Unichrome®

Chromatography

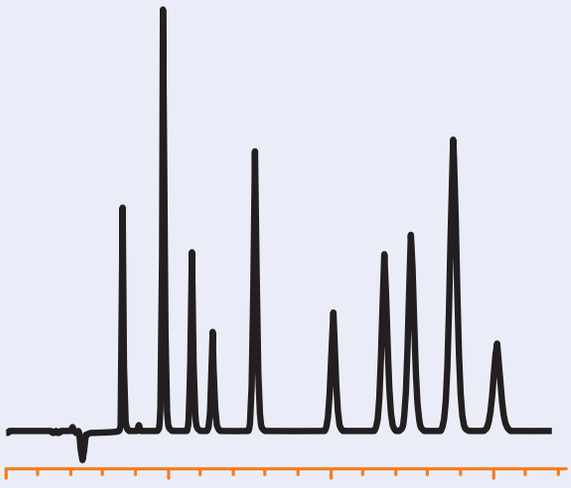
Columns and supplies catalog

HPLC

GC

SPE and Flash

Crimper & Decrimper



. . . we Meet your Needs

MACHEREY-NAGEL

www.mn-net.com

Unichrome®

MN Since 1911

Unibond PRC$_{18}$ / PRC$_8$

- **Key features**
  - Decrease of analysis time (ultra fast HPLC)
  - Shorter columns with high separation efficiency
  - Significant improvement of resolution and detection sensitivity
  - Suitable for **LC/MS** due to low bleeding characteristics
- **Unibond** 1.8 µm particles are fractionated to limit the increase in back pressure

Unibond PRC$_{18}$ / PRC$_8$
P = Particular
R = Robust
C = Column

Advantages of 1.8 µm particle size

Miniaturization in HPLC has a long history. It started in the early stage of HPLC development with the reduction of particle size from 10 µm via 7 µm to standard 5 µm – which is still the most widely used particle diameter in analytical HPLC – to 3 µm spherical particles which so far was the smallest particle size available for gaining higher theoretical plates and efficiencies. With the introduction of 1.8 µm **Unibond** particles researchers have turned over a new leaf in HPLC column technology. Columns packed with these microspherical particles show extraordinary improvements in terms of plate numbers, column efficiencies and resolution compared with their 3 µm counterparts.

- **Column back pressure**

  Due to the smaller particle size 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
η = viscosity
u = linear velocity
d_P = particle diameter

Because of the high sphericity of the Unibond particles and the very narrow particle size distribution we were able to keep the back pressure on a moderate level. Nevertheless the use of columns packed with sub 2 µm particles generally makes special demands on the HPLC equipment. Pumps should be designed for pressures of 250–1000 bars and the entire system should feature the lowest possible dead volume.

Comparison of back pressures:

Eluent: 100 % methanol
Flow rate: 1.5 mL/min
Temperature: 22 °C
Column dimension: 50 x 4.6 mm

	Unibond PRC$_{18}$	Competitor A
3 µm	70 bar	–
1.8 µm	130 bar	170 bar

Features of 1.8 µm Unibond PRC$_{18}$

- **Increase of separation efficiency by higher number of theoretical plates (N):**

  50 x 4.6 mm **Unibond PRC$_{18}$**
  3 µm: N ≥ 100 000 plates/m (h value ≤ 10)
  1.8 µm: N ≥ 166 667 plates/m (h value ≤ 6)

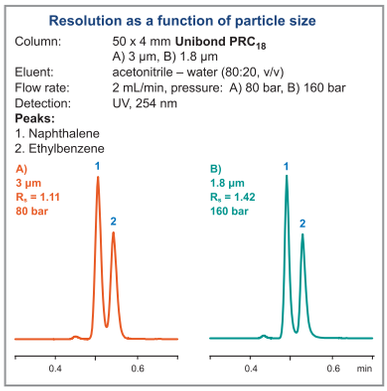
  Increase of the plate number by app. 67 % offers the possibility of using shorter columns with equal plate numbers resulting in a decrease of analysis time.

