PERMABOND® FFAP

polyethylene glycol 2-nitroterephthalate

- Polar phase

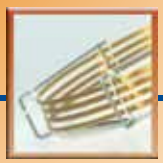


- 0.1–0.32 mm ID: max. temperature for isothermal operation 220 °C, max. temperature for short isotherms in a temperature program 240 °C;
  0.53 mm ID: max. temperatures 200 and 220 °C, resp.
- Recommended for FAME, free carboxylic acids
  Similar phases see OPTIMA® FFAP page 262

Ordering information

Length →	10 m	20 m	25 m	30 m	50 m	60 m
0.1 mm ID (0.4 mm OD)						
0.10 µm film	**723180.10**	**723180.20**				
0.25 µm film	**723181.10**					
0.25 mm ID (0.4 mm OD)						
0.10 µm film			**723936.25**		**723936.50**	
0.25 µm film	**723116.10**		**723116.25**	**723116.30**	**723116.50**	**723116.60**
0.32 mm ID (0.5 mm OD)						
0.10 µm film			**723356.25**		**723356.50**	
0.25 µm film			**723341.25**	**723341.30**	**723341.50**	**723341.60**
0.35 µm film	**723830.10**		**723830.25**		**723830.50**	
0.50 µm film	**723344.10**		**723344.25**	**723344.30**	**723344.50**	**723344.60**
0.53 mm ID (0.8 mm OD)						
1.00 µm film	**723555.10**		**723555.25**		**723555.50**	

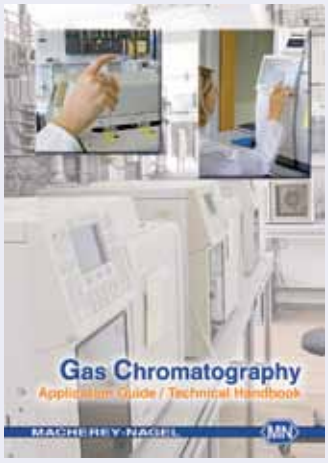
In addition to this standard program we will be happy to supply columns custom-made to your specifications.



Capillary columns for special separations

GC Application Guide

- Explaining basics and principles of GC:
  phase selection by column properties,
  important GC parameters,
  helpful hints for troubleshooting
- **280 selected applications from the fields**
  - ✓ Environmental pollutants
  - ✓ Solvents · chemicals
  - ✓ Fragrances · food and cosmetic components
  - ✓ Drugs · pharmaceutical ingredients
  - ✓ Petrochemical products
  - ✓ Chiral separations
- Latest and more applications at ***www.mn-net.com/apps***



Capillary columns for special GC separations

- Certain analytical separations can be accomplished more easily with chromatographic columns, that have been especially developed for that task, compared with standard columns. The following table summarizes our program of GC speciality capillaries, the individual columns will be described in detail on the following pages.

Separation / special application		Recommended capillary column	Page
Fast GC		OPTIMA® δ-3, OPTIMA® δ-6 OPTIMA® 1, OPTIMA® 5, OPTIMA® 17, OPTIMA® 225, OPTIMA® FFAP PERMABOND® CW 20 M, PERMABOND® FFAP all 0.10 mm ID	267
Enantiomer separation	cyclodextrin phases	FS-LIPODEX® A, FS-LIPODEX® B FS-LIPODEX® C, FS-LIPODEX® D FS-LIPODEX® E, FS-LIPODEX® G FS-HYDRODEX β-PM, FS-HYDRODEX β-3 P FS-HYDRODEX β-6TBDM FS-HYDRODEX β-TBDAc, FS-HYDRODEX γ-TBDAc	268 270
Biodiesel	methanol analysis FAME analysis glycerol and triglycerides	OPTIMA® BioDiesel M OPTIMA® BioDiesel F OPTIMA® BioDiesel G	272 272 272
Triglycerides		OPTIMA® 1-TG OPTIMA® 17-TG	274
High temperature GC		OPTIMA® 5 HT	275
Amines	polyfunctional amines amine separations	OPTIMA® 5 Amine FS-CW 20 M-AM	276 277
Petrochemical products (complex hydrocarbon mixtures)		PERMABOND® P-100	277
Environmental analyses	volatile halogenated hydrocarbons	PERMABOND® SE-54 HKW	278
Silanes (monomeric, e.g., chlorosilanes)		PERMABOND® Silane	279
Diethylene glycol, e.g., for the quality control of wine		PERMABOND® CW 20 M-DEG	279

Columns for Fast GC

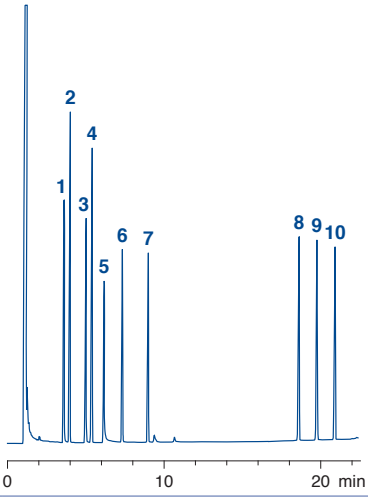
- **Characteristics of Fast GC:** decreased column diameters, high heating rates and decreased column lengths for faster GC separations with high resolution efficiency; small inner diameters combined with very fast temperature programs can reduce the analysis time by up to 80%
- High heating rates place special demands on stationary phases: OPTIMA® columns meet exactly this requirement: very low bleeding, long lifetimes, even for continuous high heating rates
- **System requirements for Fast GC:** high sensitivity detectors with small volume and very short response time, as well as very rapid data acquisition and processing · small inner diameters result in high column inlet pressures and a lower volume flow of the mobile phase: very fast injection of very small samples against a high pressure · amount of sample, which can be injected, is limited by the inner diameter and the thin film

Comparison of a separation on a 50 m standard capillary with separation on a 10 m fast GC column

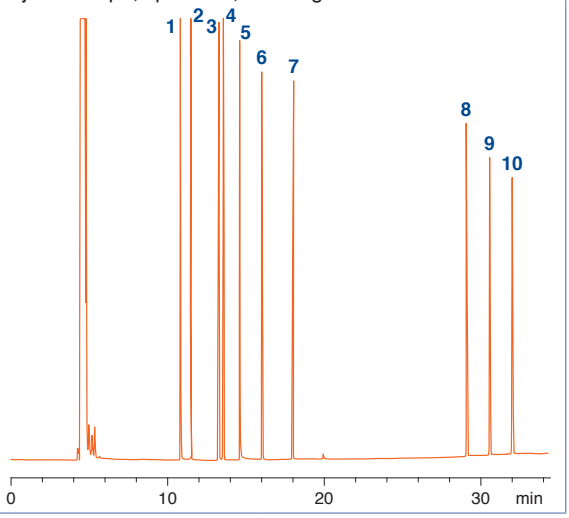
A) Fast GC column
Column: OPTIMA® 5, 0.1 µm film, 10 m x 0.1 mm ID
injection 1 µL, split 1:40, carrier gas 0.75 bar He
Both separations: temperature 80 °C → 320 °C (10 min), 8 °C/min, detector: FID
While maintaining the temperature program and halving the pressure a time saving of 30% results with identical separation efficiency

Peaks:
1. Octanol
2. Undecane
3. Dimethylaniline
4. Dodecane
5. Decylamine
6. Methyl decanoate
7. Methyl undecanoate
8. Henicosane
9. Docosane
10. Tricosane

MN Appl. No. 211260



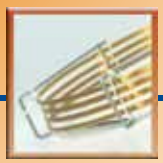
B) standard GC column
Column: OPTIMA® 5, 0.25 µm film, 50 m x 0.25 mm ID
injection 1 µL, split 1:35, carrier gas 1.5 bar He



Ordering information

Phase	Max. temperature	ID [mm]	Film thickness [µm]	REF (10 m)	REF (20 m)
OPTIMA® 1	340 / 360 °C	0.10	0.10	726024.10	726024.20
		0.10	0.40		726025.20
OPTIMA® 5	340 / 360 °C	0.10	0.10	726846.10	
OPTIMA® δ-3	340 / 360 °C	0.10	0.10	726410.10	726410.20
OPTIMA® δ-6	340 / 360 °C	0.10	0.10	726490.10	
OPTIMA® 17	320 / 340 °C	0.10	0.10	726848.10	
OPTIMA® 225	260 / 280 °C	0.10	0.10	726080.10	
OPTIMA® FFAP	250 / 260 °C	0.10	0.10	726180.10	
PERMABOND® CW 20 M	220 / 240 °C	0.10	0.10	723064.10	
PERMABOND® FFAP	220 / 240 °C	0.10	0.10	723180.10	723180.20
		0.10	0.25	723181.10	
OPTIMA® 5 Amine	300 / 320 °C	0.10	0.40	726361.10	
FS-CW 20 M-AM	220 / 240 °C	0.10	0.20	733111.10	
FS-LIPODEX® E	200 / 220 °C	0.10	0.10	723382.10	
FS-HYDRODEX β-6TBDM	230 / 250 °C	0.10	0.10	723383.10	

In addition to this standard program, all MN GC phases can be custom-made as fast GC columns.



Capillary columns for enantiomer separation

LIPODEX® — cyclodextrin phases for enantiomer separation

- Base material: cyclic oligosaccharides consisting of six (α-cyclodextrin), seven (β-cyclodextrin) or eight (γ-cyclodextrin) glucose units bonded through α-1,4-linkages

  Regioselective alkylation and / or acylation of the hydroxyl groups leads to lipophilic phases with varying enantioselectivity, which are well suited for GC enantiomer analyses

  Important advantage: many compounds can be analyzed without derivatization (however, for certain substances enantioselectivity can be favorably influenced by formation of derivatives)
- A large number of separations have been achieved, however, it is not possible to make a general prediction, which phase could solve a given separation task. Even for compounds with small structural differences or within homologous series the enantiodifferentiation can be quite different. The descriptions below list some of the typical separations possible with individual phases.
- Water as solvent is strictly forbidden for all cyclodextrin phases. We recommend to dry the sample with our CHROMAFIX® Dry cartridges (page 47) and to dissolve it in an appropriate nonpolar solvent in any case.

LIPODEX® A — hexakis-(2,3,6-tri-O-pentyl)-α-cyclodextrin

- Recommended application: carbohydrates, polyols, diols, hydroxycarboxylic acid esters, (epoxy-) alcohols, glycerol derivatives, spiroacetals, ketones, alkyl halides

Max. temperature for isothermal operation 200 °C, max. temperature for short isotherms in a temperature program 220 °C

LIPODEX® B — hexakis-(2,6-di-O-pentyl-3-O-acetyl)-α-cyclodextrin

- Recommended application: lactones, diols (cyclic carbonates), aminols, aldols (O-TFA), glycerol derivatives (cyclic carbonates)

Max. temperature for isothermal operation 200 °C, max. temperature for short isotherms in a temperature program 220 °C

LIPODEX® C — heptakis-(2,3,6-tri-O-pentyl)-β-cyclodextrin

- Recommended application: alcohols, cyanhydrins, olefins, hydroxycarboxylic acid esters, alkyl halides

Max. temperature for isothermal operation 200 °C, max. temperature for short isotherms in a temperature program 220 °C

LIPODEX® D — heptakis-(2,6-di-O-pentyl-3-O-acetyl)-β-cyclodextrin

- Recommended application: amines (TFA), aminols (TFA), trans-cycloalkane-1,2-diols, trans-cycloalkane-1,3-diols (TFA), β-amino acid esters

Max. temperature for isothermal operation 200 °C, max. temperature for short isotherms in a temperature program 220 °C

LIPODEX® E — octakis-(2,6-di-O-pentyl-3-O-butyryl)-γ-cyclodextrin

- Recommended application: α-amino acids, α- and β-hydroxycarboxylic acid esters, alcohols (TFA), diols (TFA), ketones, pheromones (cyclic acetals), amines, alkyl halides, lactones

Max. temperature for isothermal operation 200 °C, max. temperature for short isotherms in a temperature program 220 °C

LIPODEX® G — octakis-(2,3-di-O-pentyl-6-O-methyl)-γ-cyclodextrin

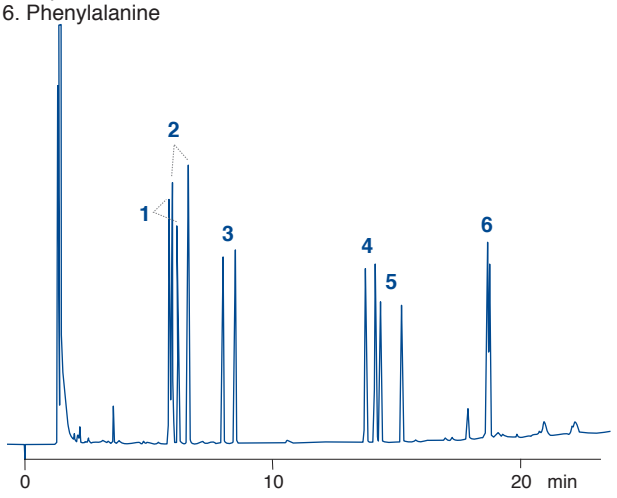
- Recommended application: menthol isomers, ketones, alcohols, carboxylic acid esters, terpenes

Max. temperature for isothermal operation 220 °C, max. temperature for short isotherms in a temperature program 240 °C

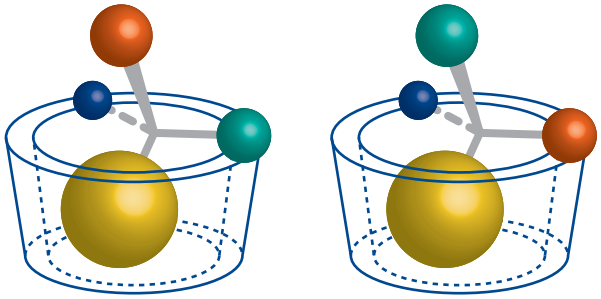
Enantiomer separation of amino acid methyl esters (TFA)

Column: FS-LIPODEX® E, 25 m x 0.25 mm ID
Volume: 1 µL, split ~ 1:100
Carrier gas: 60 kPa H_2
Temperature: 90 → 190 °C, 4 °C/min
Detector: FID 250 °C

Peaks:
(D is eluted before L except for proline: L before D)
1. Alanine
2. Valine
3. Leucine
4. Proline
5. Aspartic acid
6. Phenylalanine



MN Appl. No. 202592

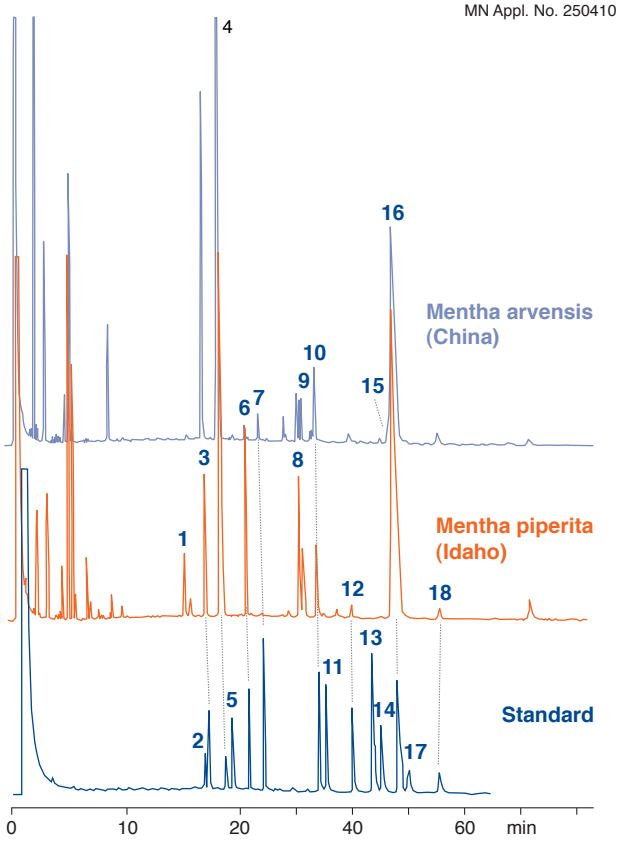


Separation of chiral constituents of peppermint oil

W. A. König et al., High Resol. Chromatogr. **20** (1997) 55–61
Column: FS-LIPODEX® G, 25 m x 0.25 mm ID
Carrier gas: 50 kPa H_2
Temperature: 75 °C, isothermal
Detector: FID

