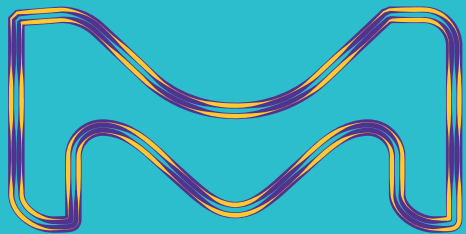


supelco HPLC and GC COLUMNS and ACCESSORIES

Irina Galushko,
irina.galushko@merckgroup.com



MERCK

01

HPLC

Leading Innovations in HPLC

Stable 5 μm (2nd after DuPont)

Monomeric bonded phase (maybe 1st)

5 cm columns for fast analysis (1st)

Base-deactivated (1st) (DB)

3 μm porous silica (2nd after Perkin-Elmer)

Special applications:

- Specialty column for tricyclic antidepressants (1st) (LC-PCN)
- 15 cm column for fast analysis of PAHs (1st, maybe 2nd after P-E) (LC-PAH)
- Nucleoside and nucleotide columns (1st) (LC-18-S, LC-18-T)
- Direct serum injection phase (2nd after Pinkerton) (Hisep SHP)
- Chiral phases (Many 1^{sts}) (Astec)

Polar embedded (1st) (amide-based phases, Suplex, ABZ, RP-Amides)

Fused-Core technology (co-1st with AMT) (Ascentis Express)

Titan – UHPLC columns with Monodisperse Silica

Late
1970s



Today

Supelco HPLC Product History

2013: Titan

2007: Ascentis Express

1998: Chirobiotic (by Astec)

Mid-1990s: Ascentis

1990s: Discovery

1970s: Supelcosil



Extensive knowledge and understanding of bonding chemistry by the R&D team of Supelco drove the innovations.

1978

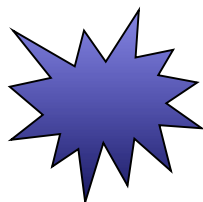


Ascentis Express – Fused-Core Technology

www.sigmaaldrich.com/express

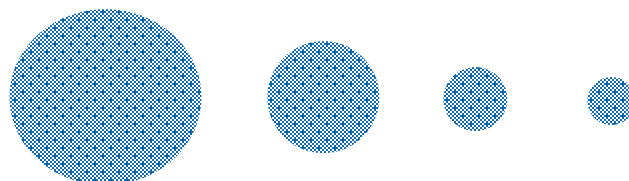
History of HPLC particle design

Irregular



*Difficult to pack, clogging,
not very robust*

Total Porous



*Current state-of-the-
art in HPLC*

Fused-Core™



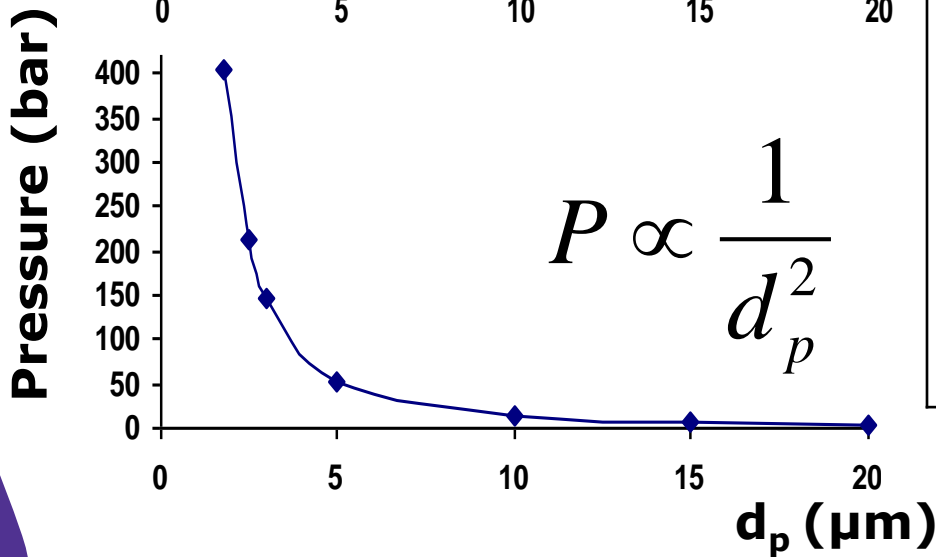
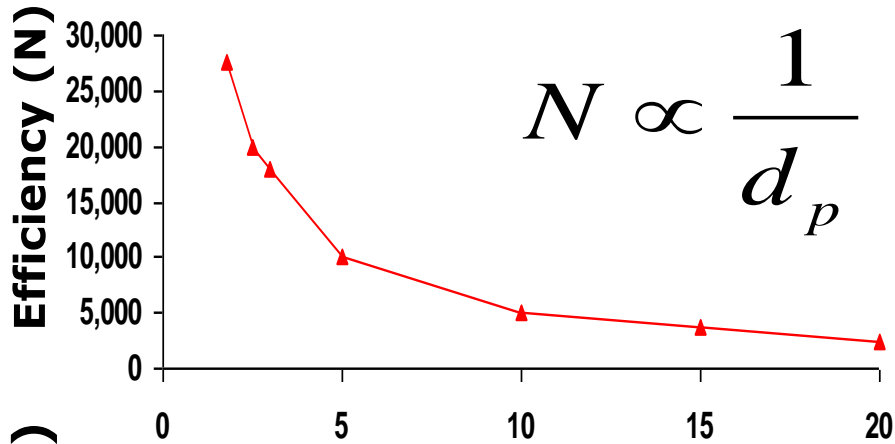
The NEW technology

Fused-Core is a trademark of
Advanced Materials Technology,
Inc.

Nowadays also known as core-shell, superficially porous, solid-core, ...

Particle size: Influence on efficiency and pressure

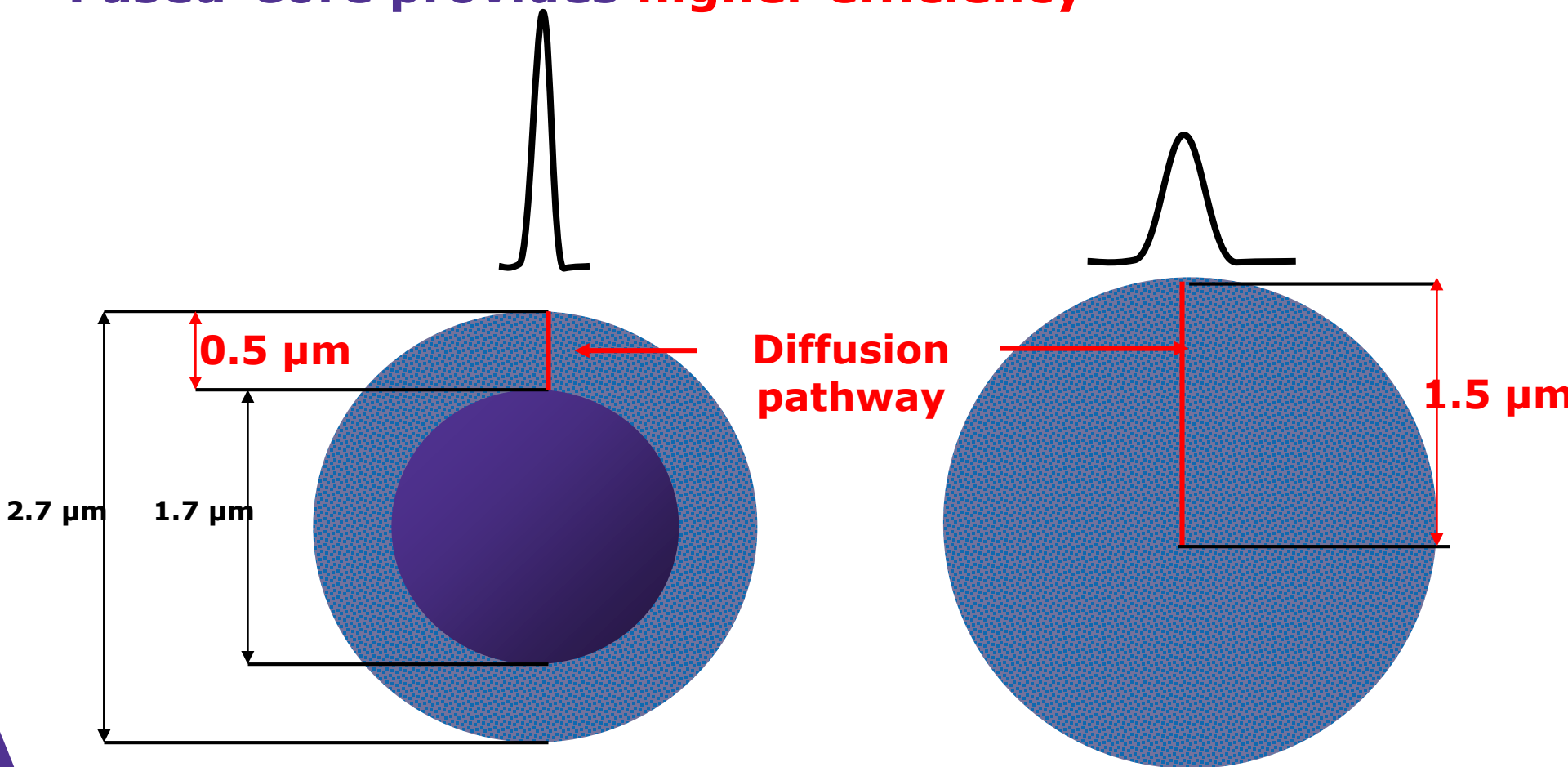
Doubling the efficiency by halving the particle size results in a pressure increase by a factor of four.