- **Significant improvement in resolution**

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

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

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

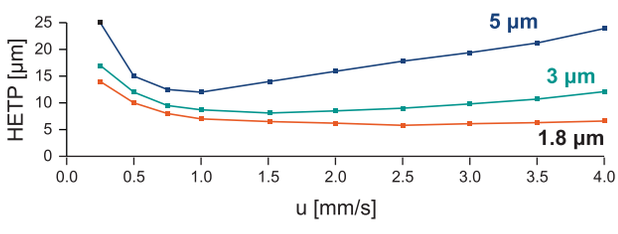


- **Higher flow rates and shorter run times**

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

Van-Deemter plot

column 50 x 4.6 mm, acetonitrile – water (50:50, v/v), analyte toluene



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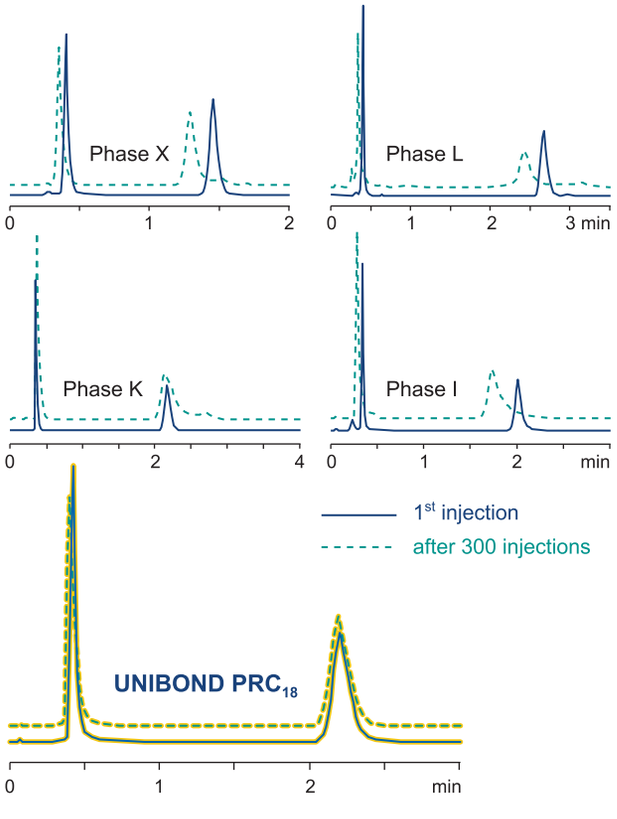
Nonpolar high density phases

The following chromatograms demonstrate the stability of Unibond PRC_{18} under alkaline con - ditions in comparison with 4 commercially available modern RP18 phases. Again, the ultrapure with its unique high density surface bonding technology withstands strong alkaline mobile phase conditions. Even after 300 injections no loss of column efficiency, identified, e.g., by peak broadening or decrease in retention times, could be observed.

Stability of UNIBOND PRC_{18} under alkaline conditions compared with different C_{18} phases

Columns: 50 x 4.6 mm
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 volume: 2.0 µL

Peaks:
1. Theophylline
2. Caffeine



MN Appl. No. 120850

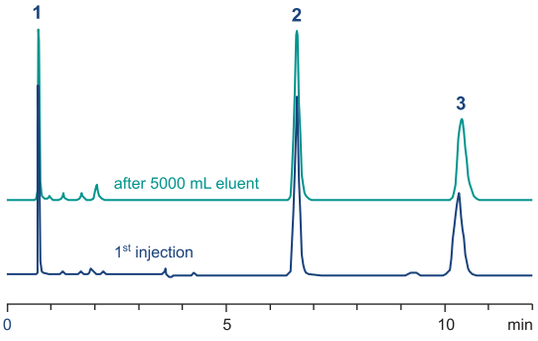
The pH stability of silica under alkaline conditions is mainly a kinetic effect and based on the velocity of the dissolution of the silica support. It is worth mentioning, that this phenomenon also depends on type and concentration of buffers, as well as on the temperature. It is well known, that the 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 UNIBOND PRC_{18} in acidic conditions. The retention time of all three compounds in the column performance test remains 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 UNIBOND PRC_{18} at pH 1.5