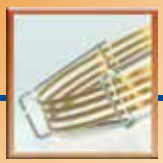
Peaks:
1. (+)-*trans*-Sabinene hydrate
2. (+)-Menthone
3. (+)-Isomenthone
4. (–)-Menthone
5. (–)-Isomenthone
6. (+)-Menthofuran
7. (–)-Isopulegol
8. (–)-Menthyl acetate
9. (+)-Pulegone
10. (+)-Neomenthol
11. (–)-Neomenthol
12. (+)-Neoisomenthol
13. (+)-Menthol
14. (–)-Neoisomenthol
15. (+)-Piperitone
16. (–)-Menthol
17. (+)-Isomenthol
18. (–)-Isomenthol

MN Appl. No. 250410



Ordering information

Length → all columns 0.4 mm OD	10 m 0.10 mm ID	25 m 0.25 mm ID	50 m 0.25 mm ID
FS-LIPODEX® A		723360.25	723360.50
FS-LIPODEX® B		723362.25	723362.50
FS-LIPODEX® C		723364.25	723364.50
FS-LIPODEX® D		723366.25	723366.50
FS-LIPODEX® E	723382.10	723368.25	723368.50
FS-LIPODEX® G		723379.25	723379.50



Capillary columns for enantiomer separation

HYDRODEX — cyclodextrin phases for enantiomer separation

- Cyclodextrin derivatives with high melting point: for GC enantiomer separation diluted with polysiloxanes

HYDRODEX β-PM — heptakis-(2,3,6-tri-O-methyl)-β-cyclodextrin (CD)

Phase diluted with optimized polysiloxane

- Recommended application: hydroxycarboxylic acid esters, alcohols, diols, olefins, lactones, acetals

Max. temperature for isothermal operation 230 °C, max. temperature for short isotherms in a temperature program 250 °C

HYDRODEX β-3P — heptakis-(2,6-di-O-methyl-3-O-pentyl)-β-CD

Phase diluted with optimized polysiloxane

- Recommended application: terpenes, dienes, allenes, terpene alcohols, 1,2-epoxyalkanes, carboxylic acids (esters), hydroxycarboxylic acid esters, pharmaceuticals, pesticides

Max. temperature for isothermal operation 230 °C, max. temperature for short isotherms in a temperature program 250 °C

HYDRODEX β-6TBDM — heptakis-(2,3-di-O-methyl-6-O-*t*-butyldimethyl-silyl)-β-CD

Phase diluted with optimized polysiloxane

- Recommended application: γ-lactones, cyclopentanones, terpenes, esters, tartrates

Max. temperature for isothermal operation 230 °C, max. temperature for short isotherms in a temperature program 250 °C

HYDRODEX β-TBDAc — heptakis-(2,3-di-O-acetyl-6-O-*t*-butyldimethyl-silyl)-β-CD

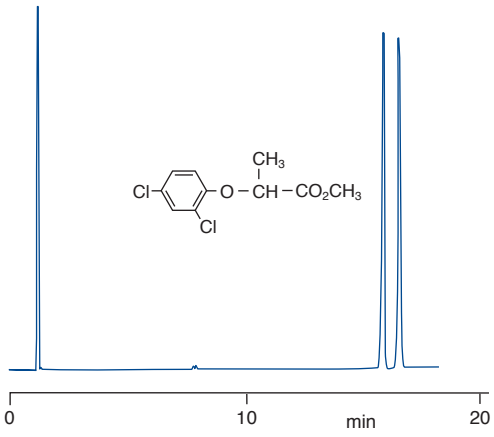
Phase diluted with optimized polysiloxane

- Recommended application: alcohols, esters, ketones, aldehydes, δ-lactones etc.

Max. temperature for isothermal operation 220 °C, max. temperature for short isotherms in a temperature program 240 °C

Enantiomer separation of dichlorprop methyl ester

Column:	HYDRODEX β-3P, 25 m x 0.25 mm ID
Injection:	0.1 µL (~1 % in CH_2Cl_2), split 130 mL/min
Carrier gas:	60 kPa H_2 (1.9 mL/min)
Temperature:	160 °C
Detector:	FID 250 °C



MN Appl. No. 202542

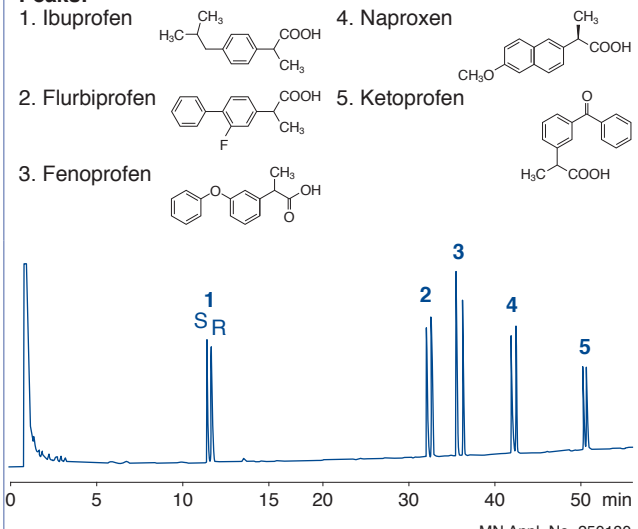
Separation of isomeric antiinflammatory drugs

Courtesy of Prof. W.A. König, Hamburg, Germany

Column:	HYDRODEX β-6TBDM, 25 m x 0.25 mm ID
Carrier gas:	He
Temperature:	135 °C → 200 °C, 1 °C/min
Detector:	FID

Peaks:

1. Ibuprofen
2. Flurbiprofen
3. Fenoprofen
4. Naproxen
5. Ketoprofen



MN Appl. No. 250180

HYDRODEX γ-TBDAc

octakis-(2,3-di-O-acetyl-6-O-*t*-butyldimethyl-silyl)-γ-CD

Phase diluted with optimized polysiloxane

- Recommended application: cyclic ketones, aromatic ketones, oxiranes, aromatic esters, aromatic amides etc.

Max. temperature for isothermal operation 220 °C, max. temperature for short isotherms in a temperature program 240 °C

HYDRODEX γ-DiMOM

octakis-(2,3-di-O-methoxymethyl-6-O-*t*-butyldimethylsilyl)-γ-CD

Phase diluted with optimized polysiloxane

- Recommended application: ketones, terpenes, cyclic ethers, alcohols, amines

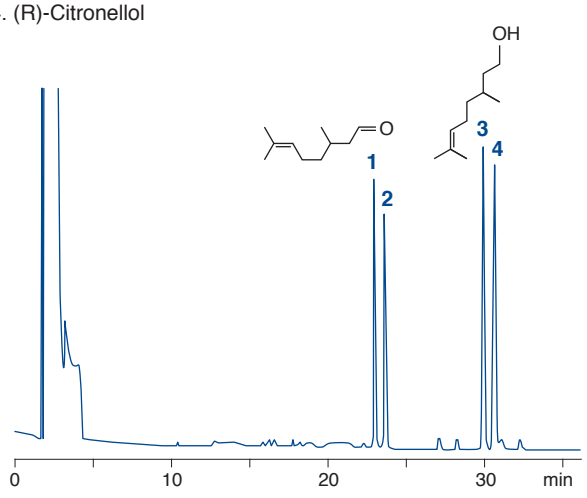
Max. temperature for isothermal operation 220 °C, max. temperature for short isotherms in a temperature program 240 °C

Separation of (R/S) citronellol + citronellal

Column: FS-HYDRODEX β-TBDAc, 50 m x 0.25 mm ID
Injection: 1 µL, 1:1000 in CH_2Cl_2, split 25 mL/min
Carrier gas: 1.5 bar H_2
Temperature: 100 °C
Detector: FID 220 °C

Peaks:

1. (R)/(S)-Citronellal
2. (S)/(R)-Citronellal
3. (S)-Citronellol
4. (R)-Citronellol



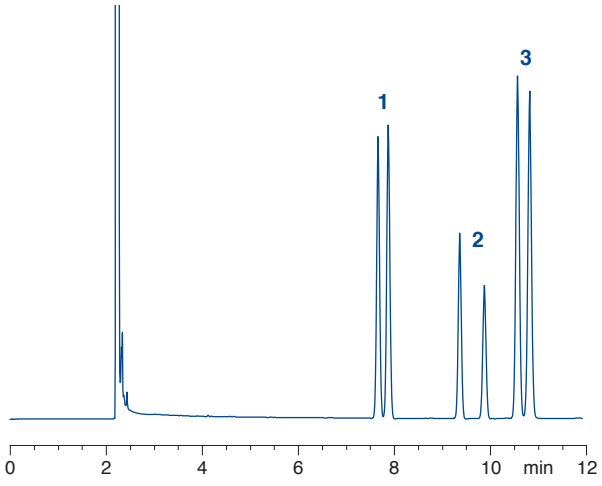
MN Appl. No. 212440

Separation of essential oils

Column: FS-HYDRODEX γ-TBDAc, 50 m x 0.25 mm ID
Injector: 220 °C
Carrier gas: 1.2 bar H_2
Temperature: 125 °C
Detector: FID 220 °C

Peaks:

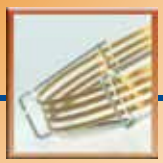
1. Fenchone (1.5 mg/mL)
2. Menthone (0.5 mg/mL)
3. Menthol (2 mg/mL)



MN Appl. No. 212980 / 212990 / 213000

Ordering information

Length →	10 m	25 m	50 m
all columns 0.4 mm OD	0.10 mm ID	0.25 mm ID	0.25 mm ID
FS-HYDRODEX β-PM		723370.25	723370.50
FS-HYDRODEX β-3P		723358.25	723358.50
FS-HYDRODEX β-6TBDM	723383.10	723381.25	723381.50
FS-HYDRODEX β-TBDAc		723384.25	723384.50
FS-HYDRODEX γ-TBDAc		723387.25	723387.50
FS-HYDRODEX γ-DiMOM		723388.25	723388.50



Capillary columns for analysis of biodiesel

OPTIMA® BioDiesel

for the analysis of biodiesel (DIN EN 14214 / ASTM D 6751)

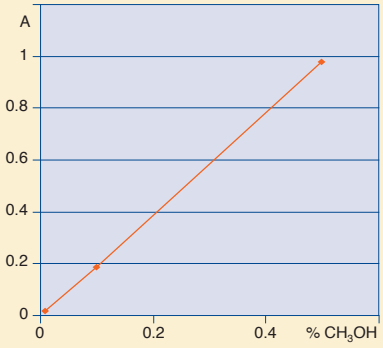
OPTIMA® BioDiesel M

for analysis of methanol in accordance with DIN EN 14110

The methanol content in biodiesel as specified in DIN EN 14110 must not exceed 0.2 %. The column OPTIMA® BioDiesel M allows the GC headspace analysis of the methanol content in biodiesel in the concentration range from 0.01 to 0.5 % with 2-propanol as internal standard. The graph on the right shows the linearity of the determination in the required range (A = area[methanol]/area[2-propanol]).

Similar phases: Select™ Biodiesel for Methanol, Trace TR-BioDiesel (M)

Max. temperature for isothermal operation 340 °C, max. temperature for short isotherms in a temperature program 360 °C



OPTIMA® BioDiesel F

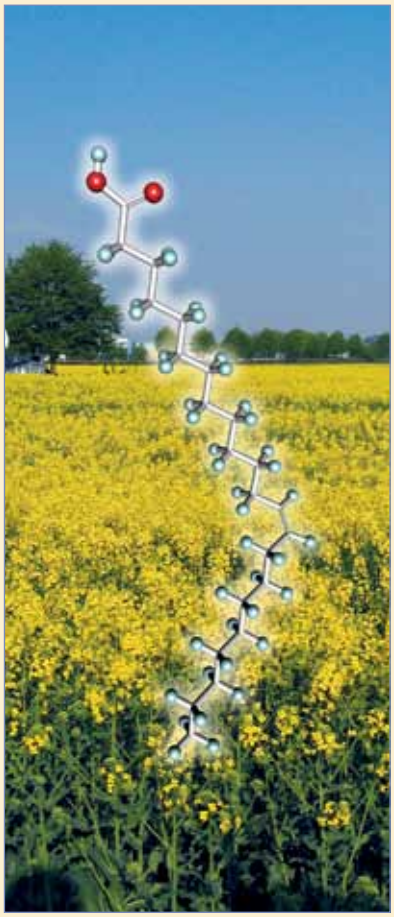
for analysis of FAMEs in accordance with DIN EN 14103:2011

The analysis of biodiesel requires separation of typical FAMEs between myristic acid (C14) and nervonic acid (C24:1) methyl esters. This analysis is possible on OPTIMA® BioDiesel F in only 22 min. Additionally, linolenic acid methyl ester can be determined due to the good resolution.

The extended standard DIN EN 14103:2011 also covers smaller FAMEs starting from C6 (see application 214510 on opposite page). Change of the internal standard from C17 to C19 also allows the analysis of animal fats.

Similar phases: Select™ Biodiesel for FAME, Trace TR-BioDiesel (F)

Max. temperature for isothermal operation 240 °C, max. temperature for short isotherms in a temperature program 250 °C



OPTIMA® BioDiesel G

for analysis of glycerol and glycerides in accordance with DIN EN 14105

The capillary column OPTIMA® BioDiesel G allows determination of free glycerol and residues of mono-, di- and triglycerides in FAMEs intended as additives for mineral oils. The procedure can be applied for FAMEs from rapeseed oil, sunflower oil and soy bean oil. Glycerol as well as mono- and diglycerides are derivatized to more volatile substances by addition of MSTFA (see page 286) in the presence of pyridine.

Similar phases: Select™ Biodiesel for Glycerides, Trace TR-BioDiesel (G), MET-Biodiesel

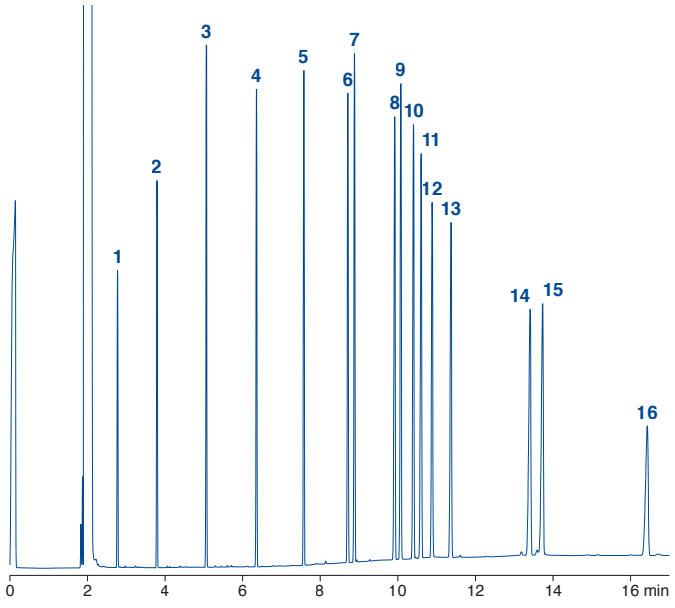
Max. temperature for isothermal operation 380 °C, max. temperature for short isotherms in a temperature program 400 °C

Capillary columns for analysis of biodiesel

Analysis of FAMEs from biodiesel in accordance with DIN EN 14103:2011

Column:	OPTIMA® BioDiesel F, 30 m x 0.25 mm ID
Sample:	50 µg/mL each in dichloromethane
Injection:	10 µL, 250 °C, split 1:20
Carrier gas:	1.2 bar He
Temperature:	80 °C → 250 °C (8.5 min), 20 °C/min
Detector:	FID 260 °C

Peaks:
1. C6:0
2. C8:0
3. C10:0
4. C12:0
5. C14:0
6. C16:0
7. C16:1
8. C18:0
9. C18:1
10. C18:2
11. C19:0, int. st.
12. C18:3
13. C20:0
14. C22:0
15. C22:1
16. C24:0