Particle (μm)	psi	bar	N
1.8	5889	406	27,500
2.5	3089	213	20,000
3	2118	146	16,500
5	769	53	10,000
10	189	13	5,000
15	87	6	3,750
20	44	3	2,500

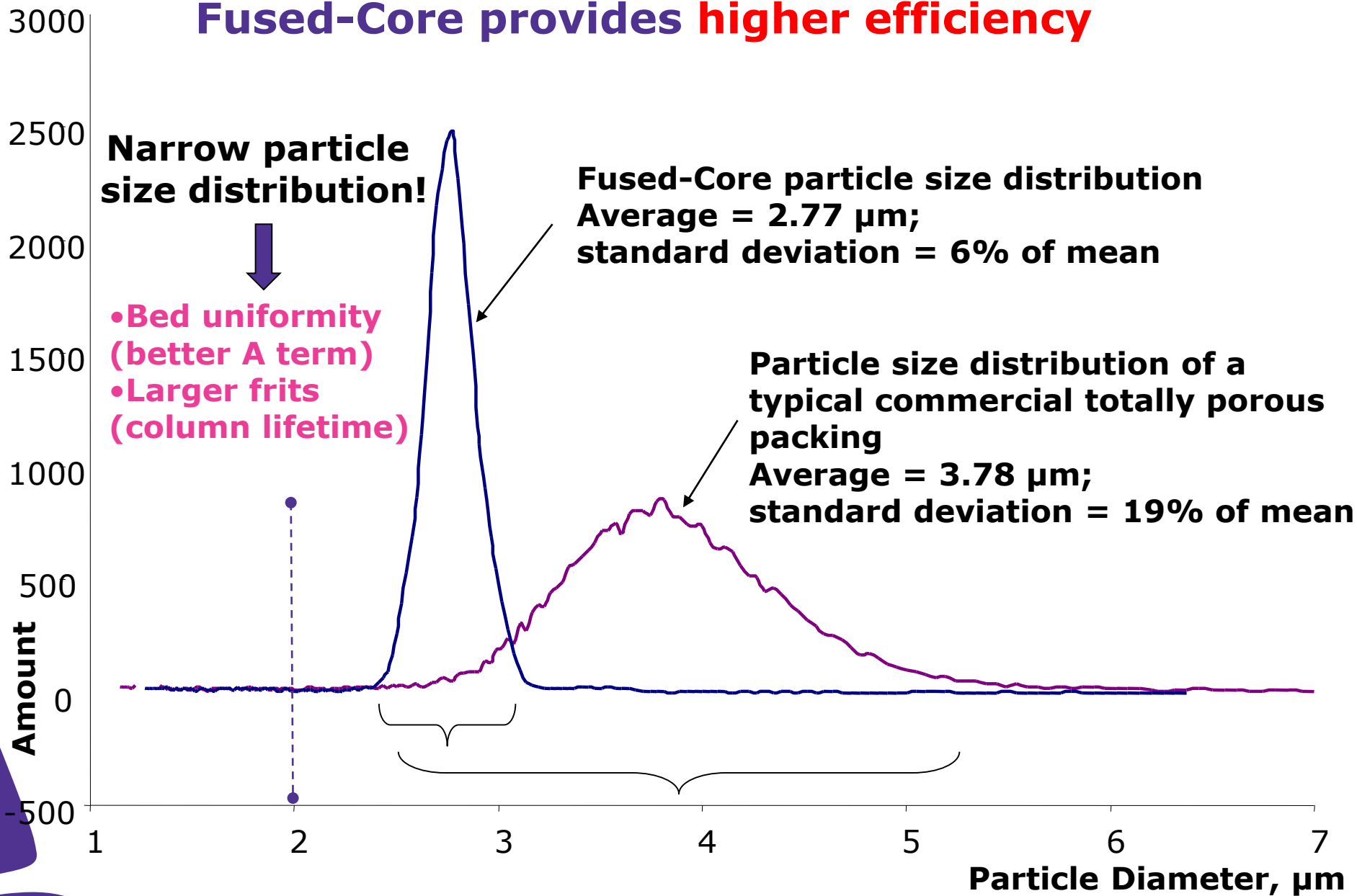
10 cm column, 3 mm/s linear velocity

Fused-Core provides **higher efficiency**

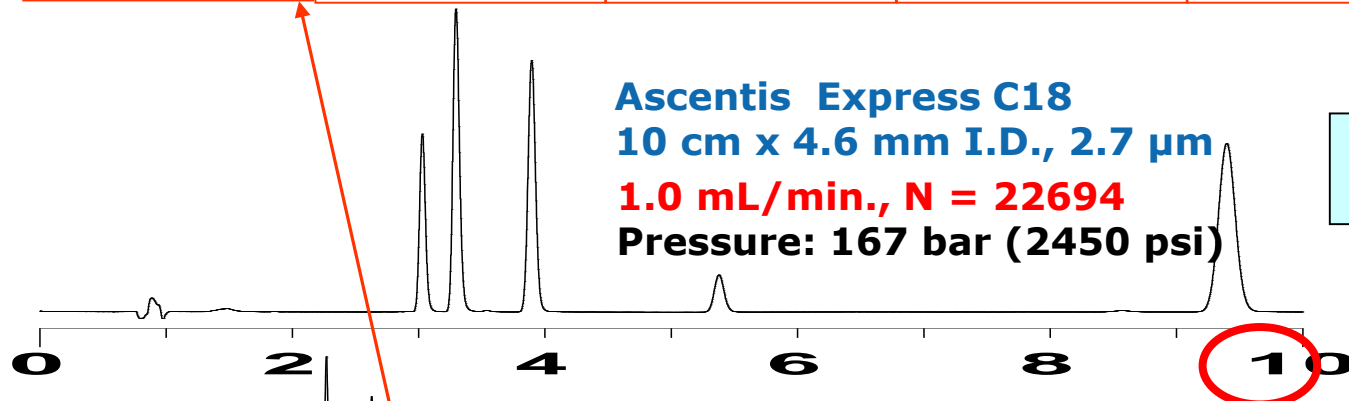
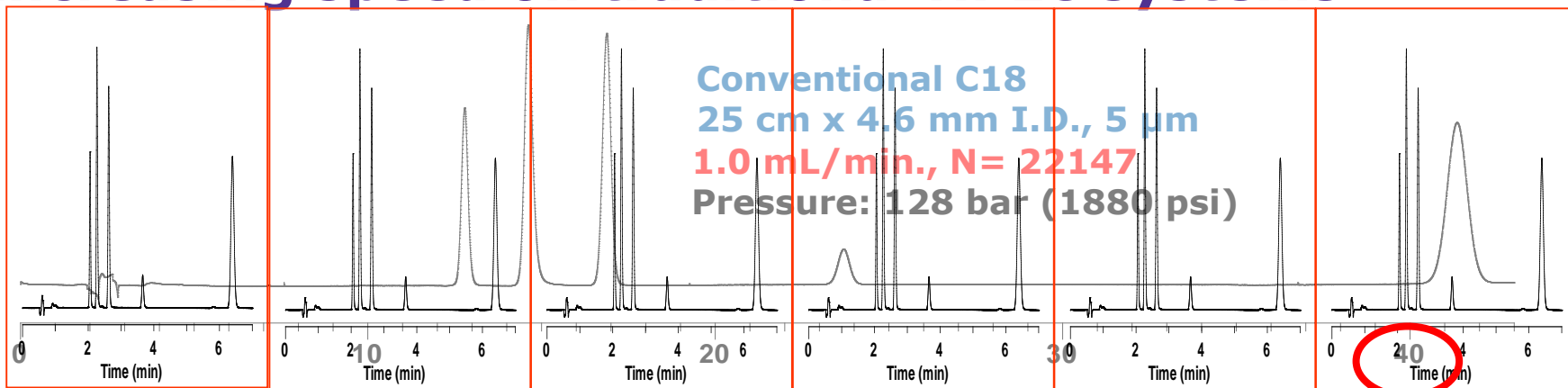


The shorter diffusion pathway facilitates the mass transfer (C term)!