Column:125 x 4 mm UNIBOND PRC_{18} 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 volume: 5 µL

Peaks:
1. Pyridine
2. Toluene
3. Ethylbenzene



MN Appl. No. 120840

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UNIBOND PRC$_{18}$ / PRC$_8$

- **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

UNIBOND PRC$_{18}$ AND UNIBOND PRC$_8$ are based on the ultrapure silica.

A unique derivatization process generates a homogeneous surface with a high density of bonded silanes (carbon content ~18 % for C_{18}, ~11 % for C $_8$). The following thorough endcapping suppresses any unwanted polar interactions between the silica surface and the sample, particularly suitable for the separation of basic and other ionizable analytes. The figure on the right shows a comparison study, where the strongly basic amitriptyline is eluted on various highly base deactivated C $_{18}$ phases under isocratic conditions.

Tanaka diagrams

Several UNIBOND phases have been examined in accordance with Tanaka et al. [J. Chromatogr. Sci. 27 (1989) 721] and Johnson et al. [Chromatographia 44 (1997) 151] with respect to the following parameters:

Capacity = k'(pentylbenzene)

Hydrophobicity = α(pentylbenzene, butylbenzene)

Steric selectivity = α(triphenylene, *o*-terphenyl)

Hydrogen bonding capacity (silanol capacity) = α(caffeine, phenol)

Ion exchange capacity at 2 different pH values (2.7 and 7.6) = α(benzylamine, phenol)

The resulting Tanaka plots are shown with the respective phases.

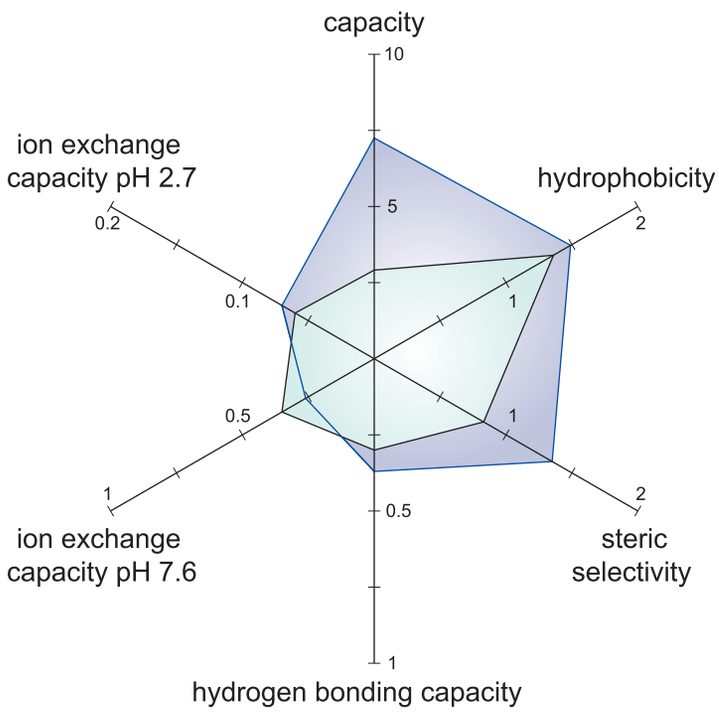
Enhanced pH stability

One major disadvantage of using silica stationary phases is the limited stability at strongly acidic or basic pH ranges. Cleavage of the siloxane bonding by hydrolysis, or dissolution of the silica will rapidly lead to a considerable loss in column performance. Therefore 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 UNIBOND PRC$_8$ / PRC$_{18}$ allow for use at an expanded pH range from pH 1 to 11.

When is enhanced pH stability beneficial?

The option to work at 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.