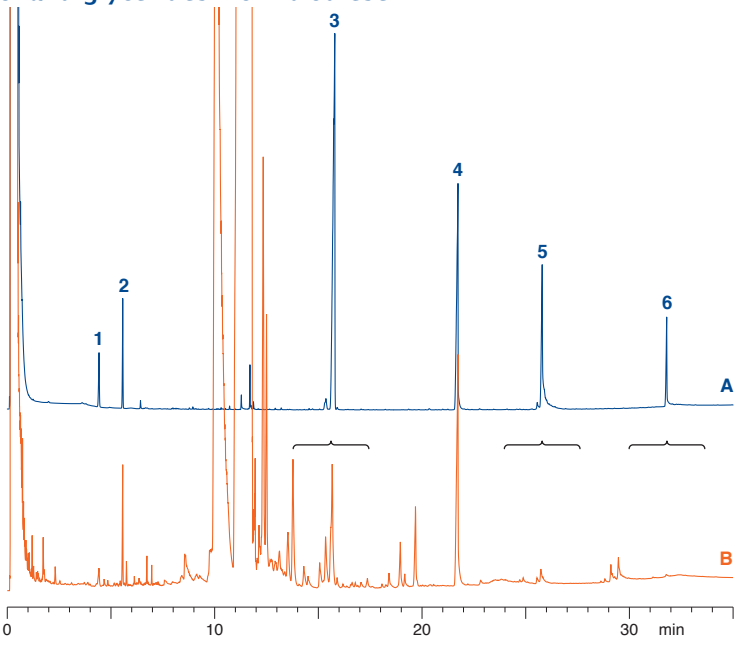


MN Appl. No. 214510

Analysis of glycerol and glycerides from biodiesel

Column:	OPTIMA® BioDiesel G, 10 m x 0.25 mm ID
Sample:	A) standard in *n*-heptane B) biodiesel
Injection:	2 µL, 350 °C, split 1:2.6 CIS (15 °C → 350 °C, 12 °C/s)
Carrier gas:	0.8 bar H_2
Temperature:	50 °C (3.5 min) → 180 °C, 15 °C/min → 280 °C, 7 °C/min → 370 °C (10 min), 10 °C/min
Detector:	FID 380 °C

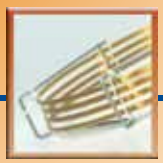
Peaks:
1. Glycerol (TMS)
2. Butanetriol (TMS), IS
3. Monoolein = glycerol monooleate (TMS)
   + monoacylglycerides
4. Tricaprin (glycerol tricaprate), IS
5. Diolein = glycerol dioleate (TMS)
   + diacylglycerides
6. Triolein = glycerol trioleate
   + triacylglycerides



MN Appl. No. 213640

Ordering information

	Length → 10 m	30 m
OPTIMA® BioDiesel M		
0.32 mm ID (0.5 mm OD)		**726905.30**
OPTIMA® BioDiesel F		
0.25 mm ID (0.4 mm OD)		**726900.30**
OPTIMA® BioDiesel G		
0.25 mm ID (0.4 mm OD)	**726903.10**	



Capillary columns for special separations

OPTIMA® 1-TG · OPTIMA® 17-TG

for triglyceride analyses

- **OPTIMA® 1-TG**
  100 % dimethylpolysiloxane
  offers separation according to carbon number
  Similar phases:
  SPB-1 TG, DB-1 HT, 400-1 HT, HT-5
- **USP G1 / G2 / G38**
- **OPTIMA® 17-TG**
  phenyl-methyl-polysiloxane (50 % phenyl) for separation according to degree of unsaturation
- **USP G3**

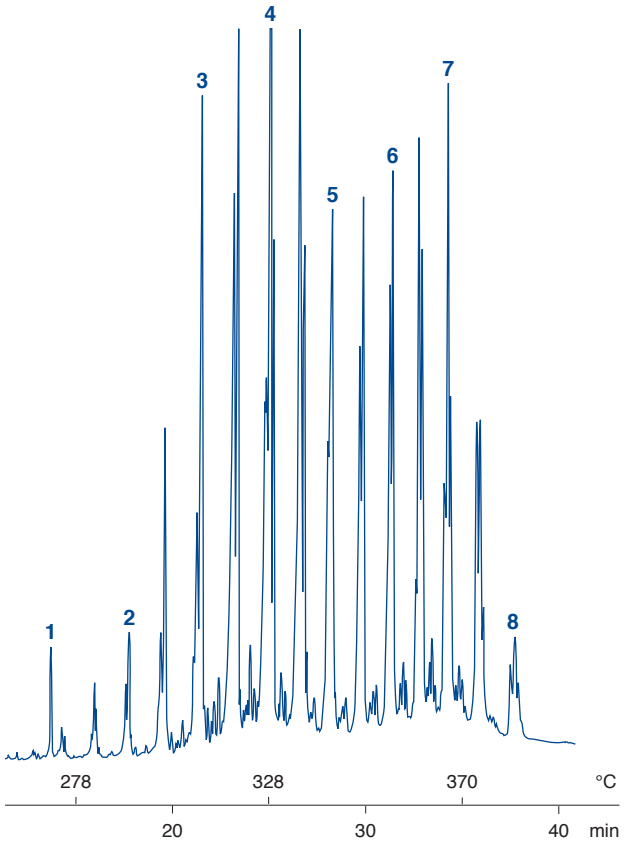
- Max. temperature for both phases: 370 °C
- Short capillary columns (max. 25 m and 0.32 mm ID) with low-bleeding stationary phases thermally stable with optimized deactivation

Triglycerides (from butter)

Column: OPTIMA® 1-TG, 25 m x 0.32 mm ID
Injection: 0.5 µL
Carrier gas: 80 kPa H_2
Temperature: 80 °C (1 min) → 250 °C, 20 °C/min → 370 °C (10 min), 5 °C/min
Detector: FID 380 °C

Peaks:
1. Cholesterol
2. T-30
3. T-34
4. T-38
5. T-42
6. T-46
7. T-50
8. T-54

MN Appl. No. 201790



Ordering information

	Length →	10 m	25 m
OPTIMA® 1-TG	0.25 mm ID (0.4 mm OD)	726133.10	726133.25
	0.32 mm ID (0.5 mm OD)	726132.10	726132.25
OPTIMA® 17-TG	0.32 mm ID (0.5 mm OD)	726131.10	726131.25

OPTIMA® 5 HT

for high temperature GC

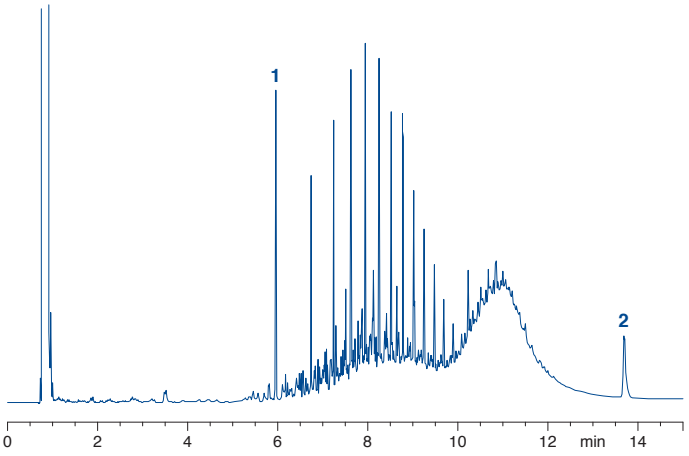
- Ultra low bleed silarylene phase with 5-type polarity
  Nonpolar phase, ideal for MS detectors, can be rinsed with solvents
- Similar phases: DB-5HT, VF-5HT, HT-5, XTI-5HT, ZB-5HT
- Max. temperature for isothermal operation 380 °C, max. temperature for short isotherms in a temperature program 400 °C
- Recommended application: for simulated distillation, hydrocarbon, fuel and oil analysis, high-boiling analytes
- **USP G27 / G36**

Separation of motor oil / mineral oil (type A + B), rapid determination in accordance with DIN H-53 / ISO DIS 9377 with a steep heating rate

Column:	OPTIMA® 5 HT, 0.25 µm film, 15 m x 0.32 mm ID
Sample:	mineral oil type A + B (hydrocarbon index kit acc. to EN ISO 9377-2) in hexane
Injection:	1 µL, splitless, 300 °C
Carrier gas:	0.6 bar He
Temperature:	40 °C (5 min) → 390 °C, 50 °C/min
Detector:	FID 280 °C

Peaks:

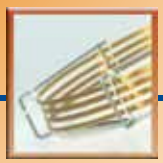
1. Decane (C10)
2. Tetracontane (C40)



MN Appl. No. 213400

Ordering information

Length →	15 m	30 m
0.25 mm ID (0.4 mm OD)		
0.10 µm film	**726102.15**	**726102.30**
0.25 µm film	**726106.15**	**726106.30**
0.32 mm ID (0.5 mm OD)		
0.10 µm film	**726104.15**	**726104.30**
0.25 µm film	**726108.15**	**726108.30**



Capillary columns for special separations

OPTIMA® 5 Amine

special column for analysis of amines

- Especially deactivated for the analysis of polyfunctional amines such as ethanolamines, amino-functionalized diols and similar compounds, which are important base materials in industrial chemistry, and show strong tailing on standard-deactivated columns

  Similar phases: Rtx-5 Amine, PTA-5, CP-Sil 8 CB for Amines
- **USP G27** / G36

- Max. temperature for isothermal operation 300 °C, max. temperature for short isotherms in a temperature program 320 °C
- Improved linearity for analyses of active components at trace levels: no amine absorptions even for aliphatic and aromatic amines at concentrations of 100 pg/peak

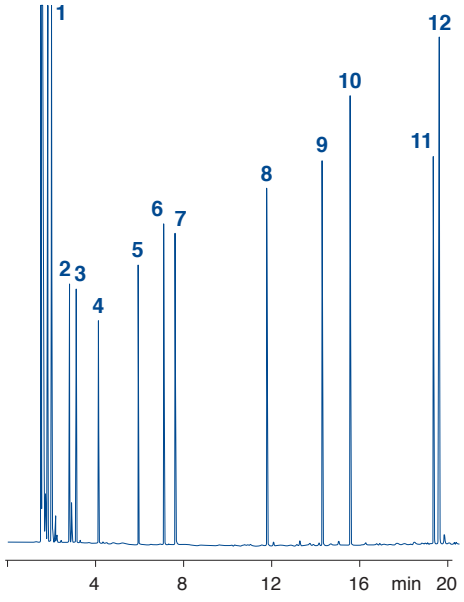
  Tested with the OPTIMA® Amine test mixture (REF 722317), which contains, amongst others, diethanolamine and propanol-pyridine (this test mixture is supplied with each column)

Separation of secondary and tertiary amines

Column: OPTIMA® 5 Amine, 0.5 µm film, 30 m x 0.25 mm ID
Injection: 1 µL, split 1:100
Carrier gas: 0.6 bar H_2
Temperature: 100 °C (3 min) → 280 °C, 10 °C/min
Detector: FID 280 °C

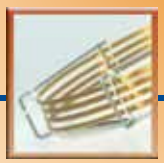
Peaks:
1. Diethylamine
2. Di-isopropylamine
3. Triethylamine
4. Di-*n*-propylamine
5. Di-*n*-butylamine
6. Tri-*n*-propylamine
7. Di-isobutylamine
8. Tri-*n*-butylamine
9. Di-isohexylamine
10. Dicyclohexylamine
11. Dibenzylamine
12. Tri-*n*-hexylamine

MN Appl. No. 210280



Ordering information

Length →	10 m	25 m	30 m
0.1 mm ID (0.4 mm OD)			
0.40 µm film	**726361.10**		
0.2 mm ID (0.4 mm OD)			
0.35 µm film		**726355.25**	
0.25 mm ID (0.4 mm OD)			
0.50 µm film			**726354.30**
1.00 µm film			**726358.30**
0.32 mm ID (0.5 mm OD)			
0.25 µm film			**726360.30**
1.00 µm film			**726353.30**
1.50 µm film			**726356.30**
0.53 mm ID (0.8 mm OD)			
1.00 µm film			**726359.30**
3.00 µm film			**726357.30**



FS-CW 20 M-AM

polyethylene glycol 20 000, non-immobilized

- Polyethylene glycol, basic for amine separations
  Similar phases: Carbowax™ Amine, CP-Wax 51, CAM, Stabilwax® DB
- **USP G16**

Max. temperature for isothermal operation 220 °C, max. temperature for short isotherms in a temperature program 240 °C

Ordering information

Length →	10 m	25 m	50 m
0.1 mm ID (0.4 mm OD)			
0.20 µm film	**733111.10**		
0.25 mm ID (0.4 mm OD)			
0.25 µm film		**733110.25**	**733110.50**
0.32 mm ID (0.5 mm OD)			
0.25 µm film		**733299.25**	**733299.50**
0.35 µm film			**733442.50**
0.53 mm ID (0.8 mm OD)			
1.00 µm film		**733551.25**	

PERMABOND® P-100

for analyses of petrochemical products

- Extra long column with nonpolar dimethylpolysiloxane phase
  High resolution and sufficient capacity for analysis of complex mixtures of hydrocarbons
- **USP G1 / G2 / G38**

Max. temperature for isothermal operation 300 °C, max. temperature for short isotherms in a temperature program 320 °C

Ordering information

Length →	100 m
0.25 mm ID (0.4 mm OD)	
0.50 µm film	**723890.100**

Capillary columns for special separations

PERMABOND® SE-54-HKW — for volatile halogenated hydrocarbons

- SE-54 optimized for volatile halogenated hydrocarbons
- **USP G36**

Max. temperature for isothermal operation 300 °C, max. temperature for short isotherms in a temperature program 320 °C

For the analysis of halogenated hydrocarbons, we recommend our optimized column PERMABOND® SE-54-HKW at 25 or 50 m length with our approved polysiloxane phase SE-54. As an alternative, or to verify analytical results, the OPTIMA® 624 has proven itself as advantageous, especially for the determination of 1,1,2-trichlorotrifluoroethane (F 113) along with dichloromethane. Both phases are also suited for the determination of vinyl chloride as well as for the separation of *cis/trans* isomers of 1,2-dichloroethene. The high film thickness secures a high capacity and an outstanding resolution. For GC/MS coupling, we recommend OPTIMA® 624 *LB* or OPTIMA® 624 with 0.2 or 0.25 mm ID.

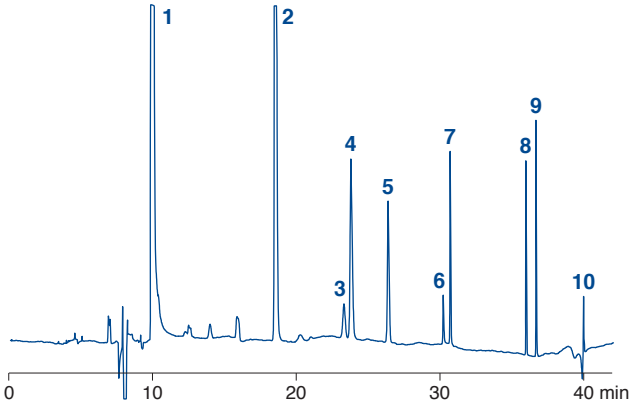
Volatile halogenated hydrocarbons

Column: PERMABOND® SE-54-HKW, 50 m x 0.32 mm ID
Injection: 1 µL, split ~ 1:30
Carrier gas: 0.9 bar He
Temperature: 35 °C (25 min) → 160 °C (5 min), 10 °C/min
Detector: ECD 300 °C

Peaks:

1. Dichloromethane (795 ng/mL)
2. Trichloromethane (75 ng/mL)
3. 1,1,1-Trichloroethane (67 ng/mL)
4. 1,2-Dichloroethane (100 ng/mL)
5. Tetrachloromethane (15.9 ng/mL)
6. Trichloroethene (14.6 ng/mL)
7. Bromodichloromethane (20 ng/mL)
8. Dibromochloromethane (122 ng/mL)
9. Tetrachloroethene (81 ng/mL)
10. Tribromomethane (28.9 ng/mL)

MN Appl. No. 2124880



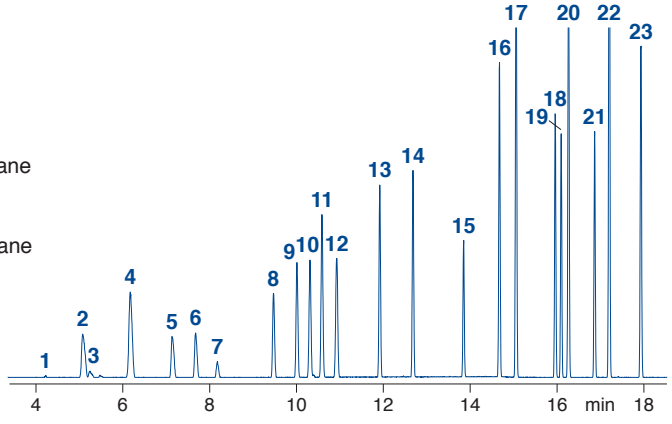
Volatile halogenated hydrocarbons and BTX

Column: OPTIMA® 624, 50 m x 0.25 mm ID
Injection: 1 µL, split 50 mL/min
Carrier gas: 0.9 mL/min He (constant flow)
Temperature: 40 °C (5 min) → 160 °C, 10 °C/min
Detector: MSD 5971

Peaks:

1. Vinyl chloride
2. Trichlorofluoromethane (F 11)
3. Pentane
4. 1,1,2-Trichlorotrifluoroethane (F 113)
5. Dichloromethane
6. *trans*-1,2-Dichloroethene
7. Hexane
8. *cis*-1,2-Dichloroethene
9. Trichloromethane
10. 1,1,1-Trichloroethane
11. Tetrachloromethane
12. 1,2-Dichloroethane + benzene
13. Trichloroethene
14. Bromodichloromethane
15. Toluene
16. Tetrachloroethene
17. Dibromochloromethane
18. Chlorobenzene
19. Ethylbenzene
20. *m*- + *p*-Xylene
21. *o*-Xylene
22. Tribromomethane
23. Bromobenzene

MN Appl. No. 200160



Ordering information

Length →	25 m	50 m
0.32 mm ID (0.5 mm OD)		
1.80 µm film	**723945.25**	**723945.50**

PERMABOND® Silane

for silane analyses

- Developed especially for the analysis of monomeric silanes and chlorosilanes (not for the separation of trimethylsilyl derivatives)
  Also suited for the separation of dimeric siloxanes and silazanes
- Columns with 0.32 mm ID: max. temperature for isothermal operation 260 °C, max. temperature for short isotherms in a temperature program 280 °C; 0.53 mm ID columns: max. temperatures 240 and 260 °C, resp.