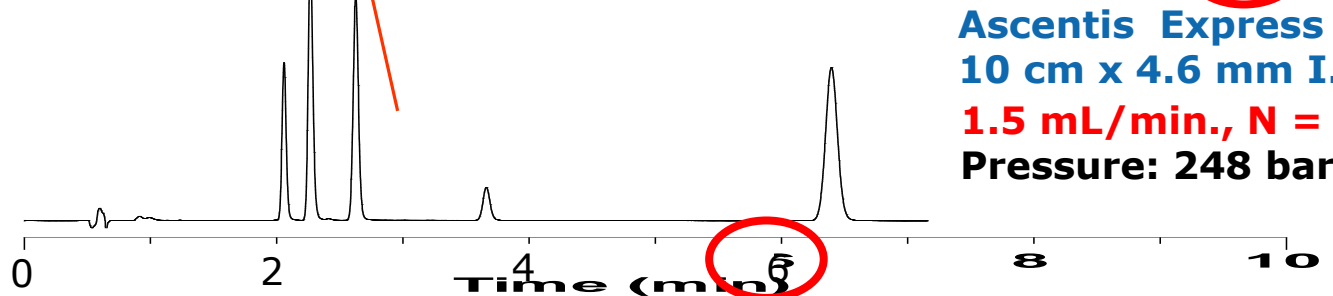
Fused-Core provides **higher efficiency**



Increasing speed on traditional HPLC systems*



Requirement on
method: N > 20.000



*Agilent 1100
HPLC System

Same efficiency compared to sub 2 μ m particles

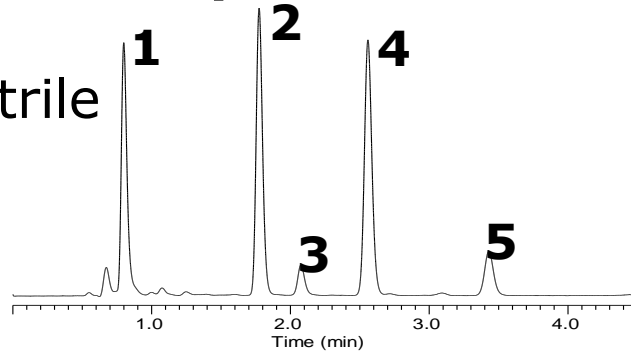
2.7 μ m Ascentis Express C18

0.3 mL/min

45 % acetonitrile

2130 psi

N = 12,500



Mobile Phase:

water : acetonitrile;
isoelutropic for β -
Estradiol

**Columns: 100 x 2.1
mm**

Flow: 0,3 mL/min

Det: 200 nm

Inj: 1 μ L

Elution order:

1. Estriol
2. β -Estradiol
3. Contaminant
4. Estrone
5. Estrone degradant

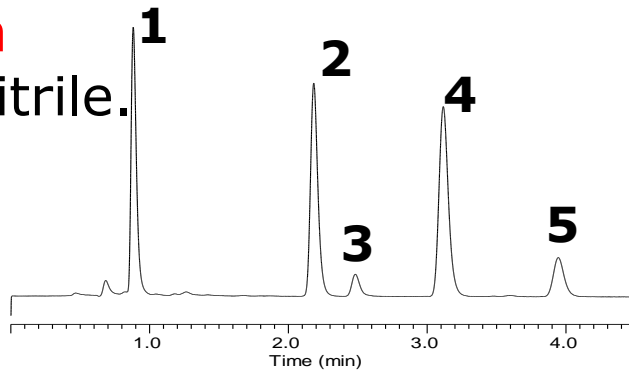
Sub-2 μ m column C18

0.3 mL/min

51 % acetonitrile.

7000 psi

N = 12,170



Fused-Core Milestones - Pioneering the Particles

2007: First 2.7 μm FC particles to achieve efficiencies $>250,000$ N/m

- Efficiencies comparable to sub-2 μm particles
- Pressure drop (flow resistance) comparable to 3 μm particle columns

2012: 5 μm FC particles to achieve efficiencies $>150,000$ N/m

- Operate at low pressures with unsurpassed ruggedness.
- Efficiencies exceed most 3 μm particles (150,000 N/m observed routinely at low pressure)
- Pressure drop of 5 μm particle columns
- Designed for traditional instruments & routine methods.

2014: 2.0 μm FC particles for superior performance in UHPLC

- Outperforms fully porous sub-2 μm particles in efficiency
- Perfect balance of pressure and performance
- Based on Fused-Core particle design geared toward maximizing performance of UHPLC systems

Ascentis Express Fused-Core Particles

NEW!

2.0 μm
Fused Core

The Best Fused Core UHPLC Column

*Higher efficiencies than sub-3 μm SPP
Overcomes disadvantages of sub-2 μm FPPs*

2.7 μm
Fused Core

FAST HPLC on ANY SYSTEM

A practical solution that delivers UHPLC performance from any HPLC instrument

5 μm
Fused Core

THE LAB-WORK HORSE COLUMN

True plug and play solution for improving existing 3 or 5 μm porous particle HPLC columns

Fused-Core Technology for Proteins/Peptides

BIOshell[™]
U/HPLC Columns

2.7 μm
Fused Core

*Peptide C18, CN
and Glycan*

3,4 μm
Fused Core

Protein C4 and C18

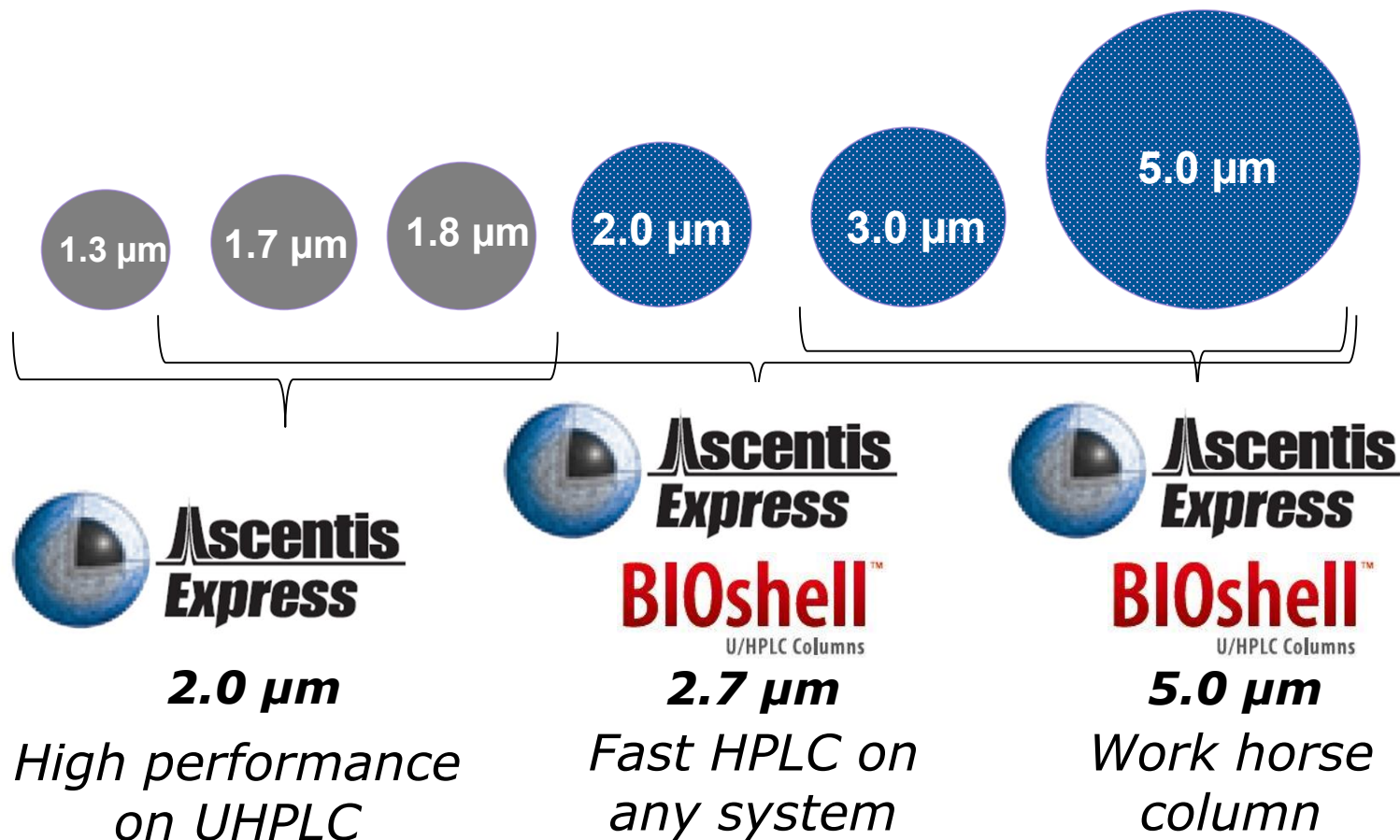
5 μm
Fused Core

Peptide C18 and CN

Which particle size for which approach?

UHPLC

HPLC



Ascentis Express Fused-Core HPLC Phases

5.0µm	2.7 µm	2.0 µm	Phase type
C18	C18	C18	Non-polar (RP)
C8	C8	C8	Non-polar (RP)
	Biphenyl		Non-polar (RP)
Phenyl-Hexyl	Phenyl-Hexyl	Phenyl-Hexyl	Non-polar (RP)
RP-Amide	RP-Amide	RP-Amide	Medium/high polarity
F5	F5	F5	Medium/high polarity
ES-Cyano	ES-Cyano	ES-Cyano	Medium/high polarity
OH5	OH5	OH5	HILIC
HILIC (silica)	HILIC (silica)	HILIC (silica)	HILIC