Tanaka plots of UNIBOND PRC$_8$ AND UNIBOND PRC$_{18}$



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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 % dimethylpoly siloxane 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.

Capillary columns for GC

Phase	Composition	Max. temperature [1]	USP	Similar phases
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
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
OPTIMA® 1 MS Accent				
OPTIMA® 5	5 % diphenyl – 95 % methylpolysiloxane	340/360 °C	G27 G36	PERMABOND® SE-52 SE-54, SE-52, HP-5, SPB™-5, CP-Sil 8, Rtx®-5, 007-5, BP5, MDN-5, AT™-5, ZB-5
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
OPTIMA® 5 MS Accent	silarylene phase with selectivity similar to 5 % diphenyl – 95 % dimethylpolysiloxane	340/360 °C	G27 G36	
OPTIMA® XLB	silarylene phase, optimized silarylene content for low bleeding	340/360 °C	–	DB-XLB, Rxi®-XLB, Rtx®-XLB, MDN-12, VF-XMS
OPTIMA® δ-3	phase with autoselectivity [3]	340/360 °C	G49	no similar phases
OPTIMA® δ-6	phase with autoselectivity [3]	340/360 °C	–	no similar phases
OPTIMA® 1301	6 % cyanopropylphenyl – 94 % dimethylpolysiloxane	300/320 °C	G43	HP-1301, DB-1301, SPB™-1301, Rtx®-1301, CP-1301, 007-1301
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
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

Summary of MN phases for GC

Phase	Composition	Max. tem - perature [1]	USP	Similar phases [2]
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
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
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
OPTIMA® 210	trifluoropropylmethylpolysiloxane (50 % tri fluoropropyl)	260/280 °C	G6	OV-210, DB-210, Rtx®-200, 007-210
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
OPTIMA® 240	33% cyanopropylmethyl – 67 % dimethylpolysiloxan	260/280 °C	–	no similar phases
OPTIMA® WAX	polyethylene glycol 20 000 Da	240/250 °C	G16	PERMABOND® CW 20 M DB-Wax, Supelcowax, HP-Wax, HP-INNOWAX, Rtx-Wax, CP-Wax 52 CB, Stabilwax, 007-CW, BP20, AT-Wax, ZB-Wax
OPTIMA WAXplus®	polyethylene glycol with opti - mized 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
OPTIMA® FFAP	polyethylene glycol 2-nitro-terephthalate	240/250 °C	G35 G25	PERMABOND® FFAP (page 265), DB-FFAP, HP-FFAP, CP-Wax 58 FFAP CB, 007-FFAP, CP-FFAP CB, Nukol™
OPTIMA® FFAPplus	polyethylene glycol 2-nitro-terephthalate with optimized cross-linking	250/260 °C	G35 G25	DB-FFAP, HP-FFAP, CP-Wax 58 FFAP CB, 007-FFAP, CP-FFAP CB, Nukol™

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

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 in cluded 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.

Unichrome®

MN Since 1911

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
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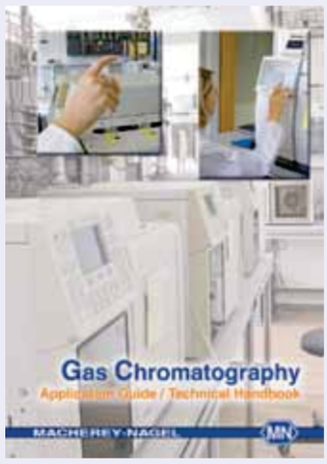

Capillary columns for GC

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
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
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
Biodiesel	methanol analysis FAME analysis glycerol and triglycerides	OPTIMA® BioDiesel M OPTIMA® BioDiesel F OPTIMA® BioDiesel G
Triglycerides		OPTIMA® 1-TG OPTIMA® 17-TG
High temperature GC		OPTIMA® 5 HT
Amines	polyfunctional amines amine separations	OPTIMA® 5 Amine FS-CW 20 M-AM
Petrochemical products (complex hydrocarbon mixtures)		PERMABOND® P-100
Environmental analyses	volatile halogenated hydrocarbons	PERMABOND® SE-54 HKW
Silanes (monomeric, e.g., chlorosilanes)		PERMABOND® Silane
Diethylene glycol, e.g., for the quality control of wine		PERMABOND® CW 20 M-DEG