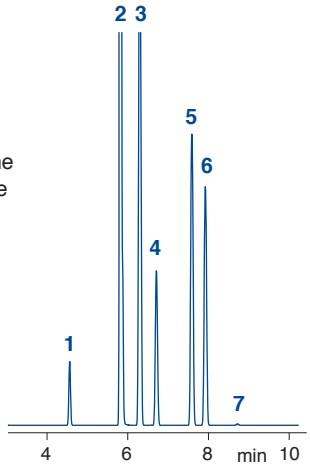
Ordering information

Length →	25 m	50 m
0.32 mm ID (0.5 mm OD)		**723409.50**
0.53 mm ID (0.8 mm OD)	**723411.25**	

Chloromethylsilanes

Column: PERMABOND® Silane, 50 m x 0.32 mm ID
Injection: 0.5 µL gas, split 80 mL/min
Carrier gas: 1 mL/min He (constant flow)
Temperature: 50 °C → 100 °C, 5 °C/min
Detector: MSD 5971

Peaks:
1. Tetramethylsilane
2. Dichloromethane
3. Tetrachlorosilane
4. Chlorotrimethylsilane
5. Methyltrichlorosilane
6. Dichlorodimethylsilane
7. Hexamethyldisiloxane

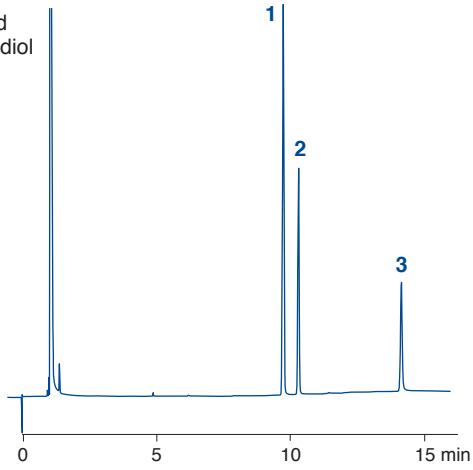


MN Appl. No. 200090

Diethylene glycol standard in wine

Column: PERMABOND® CW 20 M-DEG, 25 m x 0.25 mm ID
Injection: 0.5 µL, split ~1:40
Carrier gas: 1.2 bar N_2
Temperature: 80 °C → 200 °C, 10 °C/min
Detector: FID 260 °C

Peaks:
DEG standard
1. 1,4-Butanediol
2. Diethylene glycol
3. Glycerol



MN Appl. No. 201500

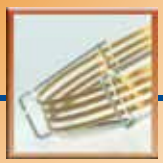
PERMABOND® CW 20 M-DEG

for determination of diethylene glycol

- Polyethylene glycol 20 000 (diethylene glycol tested)
- Recommended application: determination of diethylene glycol, e.g., for the quality control of wine
- Max. temperature for isothermal operation 220 °C, max. temperature for short isotherms in a temperature program 240 °C
- **USP G16**

Ordering information

Length →		25 m
0.25 mm ID (0.4 mm OD)	0.25 µm film	**723063.25**
0.32 mm ID (0.5 mm OD)	0.25 µm film	**723327.25**



Fused silica capillaries

Untreated capillaries

- Recommended applications:
  for capillary electrophoresis · for preparation of capillary columns · for capillary LC applications

Ordering information

Length →	1 m (pack of 3)	10 m (pack of 1)	25 m (pack of 1)
Capillaries for electrophoresis			
0.025 mm ID (0.4 mm OD)	**723793.1**	**723793.2**	
0.05 mm ID (0.4 mm OD)	**723790.1**	**723790.2**	
0.075 mm ID (0.4 mm OD)	**723791.1**	**723791.2**	
0.10 mm ID (0.4 mm OD)	**723792.1**	**723792.2**	
Untreated capillaries			
0.20 mm ID (0.4 mm OD)		**723148.10**	**723148.25**
0.25 mm ID (0.4 mm OD)		**723101.10**	**723101.25**
0.32 mm ID (0.5 mm OD)		**723151.10**	**723151.25**
0.53 mm ID (0.8 mm OD)		**723501.10**	**723501.25**

Untreated capillaries are supplied without cage.

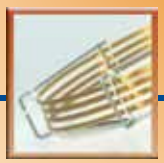
Deactivated capillary columns (precolumns)

- Recommended applications:
  Preparation of capillary columns
  As precolumns, whenever a larger contamination capacity is required.

Ordering information

Length →	10 m	25 m
Methyl-Sil deactivated (max. temperature 320 °C)		
0.25 mm ID (0.4 mm OD)	**723106.10**	**723106.25**
0.32 mm ID (0.5 mm OD)	**723346.10**	**723346.25**
0.53 mm ID (0.8 mm OD)	**723558.10**	**723558.25**
Phenyl-Sil deactivated (max. temperature 320 °C)		
0.25 mm ID (0.4 mm OD)	**723108.10**	**723108.25**
0.32 mm ID (0.5 mm OD)	**723348.10**	**723348.25**
0.53 mm ID (0.8 mm OD)	**723560.10**	**723560.25**
CW deactivated (max. temperature 250 °C)		
0.25 mm ID (0.4 mm OD)	**723105.10**	**723105.25**
0.32 mm ID (0.5 mm OD)	**723349.10**	**723349.25**
0.53 mm ID (0.8 mm OD)	**723562.10**	**723562.25**

Deactivated capillaries are supplied without cage.



Retention gaps

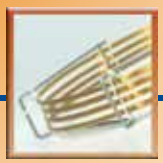
- The retention gap technique in combination with on-column injection allows to concentrate a large sample volume in the capillary column.
- Choice of the retention gap depends on the solvent used: the flooded zone after injection should be between 20–30 cm/µL

  Me-Sil retention gap: only for use with *n*-hexane and diethyl ether
  Phe-Sil retention gap: for all solvents except methanol and water
  CW retention gap: for all solvents and especially for methanol and water
- Calculation example: length of flooded zone ~ 20–30 cm/µL, retention gap 10 m x 0.32 mm ID, capillary column: 25 m x 0.32 mm ID, max. injection volume ~ 30–50 µL
- A retention gap must be inert without any noticeable retention
  Me-Sil retention gaps are more inert than Phe-Sil, while Phe-Sil is less susceptible to contamination
- Max. temperatures: for CW retention gaps 250 °C, for Me-Sil and Phe-Sil retention gaps 320 °C
- Retention gaps can also be used as transfer lines or precolumns (contamination capacity about 5–10 µg).

Ordering information

Length →	10 m	25 m
Me-Sil retention gaps (max. temperature 320 °C)		
0.25 mm ID (0.4 mm OD)	**723706.10**	**723706.25**
0.32 mm ID (0.5 mm OD)	**723707.10**	**723707.25**
0.53 mm ID (0.8 mm OD)	**723708.10**	**723708.25**
Phe-Sil retention gaps (max. temperature 320 °C)		
0.25 mm ID (0.4 mm OD)	**723709.10**	**723709.25**
0.32 mm ID (0.5 mm OD)	**723710.10**	**723710.25**
0.53 mm ID (0.8 mm OD)	**723711.10**	**723711.25**
CW retention gaps (max. temperature 250 °C)		
0.25 mm ID (0.4 mm OD)	**723712.10**	**723712.25**
0.32 mm ID (0.5 mm OD)	**723713.10**	**723713.25**
0.53 mm ID (0.8 mm OD)	**723714.10**	**723714.25**
Retention gaps are supplied without cage.		

For a considerably longer lifetime, even for contaminated or matrix-containing samples, MN offers the option of **integrated precolumns**. All capillary columns are available with a 10 m guard column with matched deactivation. For ordering, please add V1 at the end of the REF number. Guard column combinations with other lengths, IDs or different deactivation are available on request.



Reagents and procedures for derivatization

Derivatization reagents

- To improve volatility, increase thermal stability or to achieve a lower limit of detection in gas chromatography

  Prerequisite: quantitative, rapid and reproducible formation of only one derivative

  Halogen atoms inserted by derivatization, e.g., trifluoroacetates, allow the specific detection in an ECD with the advantage of high sensitivity.

  Specific derivatizations may influence elution orders and fragmentation patterns in a MS.
- We provide reagents for **acylation, alkylation (methylation),** and **silylation**.

Derivatization method development kits

Designation	Contents of the kit	REF
Derivatization method development kit		
Which type of derivatization is suited best for your sample (alkylation, acylation or silylation)?	2 x 1 mL each of TMSH, MSTFA, MBTFA	**701952**
Acylation kit		
Which is the proper reagent for acylation?	2 x 1 mL each of MBTFA, TFAA, MBHFBA	**701950**
Alkylation kit		
Which is the proper reagent for methylation?	3 x 1 mL each of TMSH, DMF-DMA	**701951**
Silylation kit		
Which is the proper reagent for silylation?	2 x 1 mL each of MSTFA, BSTFA, TSIM, MSHFBA	**701953**

Selection guide for derivatization of important functional groups in GC

Function	Method	Derivative	Recommended reagents
Alcohols, Phenols	silylation	R'O – TMS	BSA, MSTFA, MSHFBA, TSIM, SILYL-2110, SILYL-21, SILYL-1139
R'OH	acylation	R'O – CO – R	TFAA, HFBA, MBTFA, MBHFBA
	alkylation	R'O – R	TMSH
sterically hindered	silylation	R'O – TMS	TSIM, BSTFA, SILYL-991
Amines	silylation	R' – NR'' – TMS	BSA, MSTFA, MSHFBA, SILYL-991
primary, secondary	acylation	R' – NR'' – CO – R	TFAA, HFBA, MBTFA, MBHFBA
hydrochlorides	silylation	R' – NR'' – TMS	MSTFA
Amides	silylation	not stable	
	acylation	R' – CO – NH – CO – R	TFAA, MBTFA, HFBA, MBHFBA
Amino acids	silylation	R' – CH(NH – TMS) – CO – O – TMS	BSA, BSTFA, MSTFA, MSHFBA
	alkylation (a) + acylation (b)	R' – CH(NH – CO–R) – CO – O – R	a) MeOH/TMCS, TMSH b) TFAA, HFBA, MBTFA, MBHFBA
Carboxylic acids	silylation	R' – CO – O – TMS	BSA, MSTFA, MSHFBA, TMCS, TSIM, SILYL-2110, SILYL-21, Silyl 1139
(fatty acids)		susceptible to hydrolysis	
	alkylation	R' – CO – O – R	DMF-DMA, MeOH/TMCS (1 M), TMSH
salts	silylation	R' – CO – O – TMS	TMCS
		susceptible to hydrolysis	
Carbohydrates	silylation		MSTFA, TSIM, HMDS, SILYL-1139
	acylation		TFAA, MBTFA
Steroids	silylation		BSA, TSIM
	acylation		TFAA, MBTFA, HFBA, MBHFBA

Reagents and procedures for acylation

Acylation reagents

Acyl halides

By-product of acylation with acyl halides: corresponding hydrohalic acids
excess of reagent and acid have to be removed or trapped by a suitable base (e.g., pyridine)

Pentafluorobenzoyl chloride
PFBC: $C_6F_5-CO-Cl$ — M 230.52 g/mol, Bp 158–159 °C (760 mm Hg), density d20°/4° = 1.601

Anhydrides

By-products of acylation with anhydrides: corresponding acids
excess reagent and the acid formed are to be removed

Trifluoroacetic acid anhydride
TFAA: $CF_3-CO-O-CO-CF_3$ — M 210.04 g/mol, Bp 39.5–40.5 °C (760 mm Hg), density d20°/4° = 1.490

Heptafluorobutyric acid anhydride
HFBA: $C_3F_7-CO-O-CO-C_3F_7$ — M 410.06 g/mol, Bp 106–107 °C (760 mm Hg), density d20°/4° = 1.665

Bisacylamides

By-products: corresponding neutral acylamides: high volatility · easily removed; due to the neutral conditions and their favorable chromatographic characteristics, the removal of surplus bisacylamides and their by-products is often not necessary. Therefore, the sample preparation is much easier.

N-methyl-bis(trifluoroacetamide)
MBTFA: $CF_3-CO-N(CH_3)-CO-CF_3$ — M 223.08 g/mol, Bp 123–124 °C (760 mm Hg), density d20°/4° = 1.55

N-methyl-bis(heptafluorobutyramide)
MBHFBA: C3F7-CO-N(CH_3)-CO-C3F7 — M 423.1 g/mol, Bp 165–166 °C (760 mm Hg), density d20°/4° = 1.673

Methods for acylation

Acylation with fluorinated acid anhydrides:

The acylation with TFAA or HFBA, under formation of volatile, stable derivatives for FID or ECD detection, is applicable for alcohols, phenols, carboxylic acids, amines, amino acids and steroids.

Procedure:
Dissolve 0.1 to 1 mg sample in 0.1 mL solvent, add 0.1 mL of the anhydride and heat to 60–70 °C for 1–2 h. If the sample need not be concentrated prior to the analysis and if there is no danger of catalytically induced side reactions, pyridine is used as solvent. The reaction solution can be injected directly into the gas chromatograph. Otherwise, use a volatile solvent and evaporate solvent, excess reagent and free acid in a stream of nitrogen. Dissolve residue in 50 µL hexane, chloroform etc. and inject aliquot portions.

TFAA MN Appl. No. 213041 · HFBA MN Appl. No. 213042

Acylation with fluorinated acid amides:

This method is recommended for alcohols, primary and secondary amines as well as for thiols under mild, neutral conditions. MBTFA also forms very volatile derivatives with carbohydrates [J. Sullivan and L. Schewe, J. Chromatogr. Sci. **15** (1977) 196–197].

Procedure:
Add 0.5 mL MBTFA or MBHFBA to about 2 mg sample. If there is no reaction at ambient temperature, heat the reaction mixture to 120 °C. Compounds difficult to dissolve, can be trifluoroacetylated in suitable solvent mixtures.
It is recommended to use a ratio of solvent to MBTFA or MBHFBA of 4:1. The reaction mixture is chromatographed directly.

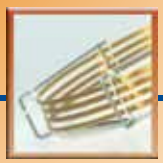
MBTFA MN Appl. No. 213051 · MBHFBA MN Appl. No. 213052

Ordering information

	Packing unit			
Substance	10 x 1 mL	20 x 1 mL	1 x 10 mL	5 x 10 mL
HFBA*		**701110.201**	**701110.110**	**701110.510**
MBTFA*		**701410.201**	**701410.110**	**701410.510**
MBHFBA*	**701420.101**	**701420.201**		
PFBC*	**701120.101**			
TFAA*			**701130.110**	**701130.510**

* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see MSDS.

Due to their purpose, derivatization reagents are very reactive substances. For this reason, they should be stored cool and protected from moisture. For easy access with a syringe, our derivatization reagents are supplied in vials with crimp caps. Vials with pierced sealing disks have limited stability and should be used soon.



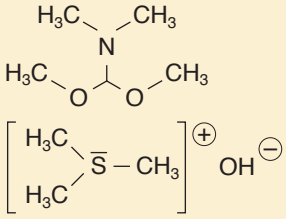
Reagents and procedures for methylation

Alkylation reagents

Apart from a few exceptions, methylation is the most common alkylation type.

Methylation reagents

N,N-dimethylformamide dimethylacetal
DMF-DMA · M 119.17 g/mol, Bp 106–107 °C (760 mm Hg), density d20°/4° = 0.897



Trimethylsulfonium hydroxide
TMSH (0.2 mol/L in methanol) · M 94.06 g/mol

Methods for methylation

Methylation with TMSH

Methylation with TMSH [W. Butte, J. Chromatogr. **261** (1983) 142] is suited for free acids, chlorophenoxycarboxylic acids, their salts and derivatives as well as for phenols and chlorophenols. The great advantage is the simplification of the sample preparation. Lipids or triglycerides can be converted to the corresponding fatty acid methyl esters (FAMEs) by simple transesterification.