**Broadest offering of stationary phases
on Fused-core (and all core-shell) particles!**

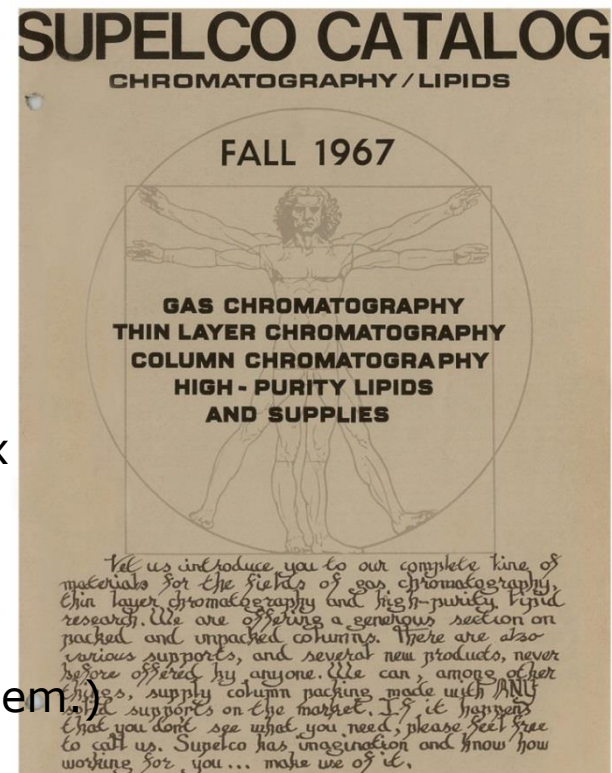
O2

GC

MERCK

Supelco GC Product History

- 1983 – SP-2560: 1. Special Column (FAMES)
- 1984 – SPB-608: 1. Special Column (Pesticide/PCBs)
- 1984 – SUPELCOWAX 10: 1. Column with bonded Wax
- 1985 – SP-2331: 1. Special Column (Dioxins)
- 1986 – VOCOL: 1. Special Column (VOCs)
- 1987 – Sup-Herb: 1. Special Column (Herbicides)
- 1988 – Petrocol DH: 1. Spec. Column (100 m, Petrochem)
- 1989 – Petrocol DH 150: 1. Column with 150 m
- 1989 – Petrocol 2887: 1. Special Column (ASTM D2887)
- 1990 – Omegawax: 1. Special Column (omega FAMES)
- 1991 – SPB-1 SULFUR: 1. Special Column (Sulfur comp.)
- 1993 – SAC-5: 1. Special Column (free sterols)
- 1994 – Carboxen-1006 PLOT: 1. Carboxen PLOT Column
- 2008 – SLB-IL100: 1. Column with ionic liquids
- 2010 – SLB-IL111: 1. Column with highest polarity



Supelcos Offering

GC Columns – Product Lines

- Over **80** different column chemistries (non-chiral and chiral)
- Each with a different combination of retention mechanisms (**selectivity**)
- Can serve many **industries** and **applications**
- Strengths
 - Highly polar columns
 - Application-specific columns
- Supelcos **Ionic Liquid GC columns** represent a new column platform
- Benefits
 - Unique **selectivity**
 - Better phase **stability**



Visit sigma-aldrich.com/gc-columns for more information.

Highlight GC Columns by Supelco

SLB-5ms

- General use, very low bleed column, but at a very competitive price

SP-2331

- SP-2331 is one of the benchmark columns for dioxin analysis

SPB-Octyl

- SPB-Octyl is one of the few columns that can separate most PCB congeners

Petrocol DH series

- Benchmark columns for this application
- Many retention index libraries are based on these columns

PLOT columns

- Supelco offers some of the best PLOT columns in the world
- In particular, the Carboxen-1010 PLOT (only column to separate oxygen, nitrogen, and carbon dioxide)

Highlight GC Columns by Supelco

SP-2560

- SP-2560 is the benchmark column for the separation of cis/trans FAME isomers

SUPELCOWAX 10

- Highest maximum temperature (280 °C) of any PEG phase column

Omegawax

- Omegawax is the benchmark column for the separation of omega 3 and omega 6 FAMES

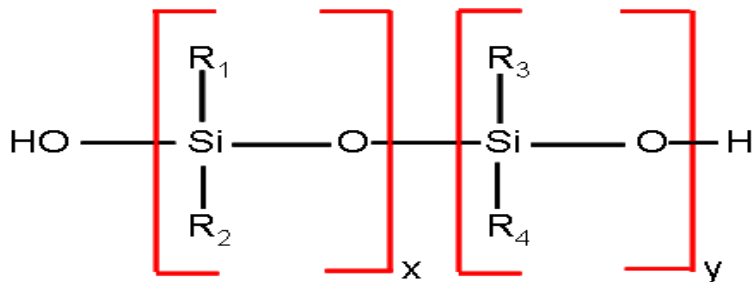
Astec CHIRALDEX, Supelco DEX

- For separation of enantiomers
- 25 unique specialized phases that incorporate derivatized cyclodextrins
 - Broad range of selectivities
 - Likely we offer a column to perform any enantiomeric GC separation

Overview

Example Structures of Non-Ionic Liquid Phases

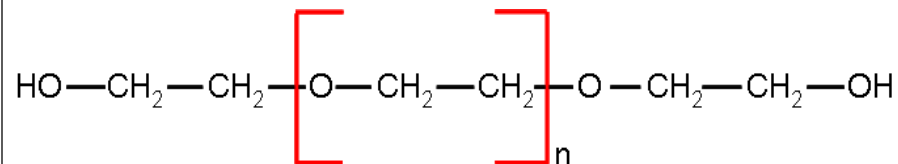
Polysiloxane Polymers (1952)



Drawbacks

- Active hydroxyl (-OH) groups at polymer termini allow a back-biting reaction
 - Results in phase degradation
 - Contributes to column bleed
- Chemistry modifications are limited to pendent group changes

Polyethylene Glycols (~1956)



Drawbacks

- Active hydroxyl (-OH) groups at polymer termini allow a back-biting reaction
 - Results in phase degradation
 - Contributes to column bleed
- Very limited chemical modifications possible
- Limited to 280 °C maximum temperature

R = methyl, phenyl, fluoropropyl, and/or cyanopropyl (listed from least polar to most polar).


x,y = percentage in the overall polymer composition.

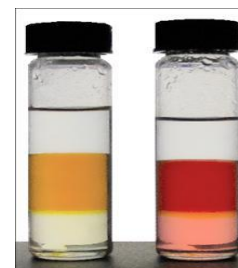
n = number of monomer repetitions to make the overall polymer.

Most recent technology development

Ionic Liquid (IL) GC Columns

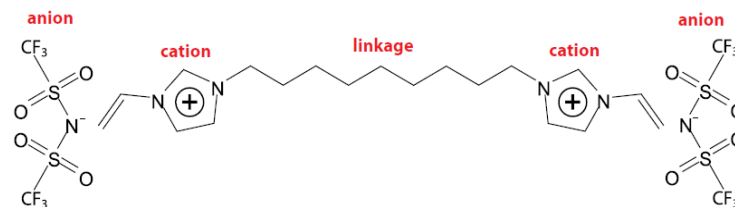
- Ionic Liquids are the **newest phase type** in GC
- They are **unique** to Merck/Sigma-Aldrich
- Properties that make them desirable as GC stationary phases
 - remain **liquid over a wide temperature range** (Room Temperature→350°C)
 - **highly polar** nature (exceed polarity range of common polymeric phases)
 - **broadest range of solvation interactions** of any known solvent
 - good **thermal stability**
 - easily tailored to provide **different polarities/selectivities**
- **Unique selectivity & polarity** enabling separations not possible with traditional phases

- Product line: 
 - **SLB-IL** columns
 - **Newest addition, Option for GC**
 - Watercol – GC columns for water determination
 - i-Series – selectivity & inertness



Water
Ionic Liquid
CHCl₃

Source: Prof. Jared Anderson, University of Toledo, USA



Example: SLB-IL100
1,9-di-(3-vinyl-imidazolium) nonane bis(trifluoromethyl) sulfonyl imidate

- SLB-IL59 - (3)
- SLB-IL60 - (7)
- SLB-IL61 - (3)
- SLB-IL76 - (3)
- SLB-IL82 - (3)
- SLB-IL100 - (7)
- SLB-IL111 - (6)
- SLB-ILD3606 - (3)

GC Column Polarity Scale

Description of our Procedure

- Each column is characterized with a series of five probes plus several n-alkane markers to determine the retention index for each probe
 - Benzene
 - Butanol
 - 2-Pentanone
 - Nitropropane
 - Pyridine
- McReynolds Constants are then calculated using the retention index data of the column relative to the retention index data for the same five probes on squalane, the most non-polar GC stationary phase
- The five McReynolds Constants are summed to obtain Polarity (P) values, which are then normalized to SLB-IL100 (set at P=100) to obtain Polarity Number (P.N.) values

Our procedure was proposed by Prof. Luigi Mondello (University of Messina, Italy).