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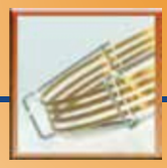
Capillary columns for special separations



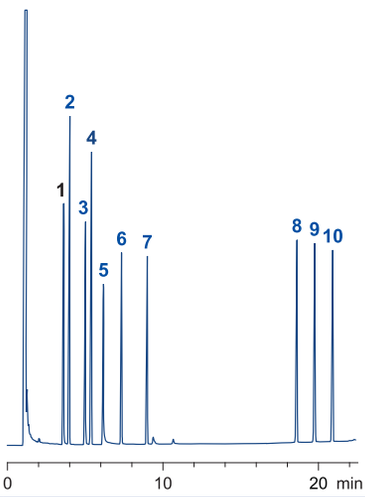
Columns for Fast GC

- **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

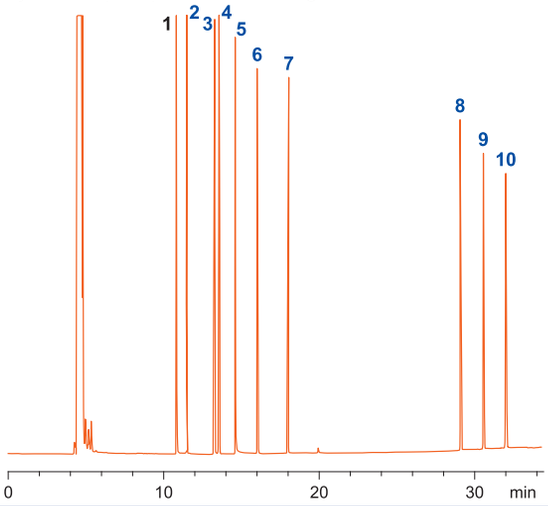
Comparison of a separation on a 50 m standard capillary with separation on a 10 m fast GC column

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



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



MN Appl. No. 211260

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 GC

Unichrome®

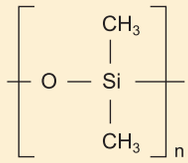
MN Since 1911

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.

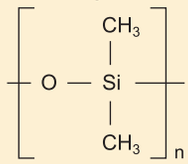
- Separation of components according to boiling points

Thick film columns ≥ 3 µm film are especially recommended for solvent analysis.

OPTIMA® 1MS

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

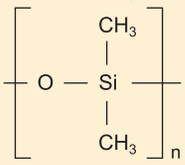
Suited for GC/MS and ECD applications and general analyses at trace level

- **USP G1 / G2 / G38**

OPTIMA® 1MS Accent

100 % dimethylpolysiloxane

- Selectivity identical to OPTIMA® 1



Increased sensitivity due to an unmatched low background level

- **USP G1 / G2 / G38**

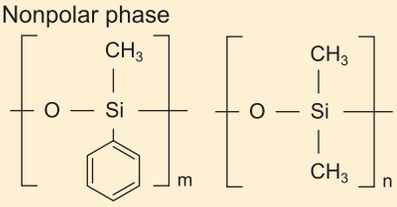
Max. temperature for isothermal operation 340 °C, max. temperature for short isotherms in a temperature program 360 °C

- 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

OPTIMA® 5

5 % phenyl – 95 % methylpolysiloxane

- 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

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**

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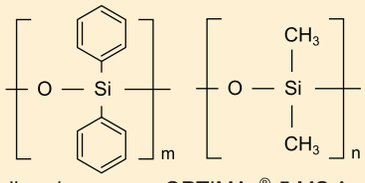
MN Since 1911