This reaction is very elegant and convenient, because it is only necessary to add the reagent (0.2 mol/L in methanol) to the sample solution. Removal of surplus reagent is not required, since at 250 °C inside the injector of the gas chromatograph, TMSH will pyrolyze solely to volatile methanol and dimethylsulfide. Due to high reactivity, a complete conversion is usually obtained at ambient temperature. Heating (e.g., 10 min at 100 °C) in a closed sample vial may be necessary, however.

Procedure:
Dissolve 100 mg sample (e.g., butter) in 5 mL of a solvent (e.g., *tert.*-butyl methyl ether). Add 50 µL reagent to 100 µL of this solution. The mixture is injected directly. The temperature of the injector must be at least 250 °C.

MN Appl. No. 213060

For GC separation of FAMEs from natural butter fat after derivatization with TMSH see Appl. 201680 at ***www.mn-net.com***

Methylation with DMF-DMA

Methylation with DMF-DMA, under formation of N-dimethyl-aminomethylene amino acid methyl esters, is applicable for fatty acids, primary amines and (partially) amino acids [Thenot et al., Anal. Letters **5** (1972) 217–223, 519–529]. Since DMF-DMA is a poor solvent, it is essential to use a mixture of DMF-DMA with pyridine, THF, acetone (barbiturates) or another solvent.

Procedure:
Add 1 mL of a mixture of DMF-DMA and pyridine (1:1) to 1–50 mg fatty acids. The sample can be injected as soon as a clear solution has formed. It is recommended, however, to heat the solution to 60–100 °C for 10–15 min.

MN Appl. No. 213070

Methylation with methanol – TMCS

A 1-molar solution of TMCS in methanol is suited for the esterification of free carboxylic acids and the transesterification of glycerides. Formation of HCl catalyzes the reaction. TMCS, resp. silyl ethers remove the water and thus drive the reaction to completion. The mixture should be freshly prepared.

Procedure:
Add 1 mL methanol – TMCS to about 50 mg carboxylic acid or glyceride and heat. Then evaporate in a stream of nitrogen and dissolve again for injection in, e.g., *n*-heptane.

MN Appl. No. 213080

Ordering information

	Packing unit			
Substance	10 x 1 mL	20 x 1 mL	1 x 10 mL	5 x 10 mL
DMF-DMA*		**701430.201**	**701430.110**	
TMSH*	**701520.101**	**701520.201**	**701520.110**	**701520.510**

* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see MSDS.

Due to their purpose, derivatization reagents are very reactive substances. For this reason, they should be stored cool and protected from moisture. For easy access with a syringe, our derivatization reagents are supplied in vials with crimp caps. Vials with pierced sealing disks have limited stability and should be used soon.

Silylation reagents

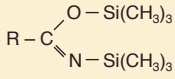
The most common form of silylation in GC is the replacing of active hydrogen atoms with a trimethylsilyl group (TMS derivative). Less frequently, trialkylsilyl groups or dimethylsilyl groups with longer alkyl chains are also in use. The alkylsilyl group increases volatility and enhances thermal stability of the sample.

Silylation can be catalyzed either acidic by addition of TMCS or basic by addition of pyridine or TSIM (e.g., for sterically hindered functionalities like *tert.* alcohols).

Reactivity of silylation reagents (acc. to M. Donike): TMS amides (e.g., BSA, MSTFA) > TMS amine = TSIM > Enol-O-TMS ether > S-TMS ether > O-TMS ether > TMS-O-TMS

Stability of the TMS derivatives: O-TMS ether > S-TMS ether > Enol-O-TMS ether > TMS amine > TMS amide

BSA · BSTFA · SILYL-991



N,O-bis-trimethylsilyl-acetamide

BSA: R = CH_3

M 203.4 g/mol, Bp 71–73 °C (35 mm Hg), density d20°/4° = 0.832

Strong silylation reagent, creating very stable TMS derivatives of a multitude of compounds, e.g., alcohols, amines, carboxylic acids, phenols, steroids, biogenic amines and alkaloids; not recommended for use with carbohydrates or very low molecular weight compounds; good solvent for polar compounds, but frequently used in combination with a solvent (pyridine, DMF etc.) or with other silylation reagents. Dissolved in DMF, BSA is the prime derivatization reagent for phenols.

N,O-bis-trimethylsilyl-trifluoroacetamide

BSTFA: R = CF_3

M 257.4 g/mol, Bp 40 °C (12 mm Hg), density d20°/4° = 0.961

Powerful trimethylsilyl donor with approx. the same donor strength as the nonfluorinated analog BSA

Advantage of BSTFA over BSA: greater volatility of its reaction products, particularly useful for GC analysis of low boiling TMS amino acids

BSTFA is nonpolar (less polar than MSTFA) and can be mixed with acetonitrile for improved solubility. For the silylation of fatty acid amides, hindered hydroxyl groups and other difficult to silylize compounds, e.g., secondary alcohols and amines, we recommend BSTFA + 1% trimethylchlorosilane (TMCS), available under the designation SILYL-991.

Silylation with BSA, BSTFA or SILYL-991 (BSTFA + 1% TMCS)

Procedure:
Add 0.5 mL of the silylation reagent to 1–10 mg sample; if necessary, add some solvent (normally pyridine or DMF [dimethylformamide]). Heat to 60–80 °C for 20 min to increase the reaction rate. 1–2 drops of TMCS (trimethylchlorosilane) or TSIM will also speed up the reaction.

BSA MN Appl. No. 213091 · BSTFA MN Appl. No. 213092
SILYL-991 MN Appl. No. 213093

Silylation with BSA in combination with other silylation reagents

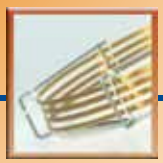
Procedure:
BSA alone silylates all sterically unhindered hydroxyl groups of the steroid skeleton; addition of TMCS will enable reaction of moderately hindered OH groups (reaction time 3–6 h at 60 °C). After addition of TSIM even strongly hindered hydroxyl groups will react (reaction time 6–24 h at 60 °C).

MN Appl. No. 213100

Ordering information

Substance	Packing unit 20 x 1 mL	1 x 10 mL	5 x 10 mL	1 x 50 mL	1 x 100 mL
BSA*		**701210.110**	**701210.510**	**701210.150**	
BSTFA*	**701220.201**	**701220.110**	**701220.510**		
SILYL-991* (BSTFA – TMCS (99:1)	**701490.201**			**701490.150**	**701490.1100**

* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see MSDS.

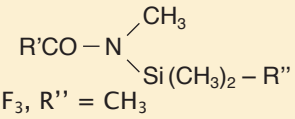


Reagents and procedures for silylation

MSTFA · MSHFBA · MBDSTFA

N-methyl-N-trimethylsilyl-trifluoroacetamide

MSTFA: R' = CF_3, R'' = CH_3



M 199.1 g/mol, Bp 70 °C (75 mm Hg), density d20°/4° = 1.11

The most volatile trimethylsilyl amide available

Very strong TMS donor which does not cause noticeable FID fouling even during long-time measuring series. The addition of protic solvents in submolar quantities, e.g., TFA for extremely polar compounds (hydrochlorides) or pyridine for carbohydrates), can improve the already good dissolving power of MSTFA.

Recommended applications: carboxylic acids, hydroxy and ketocarboxylic acids, amino acids, amines, alcohols, polyalcohols, sugars, mercaptans and similar compounds with active hydrogen atoms. Even amine hydrochlorides can be silylated directly.

Advantages: complete conversion with high reaction rates, even without a catalyst (1–2 % TMCS or TSIM); the by-product of the reaction (N-methyltrifluoroacetamide) shows a high volatility and a short retention time

N-methyl-N-trimethylsilyl-heptafluorobutyramide

MSHFBA: R' = C_3F_7, R'' = CH_3

M 299.1 g/mol, Bp 148 °C (760 mm Hg)

Similar to MSTFA in reactivity and chromatography

Recommended applications: carboxylic acids, alcohols, phenols, primary and secondary amines and amino acids; either applied alone or in combination with a catalyst (TMCS, TSIM) or another silylation reagent with or without solvent; the by-product N-methylheptafluorobutyric amide has a lower retention time than the silylating reagent; especially useful for flame ionization detection due to the large ratio of fluorine to silicon of 7:1, since degradation of the surplus MSHFBA does not produce SiO_2 but volatile, non-corrosive silicon compounds

N-methyl-N-*tert*-butyldimethylsilyl-trifluoroacetamide

MBDSTFA (MTB-TFA): R' = CF_3, R'' = C_4H_9

M 241.3 g/mol, Bp 168–170 °C (760 mm Hg), density d20°/4° = 1.121

Silylation reagent that donates a *tert*-butyldimethylsilyl group (TBDMS) for derivatizing active hydrogen atoms in hydroxyl, carboxyl and thiol groups as well as primary and secondary amines; fast reactions (typically 5–20 min) with high yields (> 96 %); by-products are neutral volatiles

TBDMS ethers are 10^4 times more stable than the corresponding TMS ethers

Due to the large protecting group, chromatographic retention times are longer. This may have a beneficial impact on some separations. The high concentration of M^+–57 ions is an interesting topic for GC/MS.

Silylation with MSTFA, MSHFBA or MBDSTFA

Procedure:
Dissolve 10–15 mg sample in 0.8 mL solvent, then add 0.2 mL of the silylation reagent. The reaction mixture can be heated to 60–70 °C for up to 1 h and can be analyzed directly. If TFA is used as a solvent, proceed as follows [M. Donike, J. Chromatogr. **85** (1973) 1–7]: dissolve 1–2 mg sample in 100 µL TFA. Dropwise add 0.9 mL of the silylating reagent. After cooling the sample can be chromatographed directly.

MSTFA MN Appl. No. 213111 · MSHFBA MN Appl. No. 213112 · MBDSTFA MN Appl. No. 213113

Ordering information

	Packing unit						
10 x 1 mL	20 x 1 mL	1 x 10 mL	5 x 10 mL	1 x 100 mL	6 x 50 mL	6 x 100 mL	12 x 100 mL
MSHFBA*							
	701260.201	**701260.110**	**701260.510**	**701260.1100**		**701260.6100**	
MSTFA*							
	701270.201	**701270.110**	**701270.510**	**701270.1100**	**701270.650**	**701270.6100**	**701270.12100**
MBDSTFA*							
701440.101	**701440.201**						

* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see MSDS.

DMCS · HMDS · TMCS · TSIM

Dimethyldichlorosilane

DMCS: $(CH_3)_2SiCl_2$

M 129.06 g/mol, Bp 70 °C (760 mm Hg), density d20°/4° = 1.07

Used to form dimethylsilyl (DMS) derivatives; DMS derivatives are much more susceptible to hydrolysis than TMS derivatives, it is therefore vital to have strictly anhydrous conditions during the conversion.

Hexamethyldisilazane

HMDS: $(CH_3)_3Si - NH - Si(CH_3)_3$

M 161.4 g/mol, Bp 126 °C (760 mm Hg), density d20°/4° = 0.7742

Weak TMS donor; used as a sole reagent, it is slow and not very effective.

With catalytic quantities, e.g., 1% of, or as a mixture with TMCS (2:1, v/v; SILYL-21 and SILYL-2110) it is perfectly suited for a quick and quantitative trimethylsilylation of organic compounds.

Aprotic solvents like acetonitrile, pyridine, dimethylformamide, carbon disulfide and dimethylacetamide recommend themselves for use with HMDS.

Trimethylchlorosilane

TMCS: $(CH_3)_3SiCl$

M 108.7 g/mol, Bp 57 °C (760 mm Hg), density d20°/4° = 0.8580

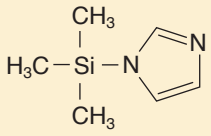
Often used as a catalyst with other trimethylsilyl reagents

As a sole reagent, it can be used to prepare TMS derivatives of organic acids.

N-Trimethylsilyl-imidazole

M 140.3 g/mol, Bp 94-96 °C (760 mm Hg), density d20°/4° = 0.961

TSIM:



Strongest hydroxyl silylator; reagent of choice for carbohydrates and most steroids (even strongly hindered steroids)

It is remarkable that TSIM reacts quickly and smooth with hydroxyl (even *tert.* OH) and carboxyl groups, but not with amines. Hence it is especially suited for multiple derivatizations, when compounds with various functional groups are to be derivatized in different ways (e.g., -O-TMS, -N-HFB derivatives of catecholamines).

Recommended applications:
alcohols, phenols, organic acids, steroids, hormones, glycols, nucleotides, narcotics

Silylation with TSIM or SILYL-1139 (TSIM - pyridine 11:39)

Procedure:
Dissolve 10-15 mg sample in 0.8 mL solvent, then add 0.2 mL of the silylation reagent. The reaction mixture can be heated to 60-70 °C for up to 1 hour and can be analyzed directly.

Recommended solvent pyridine

When using SILYL-1139, the presence of water does not interfere.

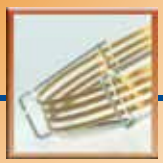
TSIM MN Appl. No. 213121 · SILYL-1139 MN Appl. No. 213122

Ordering information

	Packing unit			
Substance	20 x 1 mL	1 x 10 mL	5 x 10 mL	6 x 50 mL
DMCS*				701230.650 **
HMDS*			701240.510	701240.650 **
TMCS*	701280.201 **			701280.650 **
TSIM	701310.201	701310.110	701310.510	

* These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see MSDS.

Due to their purpose, derivatization reagents are very reactive substances. For this reason they should be stored cool and protected from moisture. For easy access with a syringe, our derivatization reagents are supplied in vials with crimp caps (** in vials with screw caps). Vials with pierced sealing disks have limited stability and should be used soon.



Reagents and procedures for silylation

Reagent mixtures for silylation

Mixture	Composition	20 x 1 mL	1 x 10 mL	5 x 10 mL	1 x 50 mL	1 x 100 mL
SILYL-271	BSA – HMDS – TSIM (2:7:1)	**701450.201**	**701450.110**	**701450.510**		
SILYL-1139	TSIM – pyridine (11:39)	**701460.201**				
SILYL-21	HMDS – TMCS (2:1)	**701470.201**				
SILYL-2110	HMDS – TMCS – pyridine (2:1:10)	**701480.201**				
SILYL-991	BSTFA – TMCS (99:1)	**701490.201**			**701490.150**	**701490.1100**

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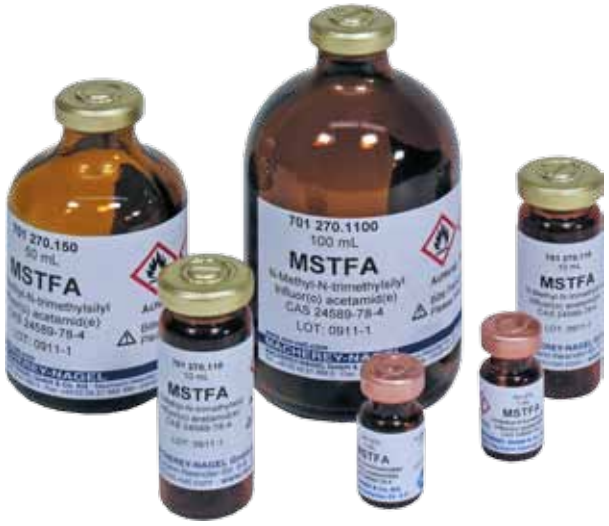
Due to their purpose, derivatization reagents are very reactive substances. For this reason, they should be stored cool and protected from moisture. For easy access with a syringe, our derivatization reagents are supplied in vials with crimp caps. Vials with pierced sealing disks have limited stability and should be used soon.

Silylation with SILYL-21 or SILYL-2110

Procedure:
Carefully add SILYL-21 or SILYL-2110 to 1–10 mg of the sample. Precipitated ammonium chloride does not interfere. If the sample should not dissolve within 5 min, heat to 75–85 °C. If no mutarotation is to be expected, you may dissolve the sugar in warm pyridine first and then add the silylation reagent. In some cases it may be advantageous to use a different solvent instead of pyridine. For derivatization of 3-ketosteroids we recommend to use DMF (dimethylformamide).

SILYL-21 MN Appl. No. 213131 · SILYL-2110 MN Appl. No. 213132

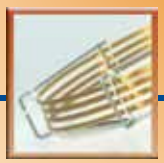
- Recommended applications: sugars, glycols, sterically unhindered alcohols, carboxylic acids, acids in urine, hydroxy fatty acids, nucleotides, steroids, vitamin D, xanthone derivatives



O-Trimethylsilylation with MSTFA followed by N-trifluoroacetylation with MBTFA

Procedure:
Completely silylate 2 mg of the sample with 0.3 mL MSTFA, e.g., as described on page 286. After addition of 0.3 mL MBTFA the N-trimethylsilyl group is replaced by the N-trifluoroacetyl group. The mixture can be analyzed directly.