GC Column Polarity Scale

Experimentally Determined Polarity Numbers

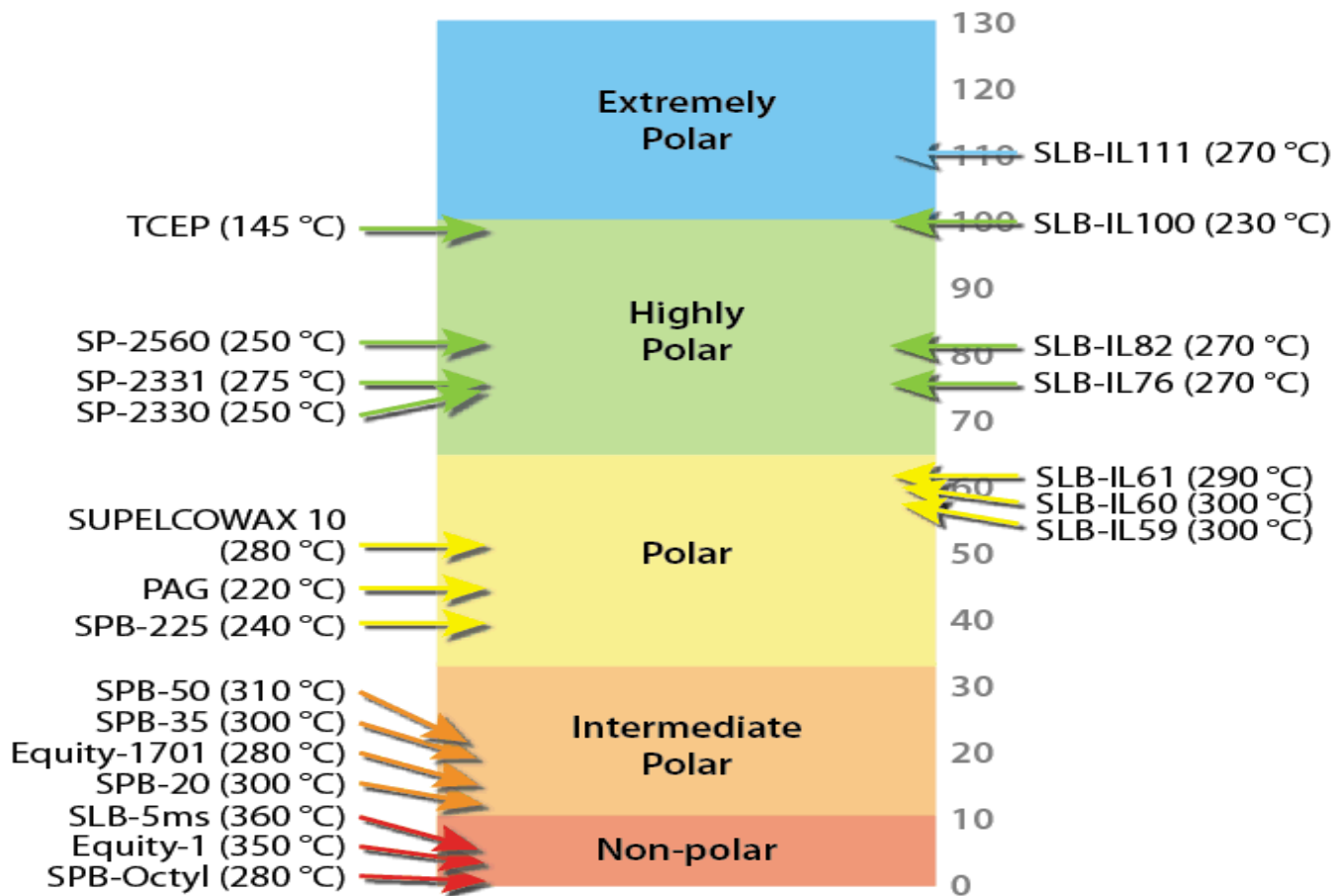
Column	McReynolds Constants					P	P.N.
	Benzene	n-Butanol	2-Pentanone	Nitropropane	Pyridine		
SPB-Octyl	17	-20	6	19	6	28	1
Equity-1	11	10	33	60	16	130	3
SLB-5ms	33	30	55	91	43	252	6
SPB-20	76	79	104	167	109	535	12
Equity-1701	82	131	150	233	136	732	16
SPB-35	175	113	151	225	175	839	19
SPB-50	154	134	176	266	218	948	21
SPB-225	233	342	342	501	375	1793	40
PAG	276	459	320	508	428	1991	45
SUPELCOWAX 10	334	509	375	601	505	2324	52
SLB-IL59	338	505	549	649	583	2624	59
SLB-IL60	362	492	525	679	564	2622	59
SLB-IL61	371	551	516	624	648	2710	61
SP-2330	469	663	608	859	712	3311	75
SLB-IL76	456	690	643	845	745	3379	76
SP-2331	495	674	622	856	735	3382	76
SP-2560	510	724	652	913	773	3572	81
SLB-IL82	532	676	701	921	808	3638	82
TCEP	622	871	772	1072	957	4294	97
SLB-IL100	602	853	884	1017	1081	4437	100
SLB-IL111	766	930	957	1192	1093	4938	111

P (Polarity) = sum of the first 5 McReynolds Constants.

P.N. (Polarity Number) = Polarity (P) normalized to SLB-IL100 (set at P=100).

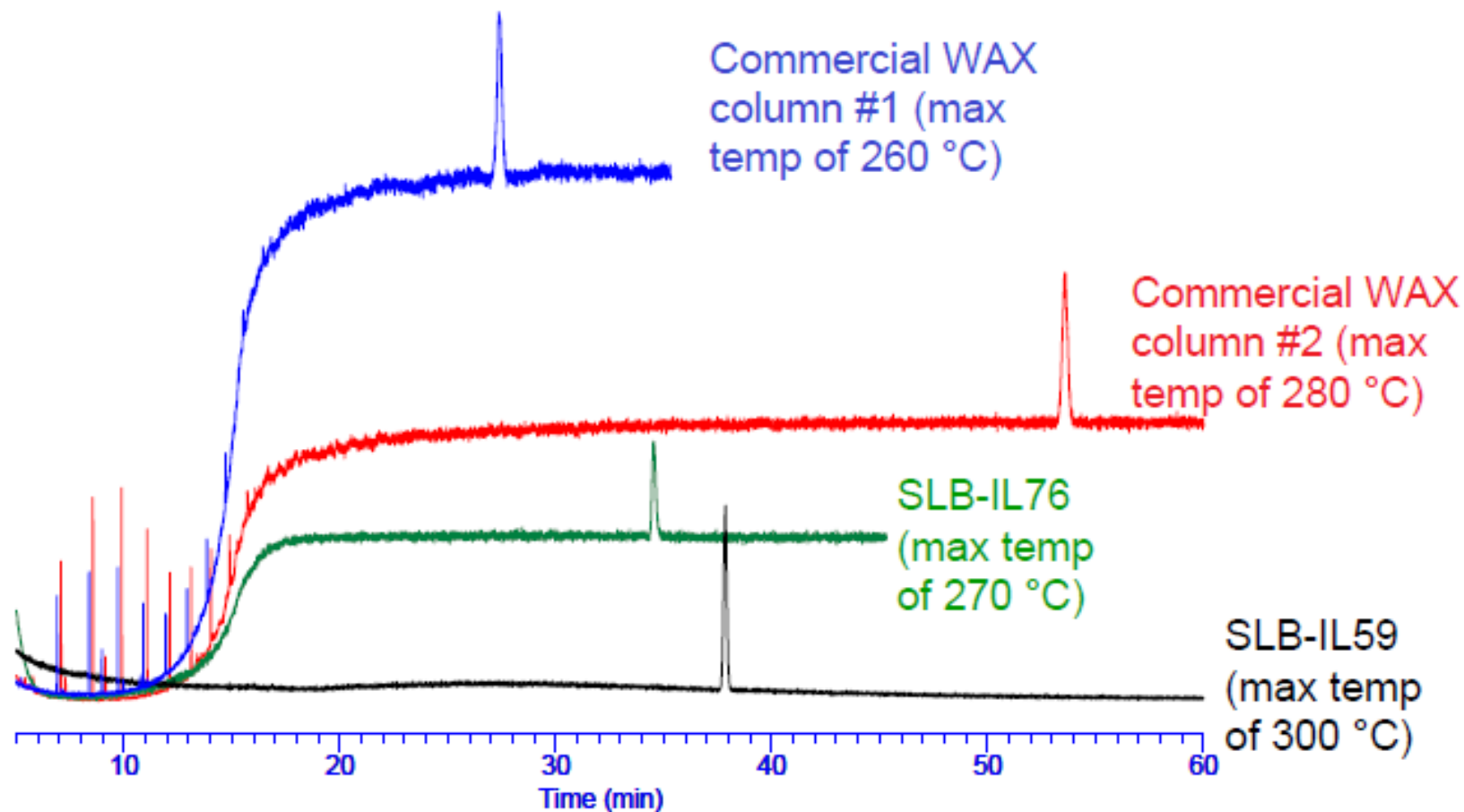
GC Column Polarity Scale

Visual Representation



**On the left: Position/Maximum temperature classical GC phases.
On the right: Position/Maximum temperature of Ionic Liquid GC phases.**