OPTIMA® high performance capillary columns

OPTIMA® 5MS

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

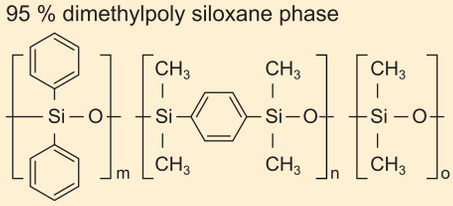
Perfect inertness for basic compounds

- **USP G27 / G36**

OPTIMA® 5 MSAccent

silarylene phase

Chemically bonded, cross-linked silarylene phase with polarity similar to a 5 % diphenyl - 95 % dimethylpoly siloxane 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

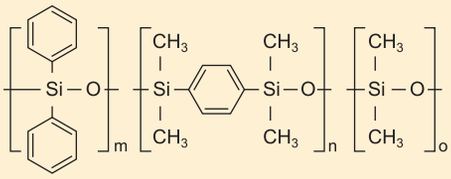
Recommended application: all-round phase for environmental analyses, trace analyses, EPA methods, pesticides, PCB, food and drug analyses

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

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

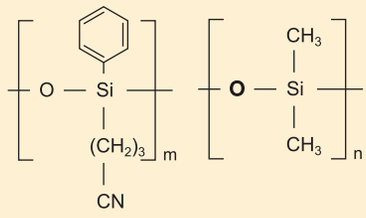
Recommended application: ultra low bleed phase, highly selective for environmental and trace analyses, pesticides

Recommended phase for PCB separations

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.

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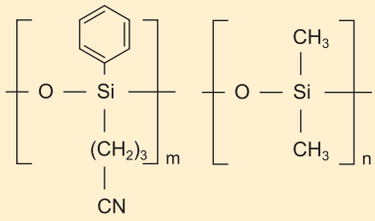
MN Since 1911

OPTIMA® high performance capillary columns

OPTIMA® 1701

14 % cyanopropyl-phenyl – 86 % dimethylpolysiloxane

- Medium polar phase



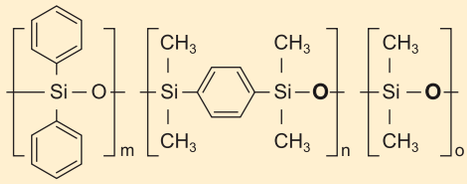
Similar phases: OV-1701, DB-1701, CP-Sil 19 CB, HP-1701, Rtx-1701, SPB-1701, 007-1701, BP10, ZB-1701

- Max. temperature for isothermal operation 300 °C, max. temperature for short isotherms in a tempera - ture 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**

OPTIMA® 35 MS

silarylene phase

Chemically bonded cross-linked silarylene phase with selectivity similar to 35 % phenyl – 65 % methyl poly-siloxane



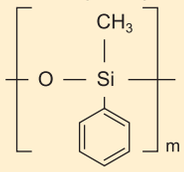
Similar phases: DB-35 MS, HP-35, SPB-35, Rxi-35SIL MS, Rtx-35, 007-35, BPX-35, MDN-35, AT-35 MS, ZB-35, OV-11, VF-35 MS

- 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**

OPTIMA® 17

phenylmethylpolysiloxane (50 % phenyl)

- Medium polar phase



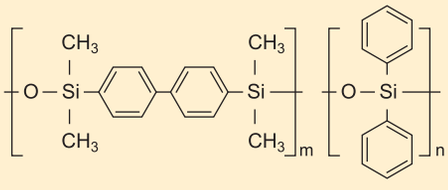
Similar phases: OV-17, DB-17, HP-50+, HP-17, SPB-50, SP-2250, Rxi-17, Rtx-50, CP-Sil 24 CB, 007-17, ZB-50

- 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**

OPTIMA® 17 MS

silarylene phase

- Medium polar silarylene phase with selectivity analogue to 50 % phenyl – 50 % methylpolysilox - ane