MN Appl. No. 213140



Test mixtures for GC

- Test mixtures for GC capillary columns to control the performance of fused silica capillary columns and the GC system
- Test mixtures for chiral GC columns

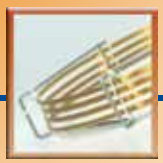
Ordering information

Designation	Composition	Pack of	REF
Polarity mixture POL_5 (qualitative) in *n*-pentane	1-butanol, benzene, methyl butyrate, toluene, cyclopentanone, 1-octene, dibutyl ether	1 mL	**722306**
Activity test mixture (FA-TMS test according to Donike) in MSTFA/*n*-hexane (1 + 4)	1 mg/mL each of TMS capric acid (C_{10}), TMS myristic acid (C_{14}), TMS stearic acid (C_{18}), TMS behenic acid (C_{22}), hexadecane (C_{16}), eicosane (C_{20}), tetracosane (C_{24}), octacosane (C_{28})	1 mL	**722307**
Grob test mixture (modified) in *n*-hexane	(in mg/mL) *n*-decane (~2.8), *n*-undecane (~2.9), *n*-octanol (~3.6), 2,6-dimethylphenol (~3.2), 2,6-dimethylaniline (~3.2), methyl decanoate (~4.2), dicyclohexylamine (~3.1), methyl undecanoate (~4.2), methyl dodecanoate (~4.1)	1 mL	**722310**
MN OPTIMA® test mixture in pentane	0.1% each of undecane, dodecane, octanol, dimethylaniline, decylamine, methyl decanoate, methyl undecanoate, henicosane, docosane, tricosane (chromatograms see page 240)	1 mL	**722316**
MN OPTIMA® amine test mixture in ethanol	0.2% diisobutylamine, 1% diethanolamine, 0.2% 2,6-dimethylaniline, 0.2% *o*-propanol-pyridine, 0.2% dicyclohexylamine, 0.2% dibenzylamine	1 mL	**722317**
FAME test mixture in hexane	0.1% each of FAMEs C4, C6, C8, C10, C12, C14, C16, C18, C18:1 *cis*, C18:1 *trans*, C18:2, C18:3, C20, C22, C22:1, C24 (chromatogram see page 262)	1 mL	**722320**

Test mixtures for chiral GC capillary columns

Test mixture for	Test compound (enantiomer mixture)	Pack of	REF
LIPODEX® A, HYDRODEX β-PM, β-3P, β-6TBDM, β-TBDAc, γ-TBDAc	1% phenylethanol in CH_2Cl_2	1 mL	**722321**
LIPODEX® B	methylbutyrolactone	1 mL	**722322**
LIPODEX® C, D	phenylethylamine (TFA)	1 mL	**722323**
LIPODEX® E, G, HYDRODEX γ-DiMOM	phenylethanol (TFA)	1 mL	**722319**

These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see MSDS.

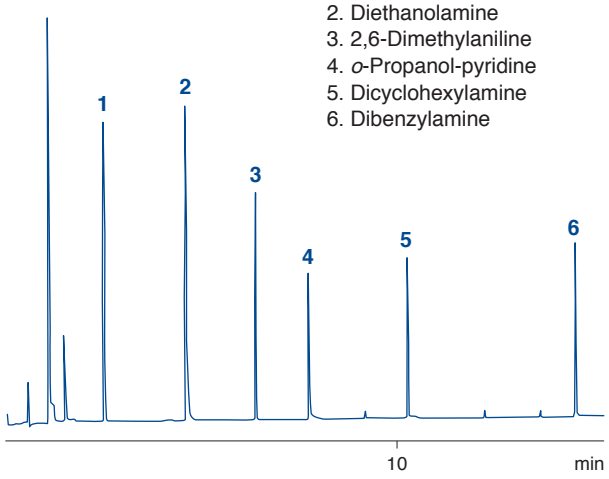


Test mixtures for GC capillary columns

OPTIMA® Amine test mixture (REF 722317)

Column: OPTIMA® 5 Amine, 1.0 µm film, 30 m x 0.32 mm ID
Injection: 1 µL, split 1:50
Carrier gas: 0.6 bar H_2
Temperature: 100 °C → 290 °C, 10 °C/min
Detector: FID 280 °C

Peaks:
1. Diisobutylamine
2. Diethanolamine
3. 2,6-Dimethylaniline
4. *o*-Propanol-pyridine
5. Dicyclohexylamine
6. Dibenzylamine

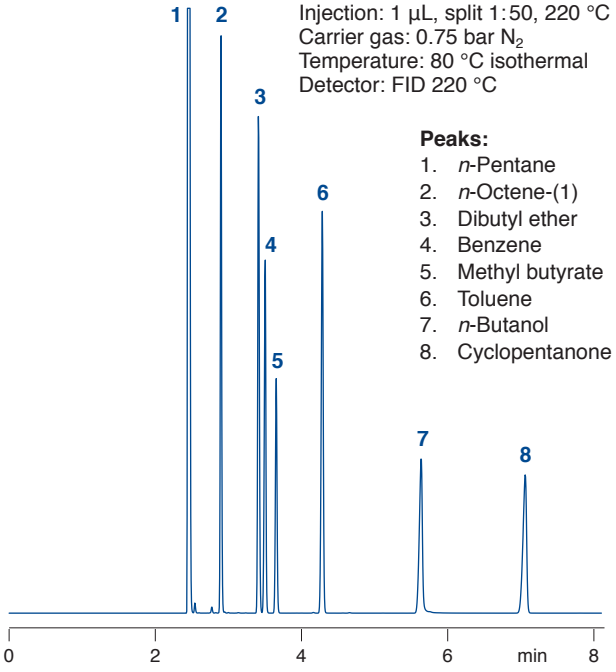


MN Appl. No. 250020

Polarity mixture POL_5 (qualitative) (REF 722306)

Column: OPTIMA® Wax, 0.25 µm film, 25 m x 0.25 mm ID
Injection: 1 µL, split 1:50, 220 °C
Carrier gas: 0.75 bar N_2
Temperature: 80 °C isothermal
Detector: FID 220 °C

Peaks:
1. *n*-Pentane
2. *n*-Octene-(1)
3. Dibutyl ether
4. Benzene
5. Methyl butyrate
6. Toluene
7. *n*-Butanol
8. Cyclopentanone

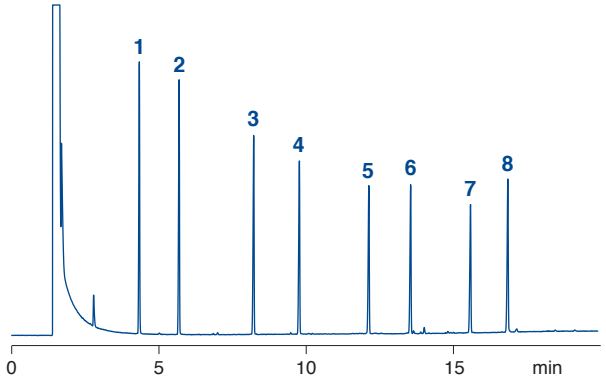


MN Appl. No. 211230

Activity test mixture (REF 722307)

Column: OPTIMA® 5, 1.0 µm film, 25 m x 0.32 mm ID
Injection: 1 µL, split 1:40, 300 °C
Carrier gas: 0.6 bar H_2
Temperature: 150 °C → 300 °C (8 min), 10 °C/min
Detector: FID 300 °C

Peaks:
1. TMS capric acid (C_{10})
2. Hexadecane (C_{16})
3. TMS myristic acid (C_{14})
4. Eicosane (C_{20})
5. TMS stearic acid (C_{18})
6. Tetracosane (C_{24})
7. TMS behenic aicd (C_{22})
8. Octacosane (C_{28})

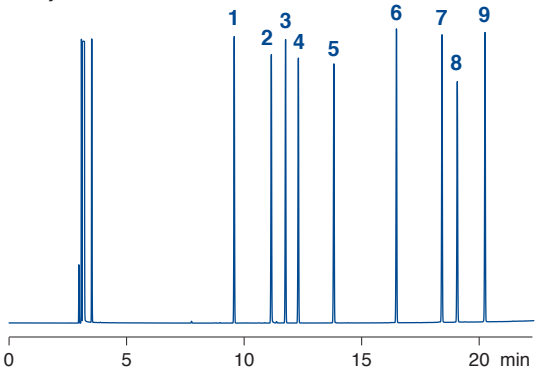


MN Appl. No. 211240

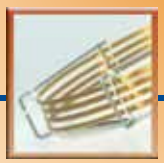
Grob test mixture (modified) (REF 722310)

Column: OPTIMA® 5, 1.0 µm film, 50 m x 0.25 mm ID
Injection: 1 µL, split 1:40, 280 °C
Carrier gas: 1.5 bar H_2
Temperature: 80 °C → 280 °C (10 min), 8 °C/min
Detector: FID 280 °C

Peaks:
1. *n*-Decane
2. 1-Octanol
3. *n*-Undecane
4. 2,6-Dimethylphenol
5. 2,6-Dimethylaniline
6. Methyl decanoate
7. Methyl undecanoate
8. Dicyclohexylamine
9. Methyl dodecanoate



MN Appl. No. 211250



Ordering information

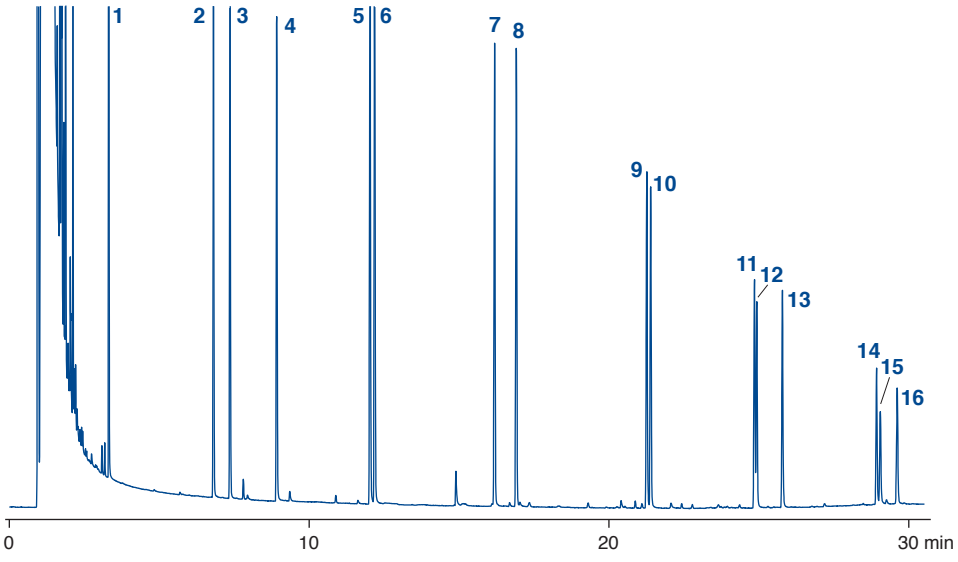
Designation	Composition	Pack of	REF
Haloform test mixture in *n*-pentane (qualitative)	9 halogenated hydrocarbons acc. to German drinking water specifications (in ng/mL): dichloromethane (795), chloroform (75), 1,1,1-trichloroethane (67), carbon tetrachloride (80), trichloroethylene (73), bromodichloromethane (100), dibromochloromethane (122), tetrachloroethylene (81), bromoform (145)	1 mL	**722311**
Haloform test mixture in methanol for headspace analyses (qualitative)	9 halogenated hydrocarbons in increased concentration for calibration acc. to German Industrial Standard DIN 38407, part 5 (in µg/mL): dichloromethane (158.4), chloroform (14.9), 1,1,1-trichloroethane (13.4), carbon tetrachloride (15.9), trichloroethylene (14.6), bromodichloromethane (20), dibromochloromethane (24.5), tetrachloroethylene (16.2), bromoform (28.9)	1 mL	**722371**
Haloform test kit (qualitative)	1 mL each of 9 single undiluted halogenated hydrocarbons and 1 mL each of test mixtures REF 722311 and REF 722371	11 x 1 mL	**722312**
PAH test mixture acc. to EPA in toluene	20 µg/mL each of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benz[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, indeno[1,2,3-cd]pyrene, dibenz[a,h]anthracene, benzo[ghi]perylene	1 mL	**722314**
PAH test mixture acc. to German drinking water specifications in toluene	20 µg/mL each of fluoranthene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, indeno[1,2,3-cd]pyrene, benzo[ghi]perylene	1 mL	**722331**
BTX test mixture in methanol	10 ng/µL each of benzene, ethylbenzene, toluene, *m*-, *o*-, *p*-xylene	1 mL	**722372**

These products contain harmful substances which must be specially labeled as hazardous. For detailed information please see MSDS.

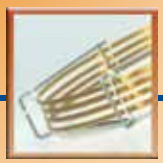
PAH test mixture acc. to EPA for GC (REF 722314)

Column: OPTIMA® 5, 0.25 µm film, 30 m x 0.32 mm ID
Sample: PAH test mixture according to EPA (20 µg/mL each in toluene)
Injection: 1.0 µL, split 1:15
Carrier gas: H_2, 70 kPa
Temperature: 100 °C, 7 °C/min → 300 °C
Detector: FID 300 °C

Peaks:
1. Naphthalene
2. Acenaphthylene
3. Acenaphthene
4. Fluorene
5. Phenanthrene
6. Anthracene
7. Fluoranthene
8. Pyrene
9. Benz[a]anthracene
10. Chrysene
11. Benzo[b]fluoranthene
12. Benzo[k]fluoranthene
13. Benzo[a]pyrene
14. Indeno[1,2,3-cd]pyrene
15. Dibenz[ah]anthracene
16. Benzo[ghi]perylene



MN Appl. No. 200510



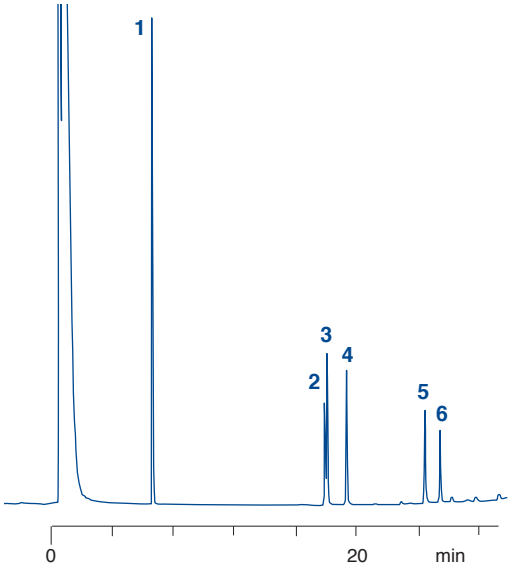
Test mixtures for environmental analyses

PAH test mixture acc. to German drinking water specifications (REF 722331)

Column: OPTIMA® 5, 0.25 µm film, 25 m x 0.,32 mm ID
Injection: 2 µL, split 1:10
Carrier gas: 0.6 bar H_2
Temperature: 80 °C ↑ 180 °C → 300 °C, 4 °C/min
Detector: FID 300 °C

Peaks:

1. Fluoranthene
2. Benzo[b]fluoranthene
3. Benzo[k]fluoranthene
4. Benzo[a]pyrene
5. Indeno[1,2,3-cd]pyrene
6. Benzo[ghi]perylene



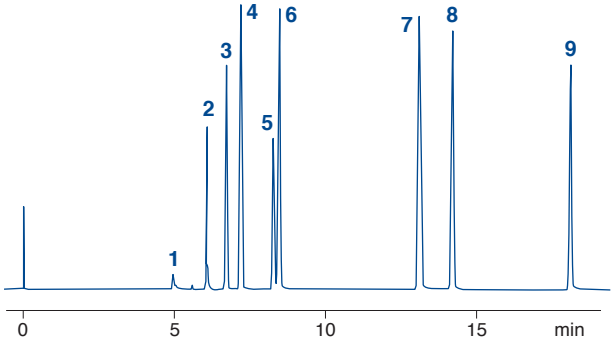
MN Appl. No. 200450

Haloform test mixture (REF 722311)

Column: FS-SE-54, 0.35 µm film, 50 m x 0.25 mm ID
Injection: 1 µL, split ~ 1:30
Carrier gas: 1 bar N_2
Temperature: 45 °C (10 min) → 120 °C, 8 °C/min
Detector: ECD 260 °C

Peaks:

1. Dichloromethane
2. Trichloromethane
3. 1,1,1-Trichlorethane
4. Tetrachloromethane
5. Trichloroethene
6. Bromodichloromethane
7. Dibromochloromethane
8. Tetrachloroethene
9. Tribromomethane



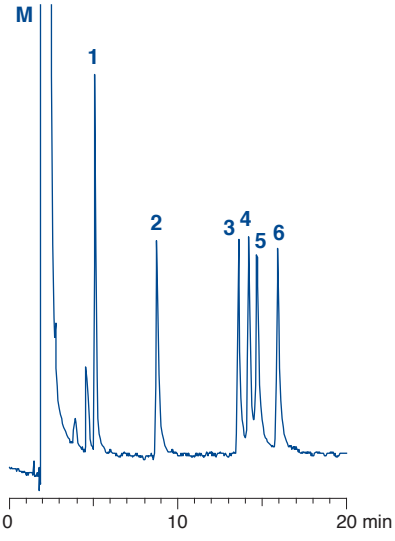
MN Appl. No. 211190

BTX test mixture (REF 722372)

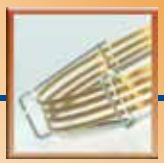
Column: HYDRODEX β-PM, 50 m x 0.25 mm ID
Injection: 2 µL (10 ng/µL each in methanol), split 40 mL/min
Carrier gas: 120 kPa H_2 (2.45 mL/min)
Temperature: 60 °C → 100 °C, 2 °C/min
Detector: FID 250 °C

Peaks:

M = methanol
1. Benzene
2. Toluene
3. *p*-Xylene
4. *m*-Xylene
5. Ethylbenzene
6. *o*-Xylene



MN Appl. No. 211220



Ferrules for GC

- **Graphite** ferrules provide the highest temperature stability (up to 450 °C). They are reusable, if handled with care. We also offer 1/16" graphite ferrules specially designed for Carlo Erba / Fisons or for Agilent gas chromatographs.
- Vespel ferrules come in three types: pure Vespel, Vespel with 15% graphite and Vespel with 40% graphite. All versions are temperature-stable up to 400 °C and reusable.
- **PTFE** ferrules can only be used up to 250 °C. They are not reusable and not recommended for temperature programming. However, they show the best chemical inertness of all ferrules.