Comparison of GC-MS TIC Bleed



All TICs are on the same Y-scale

Mass Spectrum of Chrysene

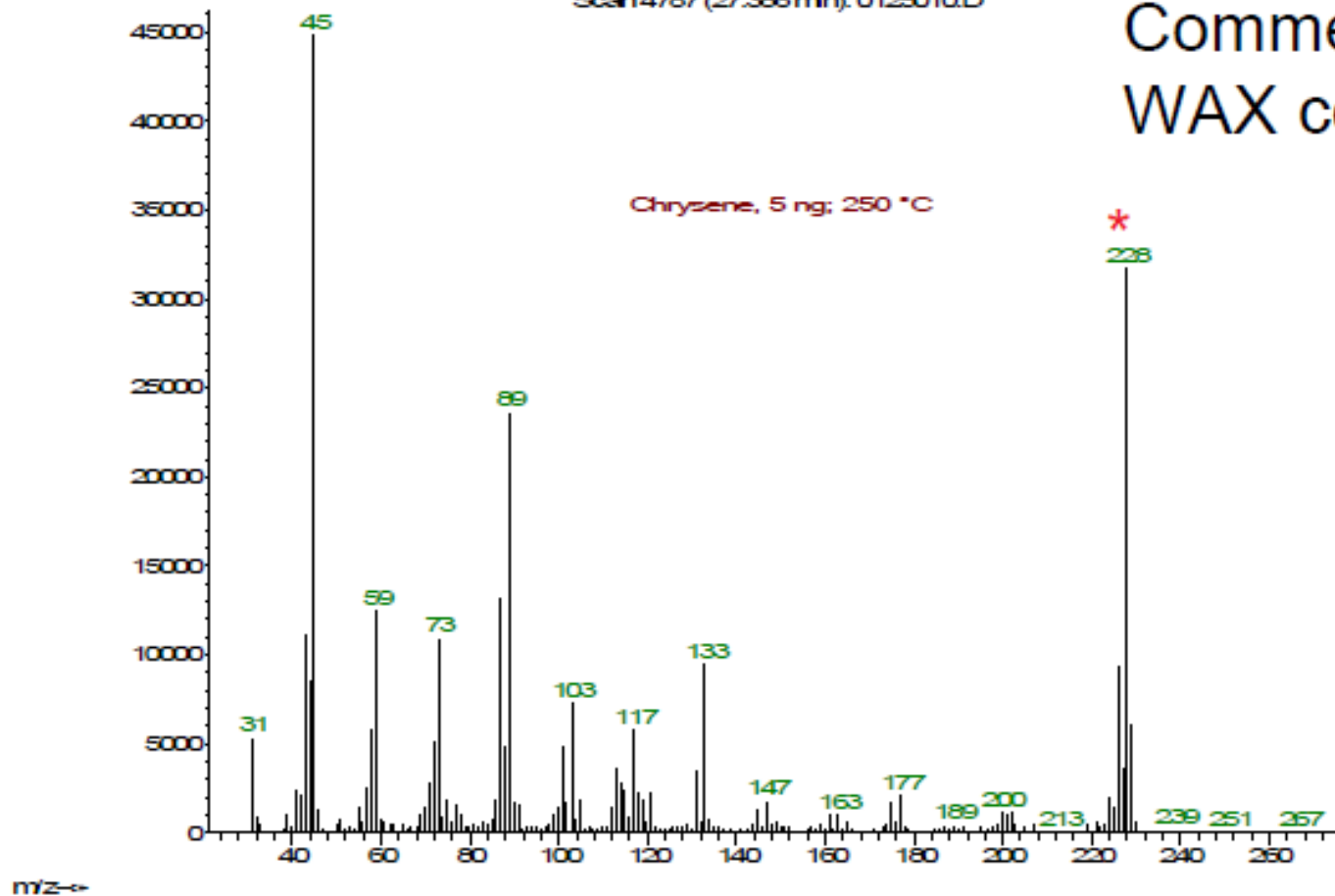
5 ng on-column, Wax column, 250 °C

Abundance

Scan 4787 (27.386 min): 0125010.D

Commercial
WAX column #1

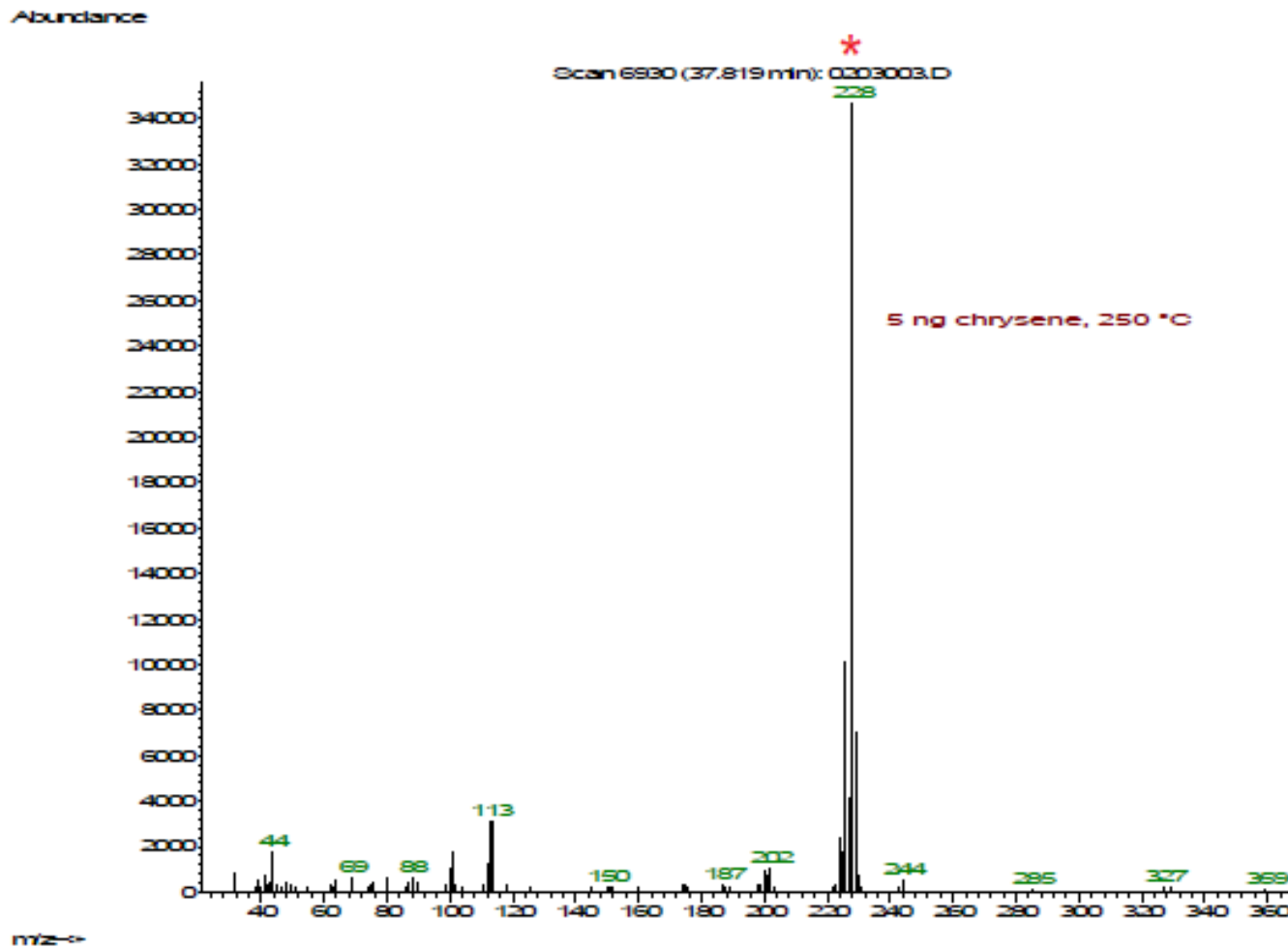
Chrysene, 5 ng; 250 °C



* Base peak in spectrum of chrysene

Mass Spectrum of Chrysene

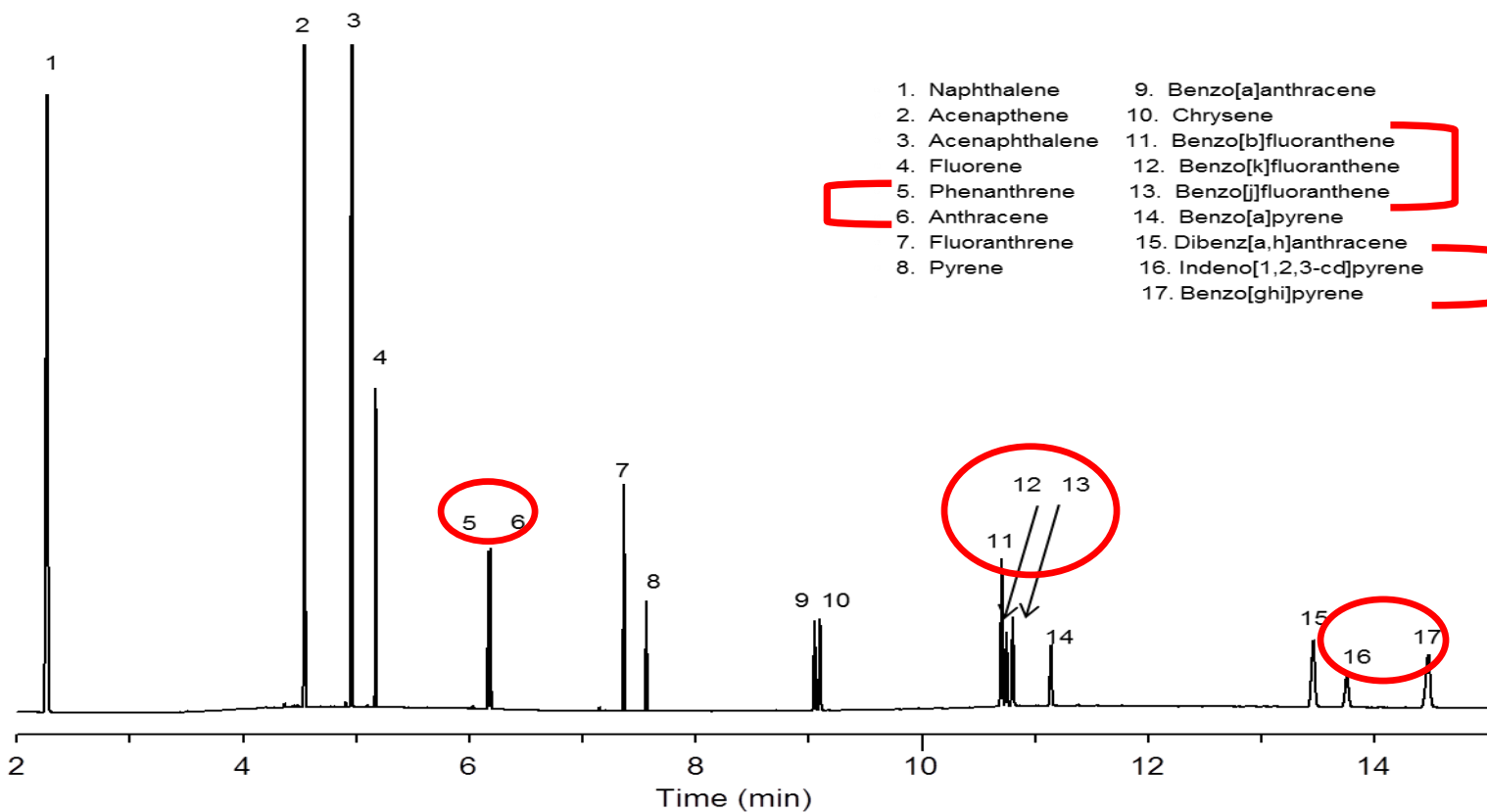
5 ng on-column, SLB-IL59, 300 °C



* Base peak in spectrum of chrysene

SLB IL-PAH

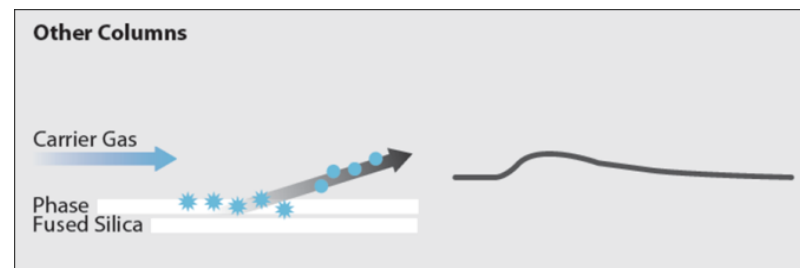
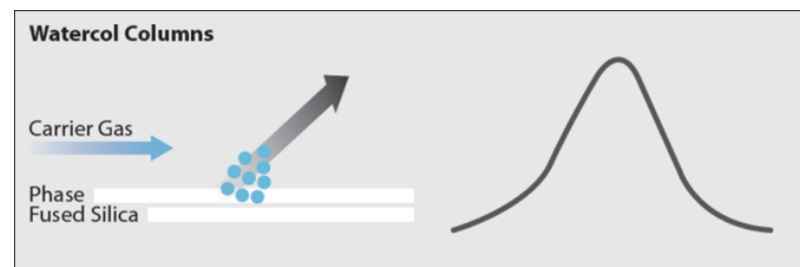
Selectivity and inertness to separate the PAHs specified under EFSA PAH4 with faster analysis time



Watercol™ -GC Columns



- Contain innovative ionic liquid stationary phases
 - highly polar but stable vs. water
 - produce a **sharp peak shape for water** providing:
- **Qualitative and Quantitative Measurement of Water with GC** (With appropriate detector like TCD, BID, MS, VUV)
- Show narrow peak widths and optimal peak heights also for many other small polar analytes.



Water determination with a GC is a new routine use option of a GC Instrument

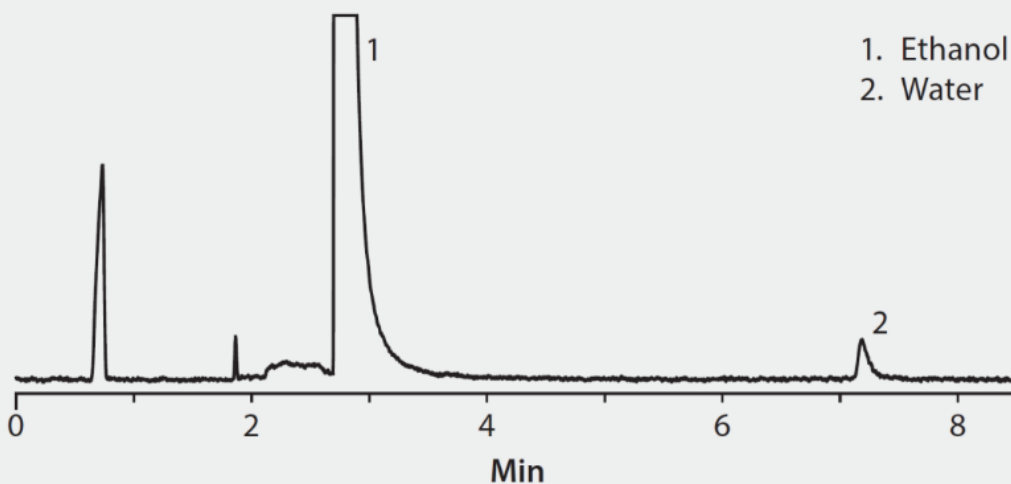
sigma-aldrich.com/watercol

Water Determination with Watercol 1910

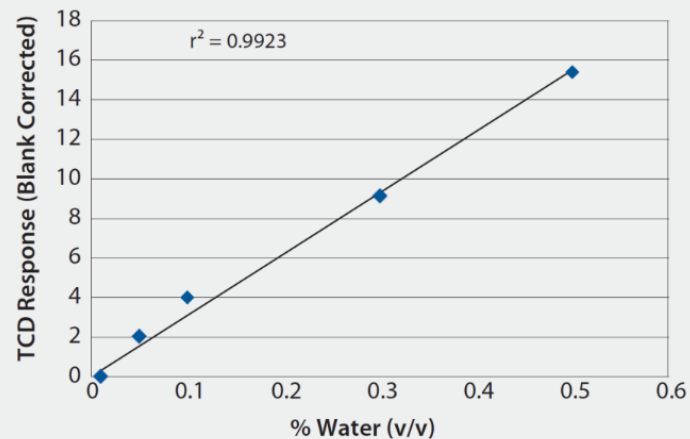
Watercol – Water determination with GC



column: Watercol 1910, 30 m × 0.25 mm I.D., 0.20 μm (29711-U)
oven: 80 °C (10 min)
inj. temp.: 250 °C
detector: TCD, 200 °C
carrier gas: helium, 26 cm/sec
injection: 0.5 μL, 100:1 split
liner: 4 mm I.D., split type, cup design
sample: water at 0.05% (v/v) in ethanol



sample: 5 standards, water
at 0.01, 0.05, 0.1, 0.3, and 0.5% (v/v), in ethanol



Watercol Series Capillary GC Columns

Key Benefits of a Sharp Water Peak Shape

- Measurement of water
 - qualitative and quantitative
- Linear response over a very wide range (0.01% water to 100% water)
- Great sensitivity
 - 100 ppm using a thermal conductivity detector (TCD)
 - Anticipate much better sensitivity with
 - A mass spectrometer (MS) operated in the SIM mode
 - Vacuum ultraviolet (VUV) absorption spectroscopy