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 analy - ses
- **USP G3**

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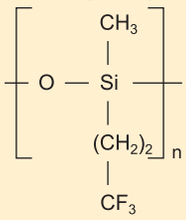
OPTIMA® 210

trifluoropropyl-methylpolysiloxane (50% trifluoropropyl)

- Medium polar phase



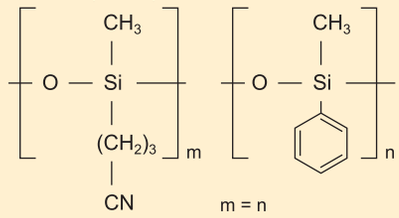
- Max. temperature for isothermal operation 260 °C, max. temperature for short isotherms in a temperature program 280 °C
- Recommended application: environmental analyses, especially for *o*-, *m*- and *p*-substituted aromatic hydrocarbons
- Close equivalent to **USP G6**

Similar phases: OV-210, DB-210, Rtx-200, 007-210

OPTIMA® 225

50% cyanopropyl-methyl – 50% phenylmethylpolysiloxane

- Medium polar phase



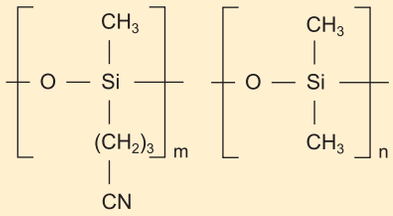
- Max. temperature for isothermal operation 260 °C, max. temperature for short isotherms in a temperature program 280 °C
- Recommended for fatty acid analyses

  Similar phases: DB-225, HP-225, OV-225, Rtx-225, CP-Sil 43, 007-225, BP225
- Close equivalent to **USP G7 / G19**

OPTIMA® 240

33% cyanopropyl-methyl – 67% dimethylpolysiloxane

- Medium polar phase



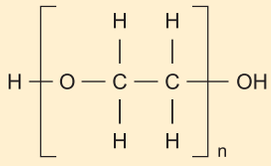
- Max. temperature for isothermal operation 260 °C, max. temperature for short isotherms in a temperature program 280 °C
- Recommended for FAMEs, dioxins

  No similar phases

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

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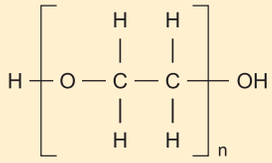
OPTIMA® high performance capillary columns

OPTIMA WAXplus®

cross-linked polyethylene glycol

- Polar phase with improved cross-linking for lower column bleed and better temperature stability



NEW!

- **USP G16**

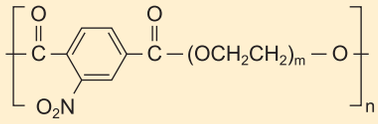
- Max. temperature for isothermal operation 260 °C, max. temperature for short isotherms in a temperature program 270 °C
- Recommended application:
  broad range of application, e.g., for solvents and alcohols, suitable for aqueous solutions

  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

OPTIMA® FFAP

polyethylene glycol 2-nitroterephthalate

- Polar phase



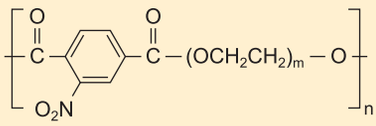
Similar phases: PERMABOND® FFAP (page 265), DB-FFAP, HP-FFAP, CP-Wax 58 (FFAP) CB, 007-FFAP, CP-FFAP CB, Nukol, BP21

- 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

OPTIMA® FFAPplus

polyethylene glycol 2-nitroterephthalate

- Polar phase



NEW!