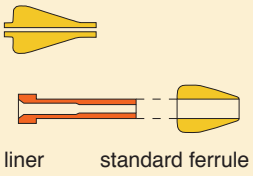
Ordering information (packing unit 10 ferrules)

Bore (= column OD)	Graphite	Vespel			PTFE
		plain	+ 15% graphite	+ 40% graphite	
max. temperature →	450 °C	400 °C	400 °C	400 °C	250 °C
1/16" ferrules					
no bore	708336	706187	706167		706177
0.4 mm	708309			706246	
0.5 mm	708308			706247	
0.8 mm	708301			706248	
1.0 mm	708302				
1.2 mm	708303				
1/16"	706155	706180	706160	706190	706170
1/16" ferrules for Carlo Erba (Fisons) instruments					
0.4 mm	708338				
0.5 mm	708339				
0.8 mm	708340				
1/16" ferrules for Hewlett-Packard (Agilent) instruments					
0.4 mm	708353				
0.5 mm	708354				
0.8 mm	708355				
1/8" ferrules					
no bore	708341	706188	706168		706178
0.4 mm	708342	706266	706249	706240	
0.5 mm	708343				
0.8 mm	708333	706268			
1/16"	708158	706183			
1/8"	708156	706181		706191	706171
1/4" ferrules					
no bore	708344		706169	706199	
0.4 mm	708345				
0.5 mm	708346				
1/16"			706164		
1/8"		706185			
6.0 mm	708348	706186		706196	706176
1/4"	706157	706182		706192	706172
6 mm ferrules					
no bore		706252			
6.0 mm					706259

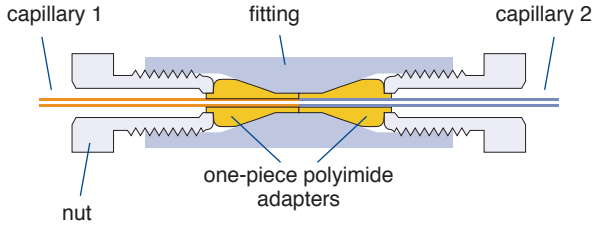
If you are in doubt about the correct size or REF please send us an old, used ferrule as a sample.

Valco fused silica adapters and fittings for capillary GC

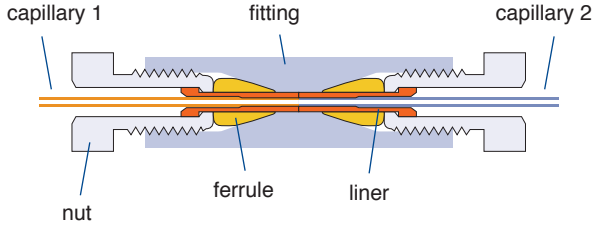
- **One-piece FS adapters:** recommended for use in fittings where the polyimide ferrule need not be removed
- **Two-piece removable FSR adapters:** recommended for use in Valco valves; consists of a liner which slides over the fused silica tubing, and a ferrule, both made of high temperature polyimide alloys
  The liner has an enlarged diameter at one end that is captured by the nut, so both (liner and tube) are removed when the nut is unscrewed from the valve (see figure below).
  The 1/16" FSR adapter comes with a special counterbored 1/16" nut (ZCN1) to receive the liner. The 1/32" adapter works with standard Valco 1/32" nuts.



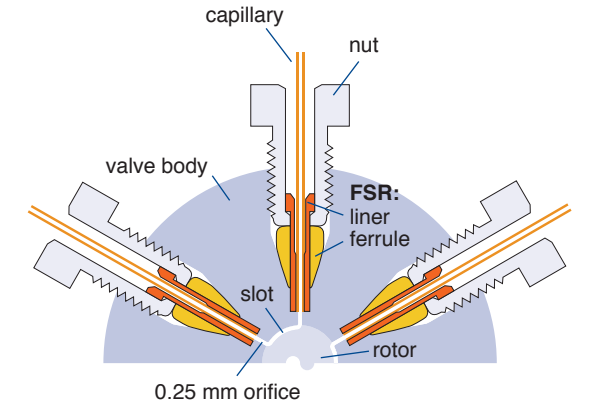
Union with FS adapters



Union with FSR adapters



Valve with FSR adapters



If you intend to use fused silica adapters (FS or FSR) with Valco unions, please order the fittings with "J" at the end of the Valco code and the appropriate number of adapters. The fittings in the table on the opposite page are supplied without stainless steel ferrules, but with standard nuts. For two-piece FSR adapters, the use of specially counterbored nuts ZCN1 (provided with the adapters) is mandatory.

Examples:

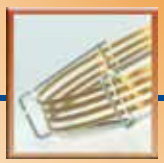
1) Connection of 2 capillaries with 0.25 mm ID and 0.4 mm OD: either use a 1/32" union ZU.5TJ and 2 FS adapters FS.4 or a 1/32" union ZU.5TJ and 2 removable FSR adapters FSR.4
2) Connection of 2 capillaries with 0.53 mm ID and 0.8 mm OD: we recommend either a 1/16" union ZU1TJ and 2 FS adapters FS1-.8 or a 1/16" union ZU1TJ and 2 removable FSR adapters FS1R.8

If capillaries 1 and 2 have different outer diameters, the corresponding different FS adapters have to be used.

If you want to use Valco valves with fused silica adapters, you need to order the required quantity of FSR adapters in addition to the valve. Please note that the specially counterbored nut ZCN1, included in FS1R.5 and FS1R.8, is still mandatory for 1/16" FSR adapters.

Examples:

1) Attachment of a capillary with 0.32 mm ID (0.5 mm OD) to a valve with 1/32" fittings: we recommend the removable FSR adapter FSR.5.
2) Attachment of a capillary with 0.53 mm ID (0.8 mm OD) to a valve with 1/16" fittings: we recommend the removable FSR adapter FS1R.8.



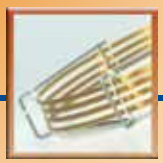
Ordering information

Valco code	Description		Pack of	REF	
One-piece fused silica adapters					
		for capillary OD			
FS.25-5	1/32"	< 0.25 mm	5	**724405**	
FS.4-5	1/32"	0.25-0.4 mm	5	**724243**	
FS.5-5	1/32"	0.4-0.5 mm	5	**724244**	
FS1.4-5	1/16"	< 0.4 mm	5	**724406**	
FS1.5-5	1/16"	0.4-0.5 mm	5	**724407**	
FS1.8-5	1/16"	0.6-0.8 mm	5	**724408**	
Removable fused silica adapters (incl. nuts)					
FSR.25-5	1/32"	< 0.25 mm	5	**724409**	
FSR.4-5	1/32"	0.25-0.4 mm	5	**724410**	
FSR.5-5	1/32"	0.4-0.5 mm	5	**724411**	
FS1R.5-5	1/16"	< 0.5 mm	5	**724335**	
FS1R.8-5	1/16"	0.5-0.8 mm	5	**724334**	
Replacement liners					
FSL.25-5	1/32"	< 0.25 mm	5	**724412**	
FSL.4-5	1/32"	0.25-0.4 mm	5	**724413**	
FSL.5-5	1/32"	0.4-0.5 mm	5	**724414**	
FS1L.5-5	1/16"	< 0.5 mm	5	**724415**	
FS1L.8-5	1/16"	0.5-0.8 mm	5	**724416**	
Special nut for fused silica adapters					
ZCN1	1/16"	counterbored	1	**724417**	
For standard Vespel ferrules as well as standard nuts please have a look at the Valco program, which is available on request.					
Unions, Tees and crosses for fused silica adapters (without ferrules, but incl. standard nuts)					
ZU.5TJ	1/32"- 1/32"	for butt connection	1	**724418**	
ZU1TJ	1/16"- 1/16"	for butt connection	1	**724333**	
ZT.5J	1/32"	Tee	1	**724421**	
ZT1CJ	1/16"	Tee, capillary bore	1	**724336**	
ZX.5J	1/32"	cross	1	**724422**	
ZX1CJ	1/16"	cross, capillary bore	1	**724337**	
Tools for Valco fused silica adapters					
OEW	open end wrench (3/16" x 1/4")		1	**724423**	for use with 1/32" fittings
PV	pin vise and drill index (0.34 to 1.0 mm)		1	**724424**	application see text below

In case of a broken tubing in a through-bore union, remove the nut and the intact tubing on the opposite site of the broken one. Clear the fitting by pushing a fine wire or capillary drill through the center.

To remove ferrules from fittings, we recommend the use of a ferrule rmoval kit (Valco code FRK1). Use a pin vise and drill index (Valco code PV) to widen the inner diameters of FS adapters.

For other fittings and valves for GC please ask for our VICI® / Valco program.

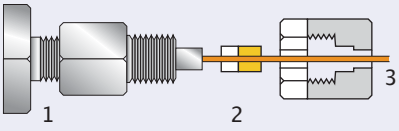


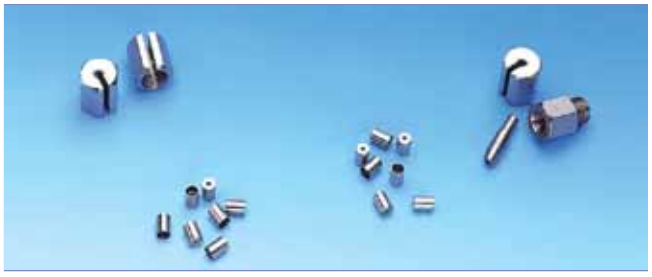
Accessories for capillary columns

Connectors for capillary GC columns

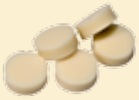
- **Graphseal ferrules** for capillary columns: a stainless steel ferrule filled with graphite – the ideal sealing material for capillaries · The capillary is mounted on a 1/16" exit (detector, injector etc.), with the appropriate ferrule, a nut (with slit) and an adapter (see table below).
- **Glass connectors** for fused silica capillary columns from 0.2 to 0.53 mm ID manufactured from deactivated glass with slightly tapered inner diameter; used to join two fused silica capillaries of equal or different diameters. Advantages compared to stainless steel fittings are easy connection without tools, optical control during connection, negligible heat capacity and no dead volume.
- **PTFE shrink tube**
  also applicable for capillary connection. The minimum ID of the expanded tubing is 1.17 mm, the maximum ID of the shrunk tube is 0.40 mm. Shrinking occurs above 310 °C. Connections with PTFE shrink tube are applicable up to 200 °C only. They should never be used above 250 °C.

Ordering information

Description	Pack of	REF	Specification
Graphseal ferrules for capillary columns			
0.4 mm bore	10 ferrules	**708337**	 1 1/16" exit, injector or detector; 2 Graphseal ferrule; 3 capillary
0.5 mm bore	10 ferrules	**708318**	
0.8 mm bore	10 ferrules	**708319**	
Universal capillary glass connectors			
linear	5 connectors	**707971**	
linear	10 connectors	**707972**	
Y splitter	1 connector	**707973**	
PTFE shrinking tube, thin-walled	1 m	**708305**	for capillary connection, min. ID expanded 1.17 mm, max. ID shrunk 0.40 mm

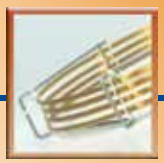


Septa for GC

Designation	Standard septa (ST)	High temperature septa (HT)	Silicone septa, soft	Silicone septa PTFE
				
Material	beige silicone	red, non-bleeding silicone	transparent silicone	white silicone, one side laminated with grey PTFE
Thickness	4 mm	3 mm	3 mm	3 mm
Hardness	60 shore A	60 shore A	45 shore A	
max. Temp.		320 °C *	250 °C	200 °C

* If used at considerably higher temperatures – and working without septum purge – interfering peaks can occur due to thermal decomposition of the material.

Accessories for capillary columns



Ordering information

Septum grade (packs of 50 septa)	Outer diameter 9 mm N 9	10 mm N 10	11 mm N 11	12 mm N 12	13 mm N 13	17 mm N 17
Standard septa (ST)	**702609**	**702610**	**702611**	**702612**	**702613**	
High temperature septa (HT)	**702619**	**702620**	**702621**	**702622**	**702623**	**702632**
Silicone septa, soft	**702602**		**702604**	**702605**	**702606**	
Silicone septa PTFE		**702625**	**702626**	**702627**	**702628**	
Septum remover (tool for removing septa baked into the injection port of the gas chromatograph)						**706141**

Tools and general accessories for GC

- **Diamond file:**
  a useful tool for cutting capillaries and smoothing ends of capillaries. Square capillary ends are especially important for butt connections (e.g., in Valco unions).
- **Magnifying lens:** an essential tool for any laboratory.
  In capillary GC it is often important to inspect column integrity or check cut ends of capillaries. When closing a column by melting the magnifying lens can be used to check whether the column is really closed or whether an open channel has been formed in the sealed end. Our lens provides 8fold magnification and is supplied with a scale as pictured in the figure below. The space between lines is equivalent to 1/10 mm.
- **Glass wool, quartz wool** and **glass fiber wadding** are used for, e.g., GC liners, packed GC columns etc.