 - A barrier discharge ionization detector (BID)
- Reproducibility, virtually no change in column performance over time



NOTE: The detector being used must be able to detect water.

sigma-aldrich.com/watercol

Column Selection Guide (KCX)

Recommendation Page

Environmental Industry

	SPB®-Octyl	SLB®-5ms	Equity®-5	SPB-624	VOCOL®	Equity-1701	SPB-608	Sup-Herb™	SPB-35	SPB-50	SPB-225	SPB-1000	SLB-IL59	SLB-IL60	SLB-IL82	SP™-2331	SLB-IL111	Chiral*
--	------------	----------	-----------	---------	--------	-------------	---------	-----------	--------	--------	---------	----------	----------	----------	----------	----------	-----------	---------

Volatiles by GC-MS
Volatiles by GC
Semivolatiles by GC-MS
Semivolatiles by GC**
Fuels (GRO, DRO, TPH)
Dioxins by GC-HRMS
PCBs by GC-HRMS
PBDEs by GC-MS
PAHs by GC or GC-MS
Oil Spill Dispersants
Odor Compounds (Geosmin, 2-MIB)

Cross-Reference Chart

Table 3. Sample Columns GC Columns with Comparable Columns from Other Manufacturers

SPB®-HAP	SPB-1	SLB®-5ms	Petrocol® DH 50.2, DH, DH 150	Petrocol 2887, EX2887	MET-Biodiesel
----------	-------	----------	-------------------------------	-----------------------	---------------

SPB®-HAP

- Application:** This column was developed to provide the best resolution of very volatile hazardous air pollutants. The thick film helps to focus analytes on the column, possibly eliminating the need to employ cryogenic focusing techniques.
- USP Code:** This column meets USP G1, G2 and G9 requirements.
- Phase:** Bonded; poly(dimethyl siloxane)
- Temp. Limits:** -60 °C to 300 °C (isothermal or programmed)

Petrocol® DH 50.2, DH, DH 150

- Application:** These highly reproducible columns have considerable theoretical plate numbers and are designed for detailed analyses of petroleum products for PIANO, PCNA and PNA-type analytes. The 100 m version includes an extensive retention index data sheet of 400+ analytes.
- USP Code:** These columns meet USP G1, G2 and G9 requirements.
- Phase:** Bonded; poly(dimethyl siloxane)
- Temp. Limits:** -60 °C to 320 °C (isothermal or programmed)