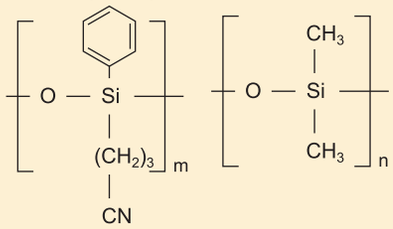
Similar phases: OPTIMA® FFAP (previous page), DB-FFAP, HP-FFAP, CP-Wax 58 (FFAP) CB, 007-FFAP, CP-FFAP CB, Nukol

- 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

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

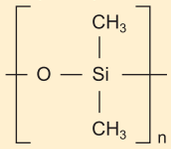
  Similar phases: HP-1301, DB-1301, SPB-1301, Rtx-1301, CP-1301, 007-1301
- **USP G43**

PERMABOND® capillary columns

PERMABOND® SE-30

100 % dimethylpolysiloxane

- Nonpolar phase

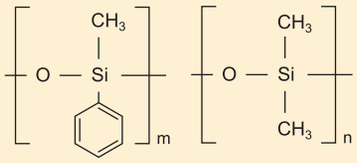


Max. temperature for isothermal operation 300 °C, max. temperature for short isotherms in a temperature

PERMABOND® SE-52

5 % phenyl – 95% dimethylpolysiloxane

- Nonpolar phase

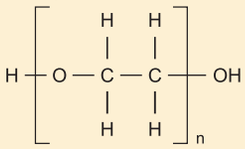


Max. temperature for isothermal operation 300 °C, max. temperature for short isotherms in a temperature

PERMABOND® CW 20 M

polyethylene glycol 20 000 Da

- Polar phase



Similar phases see OPTIMA ® WAX page 260

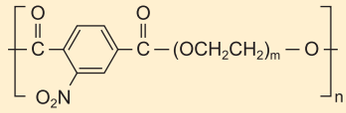
0.1–0.32 mm ID: max. temperature for isothermal operation 220 °C, max. temperature for short isotherms in a temperature program 240 °C
0.53 mm ID: max. temperatures 200 and 220 °C, resp.

- Recommended for solvent analyses and alcohols
- Suitable for aqueous solutions

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

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)

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

Crimping tools

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**

Unichrome®

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Crimping tools

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**

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CHROMABOND® HR-X *pert*

The professional concept of innovative SPE phases

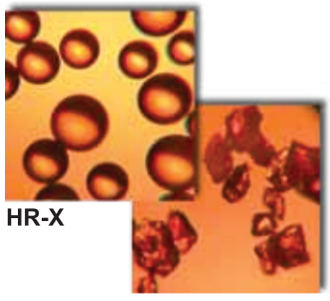
The CHROMABOND® HR-Xpert family comprises 5 polymer-based RP and mixed-mode ion exchange phases:

- **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

Solid Phase Extraction

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 enrich ment 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

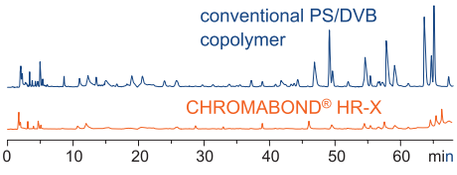


HR-X

-

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

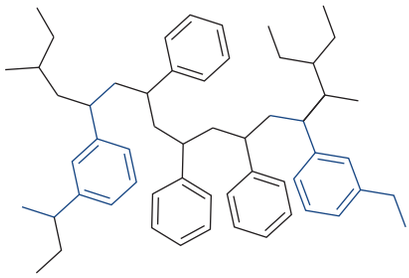
Unichrome®

MN Since 1911

CHROMABOND® HR-X *pert*

Chemical structures of the phases:

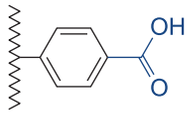
CHROMABOND® HR-X



Hydrophobic
polystyrene-divinylbenzene copolymer

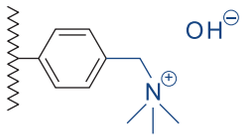
spherical base material for efficient enrichment and ideal flow behavior

CHROMABOND® HR-XCW



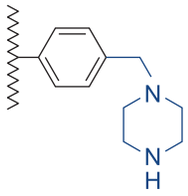
weak acidic cation exchanger

CHROMABOND® HR-XA



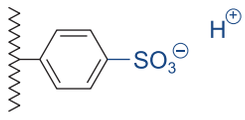
strong basic anion exchanger

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

Solid Phase Extraction