Lens with scale

Diamond file

Ordering information

Description	Specification	Pack of	REF
Tools for capillary GC			
Diamond file	for cutting capillaries and straightening capillary ends	1	**708300**
Magnifying lens with scale	magnification 8x	1	**706296**
Glass wool			
Glass wool, long fibers, DMCS treated, for packed GC columns		50 g	**706201**
Glass fiber wadding silanized, very fine fibers		25 g	**718002**
Quartz wool, very fine fibers		25 g	**718587**
Glass wool extractor for GC columns		1	**706117**
PTFE tape for sealing, reels 10 m long, 12 mm wide, 0.1 mm thick		1 reel	**706512**

Product and subject index

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Trademarks

MACHEREY-NAGEL trademarks

ALUGRAM	coated aluminium sheets for TLC
CHROMABOND	columns for solid phase extraction (SPE)
CHROMAFIL	syringe filters (membrane filters)
CHROMAFIX	cartridges for solid phase extraction (SPE)
ChromCart	cartridge system for HPLC
LIPODEX	fused silica capillary columns with cyclodextrin phases for GC enantiomer separation
NUCLEODUR	spherical high purity silica for HPLC
NUCLEOGEL	polymer-based HPLC columns
NUCLEOGEN	HPLC ion exchange columns for nucleic acid analyses
NUCLEOSHELL	core-shell silica phases for HPLC
NUCLEOSIL	spherical standard silica for HPLC
OPTIMA	fused silica high performance capillary columns with immobilized phases
OPTIMA WAXplus	fused silica high performance capillary columns with optimized polyethylene glycol phase
PERMABOND	fused silica capillary columns with immobilized phases
POLYGOSIL	irregular silica for HPLC
POLYGRAM	coated polyester sheets for TLC

Trademarks of other companies

Registered trademarks (®)

Accubond	Agilent Technologies Inc. (USA)
Acquity	Waters Corp. (USA)
Allure	Restek Corp. (USA)
Aqua	Phenomenex Inc. (USA)
Ascentis	Sigma-Aldrich Co. (USA)
Atlantis	Waters Corp. (USA)
AutoTrace	Caliper Life Sciences Inc. (USA)
AVICEL	FMC Corp. (USA)
Biomek	Beckman Coulter Inc. (USA)
Biotage	Biotage AB (Sweden)
Bond Elut	Varian Inc. (USA)
Celite	Manville Corp. (USA)
Cheminert	Valco Instruments Co. Inc. / VICI AG
ChiralCel	Daicel Chemical Industries Ltd. (Japan)
ChiralPak	Daicel Chemical Industries Ltd. (Japan)
Clean Screen	UCT United Chemical Technologies Inc. (USA)
CLEAN-UP	UCT United Chemical Technologies Inc. (USA)
CombiFlash	Teledyne Isco Inc. (USA)
Companion	Teledyne Isco Inc. (USA)
Discovery	Sigma-Aldrich Co. (USA)
Duran	Schott AG (Germany)
ep*Motion*	Eppendorf AG (Germany)
Eurocel	Knauer GmbH (Germany)
EXtrelut	Merck KGaA (Germany)
Fiolax	Schott AG (Germany)
Florisil	U.S. Silica Co.
Gemini	Phenomenex Inc. (USA)
Hypersil	Thermo Fisher Scientific Inc. (USA)
HyPurity	Thermo Fisher Scientific Inc. (USA)
Inertsil	GL Sciences (Japan)
Isco	Teledyne Isco Inc. (USA)
Isolute	Biotage AB (Sweden)
Kromasil	Eka Chemicals AB (Sweden)
LiChrolut	Merck KGaA (Germany)
LiChrospher	Merck KGaA (Germany)
Luna	Phenomenex Inc. (USA)
Microlab	Hamilton Co. (USA)
MultiProbe	PerkinElmer Inc. (USA)
Oasis	Waters Corp. (USA)
Polaris	Agilent Technologies Inc. (USA)
ProntoSil	Bischoff Chromatography (Germany)
Purospher	Merck KGaA (Germany)
Pyrex	Corning Inc. (USA)
Quadra 3	Tomtec Inc. (USA)
RapidTrace	Caliper Life Sciences Inc. (USA)
Rxi	Restek Corp. (USA)
Rtx	Restek Corp. (USA)
Sep-Pak	Waters Corp. (USA)
SOTAX	Sotax AG (Schweiz)
Spherisorb	Waters Corp. (USA)
Stabilwax	Restek Corp. (USA)
Styre Screen	UCT United Chemical Technologies Inc. (USA)
Superspher	Merck KGaA (Germany)
Symmetry	Waters Corp. (USA)
Synergi	Phenomenex Inc. (USA)
Vespel	E. I. du Pont de Nemours & Co. (USA)
VICI	Valco Instruments Co. Inc. / VICI AG
Viton	DuPont Performance Elastomers (USA)
Xterra	Waters Corp. (USA)
YMC	YMC Co. Ltd. (Japan)
ZIC	Merck Sequant AB (Sweden)
Zorbax	Agilent Technologies Inc. (USA)
Zymark	Caliper Life Sciences Inc. (USA)
Zymate	Caliper Life Sciences Inc. (USA)

Trademarks

Common law trademarks (™)

AmyCoat	Eka Chemicals AB (Sweden)
ASPEC	Gilson Inc. (USA)
AT	Alltech Associates Inc. (USA)
Bakerbond	Mallinckrodt Baker Inc. (USA)
Benchmate	Caliper Life Sciences Inc. (USA)
BPX	SGE Analytical Sciences Pty Ltd. (Australien)
Carbowax	Union Carbide Corp. (USA)
CelluCoat	Eka Chemicals AB (Sweden)
Chem Elut	Varian Inc. (USA)
DB	J&W Scientific Inc. (USA)
Equity	Sigma-Aldrich Co. (USA)
FlashMaster	Biotage AB (Sweden)
Flash 12i	Biotage AB (Sweden)
Focus	Varian Inc. (USA)
Genesis	Tecan Group AG
Hydromatrix	Varian Inc. (USA)
HyperSep	Thermo Fisher Scientific Inc. (USA)
Hypersil	Thermo Fisher Scientific Inc. (USA)
HyPURITY	Thermo Fisher Scientific Inc. (USA)
Kinetex	Phenomenex Inc. (USA)
Lux	Phenomenex Inc. (USA)
Obelisc	Sielc Technologies (USA)
Nukol	Sigma-Aldrich Co. (USA)
PEEK	Victrex plc. (UK)
Porapak	Waters Corp. (USA)
Poroshell	Agilent Technologies Inc. (USA)
SPB	Sigma-Aldrich Co. (USA)
Select	Agilent Technologies Inc. (USA)
Sequant	Merck Sequant AB (Sweden)
Strata	Phenomenex Inc. (USA)
SunFire	Waters Corp. (USA)
Supelclean	Sigma-Aldrich Co. (USA)
Supelcosil	Sigma-Aldrich Co. (USA)
Supelcowax	Sigma-Aldrich Co. (USA)
SymmetryShield	Waters Corp. (USA)

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Regarding these products or services we can not grant any guarantees regarding selection, efficiency or operation.

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MACHEREY-NAGEL chromatography products are intended, developed, designed and sold FOR RESEARCH AND DEVELOPMENT PURPOSES AND ANALYTICAL QUALITY CONTROL / ROUTINE MEASUREMENTS ONLY, except, however, any other function of the product being EXPRESSLY set forth in original MACHEREY-NAGEL product leaflets.

MACHEREY-NAGEL products are intended for GENERAL LABORATORY USE ONLY!

MACHEREY-NAGEL products are suited for QUALIFIED PERSONNEL ONLY !

MACHEREY-NAGEL products shall in any event be used wearing adequate PROTECTIVE CLOTHING.

For detailed information please refer to the respective Material Safety Data Sheet of the product !

MACHEREY-NAGEL products shall exclusively be used in an ADEQUATE TEST ENVIRONMENT.

MACHEREY-NAGEL does not assume any responsibility for damages due to improper application, abuse, misuse, storage or maintance of our products. Prior to application the user has to read carefully and understand the instruction or product leaflets included in the product package (if applicable or available on the webpage) – in case of any doubts the customer has to contact MACHEREY-NAGEL.

Application on the human body is STRICTLY FORBIDDEN. The respective user is liable for any and all damages resulting from such application.

The user has to ensure that the products used are suitable for the intended application.

MACHEREY-NAGEL does not warrant the reproducibility of published applications.

USP list of MN HPLC phases

Code	Specification	MN **HPLC** phases	Page
USP L1	Octadecyl silane chemically bonded to porous silica particles, 1.8 to 10 µm diameter	NUCLEODUR® C_{18} ec	133
		NUCLEODUR® C_{18} Gravity	116
		NUCLEODUR® C_{18} HTec	130
		NUCLEODUR® C_{18} Isis	120
		NUCLEODUR® C_{18} PAH	168
		NUCLEODUR® C_{18} Pyramid	122
		NUCLEODUR® PolarTec	124
		NUCLEODUR® Sphinx RP	128
		NUCLEOSHELL® RP 18	148
		NUCLEOSIL® C_{18}	157
		NUCLEOSIL® C_{18} AB	144
		NUCLEOSIL® C_{18} HD	158
		NUCLEOSIL® C_{18} MPN	182
		NUCLEOSIL® C_{18} PAH	170
		NUCLEOSIL® C_{18} PPN	183
USP L3	Porous silica particles, 5 to 10 µm diameter	NUCLEODUR® SiOH	142
		NUCLEOSIL® SiOH	165
USP L7	Octyl silane chemically bonded to totally porous silica particles, 1.8 to 10 µm diameter	NUCLEODUR® C_8 ec	133
		NUCLEODUR® C_8 Gravity	116
		NUCLEOSIL® C_8	160
		NUCLEOSIL® C_8 HD	161
USP L8	An essentially monomolecular layer of aminopropyl silane chemically bonded to totally porous silica gel support, 3 to 10 µm diameter	NUCLEODUR® NH_2 / NH_2-RP	161
		NUCLEOSIL® Carbohydrate	185
		NUCLEOSIL® NH_2 / NH_2-RP	163
USP L9	Irregular or spherical, totally porous silica gel having a chemically bonded, strongly acidic cation exchange coating, 3 to 10 µm diameter	NUCLEOSIL® SA	164
USP L10	Nitrile groups chemically bonded to porous silica particles, 3 to 10 µm diameter	NUCLEODUR® CN / CN-RP	138
		NUCLEOSIL® CN / CN-RP	164
USP L11	Phenyl groups chemically bonded to porous silica particles, 3 to 10 µm diameter	NUCLEODUR® Sphinx RP	128
		NUCLEOSIL® C_6H_5	162
USP L14	Silica gel having a chemically bonded, strongly basic quaternary ammonium anion exchange coating, 5 to 10 µm diameter	NUCLEOSIL® SB	165
USP L16	Dimethyl silane chemically bonded to porous silica particles, 5 to 10 µm dia.	NUCLEOSIL® C_2	162
USP L17	Strong cation exchange resin consisting of sulfonated cross-linked PS/DVB copolymer in the H form, 7 to 11 µm particles	NUCLEOGEL® ION 300 OA	187
		NUCLEOGEL® SUGAR 810 H	186
USP L19	Strong cation exchange resin consisting of sulfonated cross-linked PS/DVB copolymer in the Ca form, ~ 9 µm particles	NUCLEOGEL® SUGAR 810 Ca	186
		NUCLEOGEL® SUGAR Ca	187
USP L20	Dihydroxypropane groups chemically bonded to porous silica particles, 5 to 10 µm diameter	NUCLEOSIL® OH (Diol)	162
USP L21	A rigid, spherical styrene-divinylbenzene copolymer, 5 to 10 µm particles	NUCLEOGEL® RP	184
USP L22	Cation exchange resin with porous polystyrene gel with sulfonic acid groups, ~ 10 µm particles	NUCLEOGEL® SCX	181
USP L23	Anion exchange resin of porous polymethacrylate or polyacrylate gel with quaternary ammonium groups, ~ 10 µm particles	NUCLEOGEL® SAX	181
USP L26	Butyl silane chemically bonded to totally porous silica particles, 5 to 10 µm diameter	NUCLEOSIL® C_4	161
		NUCLEOSIL® C_4 MPN	182
USP L32	A chiral ligand exchange packing · L-proline copper complex covalently bonded to irregularly shaped silica particles, 5 to 10 µm diameter	NUCLEOSIL® CHIRAL-1	176
USP L34	Strong cation exchange resin consisting of sulfonated cross-linked PS/DVB copolymer in the Pb form, ~ 9 µm particles	NUCLEOGEL® SUGAR Pb	187
USP L36	A 3,5-dinitrobenzoyl derivative of L-phenylglycine, covalently bonded to 5 µm aminopropyl silica	NUCLEOSIL® CHIRAL-3	177
USP L40	Cellulose tris-(3,5-dimethylphenylcarbamate) coated porous silic, 5 to 20 µm particles	NUCLEOCEL DELTA	174
USP L43	Pentafluorophenyl groups chemically bonded to silica particles by a propyl spacer, 5 to 1o µm diameter	NUCLEODUR® PFP	126
		NUCLEOSHELL® PFP	150
USP L45	Beta-cyclodextrin bonded to porous silica particles, 5 to 10 µm diameter	NUCLEODEX β-OH, β-PM	172

USP list of MN GC phases

Code	Specification	MN **HPLC** phases	Page
USP L58	Strong cation exchange resin consisting of sulfonated cross-linked PS/DVB copolymer in the Na form, ~ 7 to 11 µm particles	NUCLEOGEL® SUGAR Na	187
USP L60	Spherical porous silica gel, covalenty modified with alkyl amide groups and endcapped, 3 or 5 µm particles	NUCLEODUR® PolarTec	124
		NUCLEOSIL® C_{18} Nautilus	148

Code	Specification	MN **GC** phases	Page
USP G1 / G2	Dimethylpolysiloxane oil	OPTIMA® 1	242
		OPTIMA® 1 MS	243
		OPTIMA® 1 MS Accent	244
		OPTIMA® 1-TG	274
		PERMABOND® SE-30	264
		PERMABOND® P-100	277
USP G3	50% phenyl – 50% methylpolysiloxane	OPTIMA® 17	255
		OPTIMA® 17 MS	256
		OPTIMA® 17-TG	274
USP G6	Trifluoropropylmethylpolysiloxane	OPTIMA® 210	257
USP G7	50% 3-cyanopropyl – 50% phenylmethylpolysiloxane	OPTIMA® 225	258
USP G16	Polyethylene glycol (av. mol. weight ~ 15 000); a high molecular weight compound of polyethylene glycol and a diepoxide	OPTIMA® WAX	260
		OPTIMA WAXplus®	261
		PERMABOND® CW 20 M	265
		PERMABOND® CW 20 M-DEG	279
		FS-CW 20 M-AM	277
USP G19	25% phenyl – 25% cyanopropyl – 50% methylpolysiloxane	OPTIMA® 225	258
USP G25	A high molecular compound of a polyethylene glycol esterified with terephthalic acid	OPTIMA® FFAP	262
		OPTIMA® FFAPplus	263
		PERMABOND® FFAP	265
USP G27	5% phenyl – 95% methylpolysiloxane	OPTIMA® 5	245
		OPTIMA® 5 Amine	276
		OPTIMA® 5 HT	275
		OPTIMA® 5 MS	246
		OPTIMA® 5 MS Accent	247
		PERMABOND® SE-52	264
USP G28	25% phenyl – 75% methylpolysiloxane	OPTIMA® 35 MS	254
USP G32	20% phenylmethyl – 80% dimethylpolysiloxane	OPTIMA® 35 MS	254
USP G35	A high molecular compound of a polyethylene glycol and a diepoxide esterified with nitroterephthalic acid	OPTIMA® FFAP	262
		OPTIMA® FFAPplus	263
		PERMABOND® FFAP	265
USP G36	1% vinyl – 5% phenylmethylpolysiloxane	OPTIMA® 5	245
		OPTIMA® 5 Amine	276
		OPTIMA® 5 HT	275
		OPTIMA® 5 MS	246
		OPTIMA® 5 MS Accent	247
		PERMABOND® SE-54 HKW	278
USP G38	Dimethylpolysiloxane oil	OPTIMA® 1	242
		OPTIMA® 1 MS	243
		OPTIMA® 1 MS Accent	244
		OPTIMA® 1-TG	274
		PERMABOND® SE-30	264
		PERMABOND® P-100	277
USP G42	35% phenyl – 65% dimethylpolysiloxane	OPTIMA® 35 MS	254
USP G43	6% cyanopropylphenyl – 94% dimethylpolysiloxane	OPTIMA® 1301	251
		OPTIMA® 624	252
		OPTIMA® 624 LB	252
USP G46	14% cyanopropylphenyl – 86% methylpolysiloxane	OPTIMA® 1701	253
USP G49	Proprietary derivatized phenyl groups on a polysiloxane backbone	OPTIMA® δ-3	249

Filtration

Filter papers

Membrane filters

Extraction thimbles

Rapid Tests

Test papers

Test strips

Urine test strips

Water Analysis

Colorimetric and titrimetric test kits

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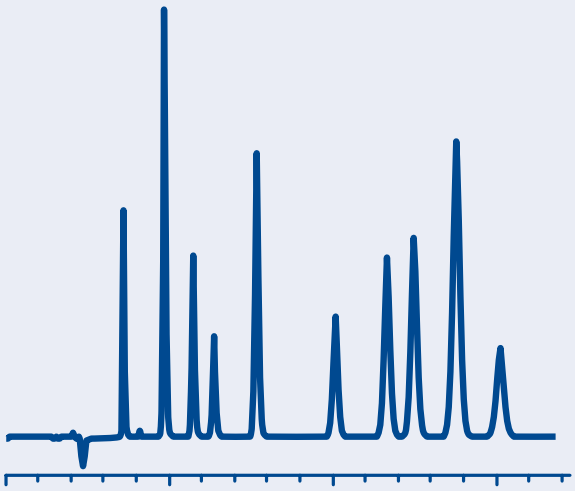

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