Petrocol 2887, EX2887

- Application:** These columns are designed for ASTM Method D2887 (simulated distillation [Sim Dis] of petroleum fractions). Choose Petrocol 2887 for samples having boiling points up to 1,000 °F. Use Petrocol EX2887 for samples having boiling points greater than 1,000 °F.
- USP Code:** These columns meet G1, G2 and G9 requirements.
- Phase:** Bonded; poly(dimethyl siloxane)
- Temp. Limits:**
 - Petrocol 2887: Subambient to 350 °C (isothermal or programmed)
 - Petrocol EX2887: Subambient to 380 °C (isothermal or programmed)

SPB-1

- Application:** This column is often used for traditional general purpose applications, where a non-polar column is required. Analytes will be separated primarily according to boiling point.
- USP Code:** This column meets USP G1, G2 and G9 requirements.
- Phase:** Bonded; poly(dimethyl siloxane)
- Temp. Limits:**
 - 60 °C to 320 °C (isothermal or programmed)
 - 60 °C to 300 °C (isothermal or programmed)
 - 60 °C to 320 °C (programmed)
 - 60 °C to 260 °C (isothermal) or 280 °C (programmed)


SLB®-5ms

- Application:** The 5% phenyl equivalent phase provides a boiling point elution order with a slight increase in selectivity, especially for aromatic compounds. The low bleed characteristics, inertness, and durable nature make it the column of choice for environmental analytes (such as semivolatiles, pesticides, PCBs, and herbicides) or anywhere a low bleed non-polar column is required.
- USP Code:** This column meets USP G27 and G36 requirements.
- Phase:** Bonded and highly crosslinked; silphenylene polymer virtually equivalent in polarity to poly(5% diphenyl/95% dimethyl siloxane)
- Temp. Limits:**
 - 60 °C to 340 °C (isothermal) or 360 °C (programmed)
 - 60 °C to 330 °C (isothermal) or 340 °C (programmed)

MET-Biodiesel


* See "by Application" section

** Includes: organochlorine pesticides, PCBs as Aroclors, herbicide haloacetic acids, disinfection by-products and solvents, and PAHs



GC Column Selection Guide

Achieve Optimal Method Performance



Performance
Reliability
Service

SIGMA-ALDRICH

Resources

Complementary Pieces

- “Applications”
 - Includes multiple chromatograms across many industry types
 - Analyte IDs and GC conditions are included in the speaker notes for most
- “Bibliography”
 - Peer-reviewed journal articles leading up to and beyond the seminal 2005 JACS (Journal of the American Chemical Society) article
 - Updated periodically



Supelco Ionic Liquid GC Columns
Applications

Updated: February 19, 2014

SUPELCO
Solutions within.

Agenda
Chromatograms
Summary / Related Products / Resources

A colorful, faceted geometric shape, resembling a crystal or a cluster of molecules, is positioned in the lower right corner of the document cover.



SIGMA-ALDRICH™

sigma-aldrich.com
595 North Harrison Road, Bellefonte, PA 16823-0048 USA
Tel: (800) 247-6628 (814) 359-3441 Fax: (800) 447-3044 (814) 359-3044

Supelco Ionic Liquid GC Columns: Bibliography

Updated: 5-Jan-2013

1999

1. D.W. Armstrong, L. He, and Y-S. Liu, "Examination of Ionic Liquids and Their Interaction with Molecules, When Used as Stationary Phases in Gas Chromatography" *Anal. Chem.* 71 (1999) p. 3873.

2001

2. A. Berthod, L. He, and D.W. Armstrong, "Ionic Liquids as Stationary Phase Solvents for Methylated Cyclodextrins in Gas Chromatography" *Chromatographia* 53 (2001) p. 63.

2002

3. J.L. Anderson, J. Ding, T. Welton, and D.W. Armstrong, "Characterizing Ionic Liquids on the Basis of Multiple Solvation Interactions" *J. Am. Chem. Soc.* 124 (2002) p. 14247.

2003

4. J.L. Anderson and D.W. Armstrong, "High-Stability Ionic Liquids. A New Class of Stationary Phases for Gas Chromatography" *Anal. Chem.* 75 (2003) p. 4851.

2004

5. J. Ding, T. Welton, and D.W. Armstrong, "Chiral Ionic Liquids as Stationary Phases in Gas Chromatography" *Anal. Chem.* 76 (2004) p. 6819.

2005

6. J.L. Anderson and D.W. Armstrong, "Immobilized Ionic Liquids as High-Selectivity/High-Temperature/High-Stability Gas Chromatography Stationary Phases" *Anal. Chem.* 77 (2005) p. 6453.
7. M. Koel, "Ionic Liquids in Chemical Analysis" *Crit. Rev. Anal. Chem.* 35 (2005) p. 177.

Both pieces can be downloaded from <sigma-aldrich.com/il-gc-lit>.

Summary Ionic Liquid GC

GC phases based on Ionic Liquids:

- have a different selectivity compared to conventional phases
- allow for shorter analysis times
- provide lower bleeding and long lifetime
- Offer a broader temperature range compared to conventional polar phases
- Improve multidimensional separations (orthogonal selectivity and high thermal stability of polar phase)

03

ACCESSORIES

GC Accessories

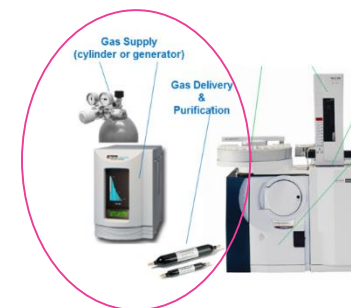
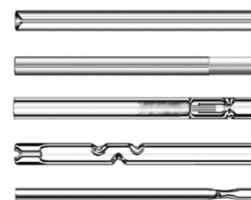
Besides packed and capillary GC columns we offer a **comprehensive range of GC accessories** around the instruments:

GC Instrument Accessories

- Liner, Injector Septa, Ferrules, Fittings
- Syringes, Vials

Gas Management

- Gas Generators, Gas Purifiers
- Tubing, Valves & Pressure Regulators, Flow Meter



sigma-aldrich.com/gc

Accessories: Syringes from Leading Manufactures

- Syringe is the introduction of the sample into the GC Injector port

Syringes from Leading Manufactures

- Hamilton
- SGE
- VICI Precision Sampling



In Supelco Catalog are more than 30 pages for syringes and spare parts

Vials - Overview



Vial

- Volume – (with / without insert)
 - 1,5-2 mL for liquid inj.
 - 5-20 mL for headspace
- Neck style - Screw, snap or crimp,
 - large or narrow opening
- With marking spot, graduated
- Clear or amber, glass or plastic



Standard Screw Neck

Short Thread leaves Space for robotic arms

Cap

- Solid or with hole
- Plastic or Metal (Aluminium or Magnetic)



Septa type

- PTFE/Silicon
- Rubber

Fit for Autosampler tray and handling

sigma-aldrich.com/vials

Accessories: Vial Accessories

- There are always some easy to sell items coming with this product group:



CRIMP the vials!



Glass „Magnet“ Holder –
Don't work without it!



Take the cap off the vial!



Stack and Store them!

Gas Supply

Product Areas

- **Gas generation**

- Gas generators, air compressors

- **Gas delivery**

- **Gas purification**

- Polishing purifiers, contaminant traps (remove hydrocarbons, moisture, oxygen, carbon dioxide), gas purifiers (clean helium), filters (remove particles, oil)

- **Gas management & delivery**

- Pressure regulators, flow regulators, leak detectors,
- Tubing, cutters, reamers, benders, fittings, shutoff valves



Visit sigma-aldrich.com/gaspurifiers for more information.

sigma-aldrich.com/gc

GC Accessories Maximize Performance! Brochure

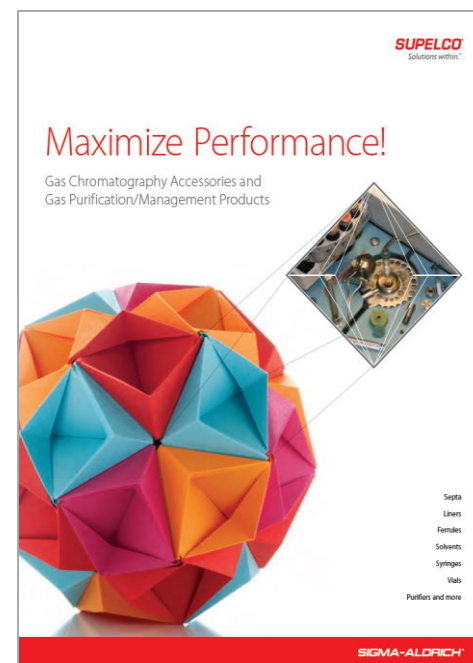
28-page, 4-color, bundling brochure

Lists common replacement items...

- Septa, liners, ferrules, solvents, syringes, vials, purifiers, and much more

for several GC makes/models

- Agilent/HP, PerkinElmer, Shimadzu, Thermo, and Varian



(JWE, T407103C)

A 'must-have' for all GC labs!
You can request hard copies through the Sigma-Aldrich literature houses.

Summary GC by product type

- GC Columns

- Packed
- Capillary
 - Common phases (e.g. SLB-5ms, SLB-35ms)
 - Special Purpose (e.g. SP-2560, SP-23131, Petrocol)
 - Ionic Liquid (Newest Technology)
 - i-Series
 - Watercol

- Accessories

- Fittings, Septa, Flow Meters, Column Installation
- Vials & Syringes
- Gas Supply & Gas Purification

- Applications

- Various fields of work (Envi, Food&Bev, Petrochem...)

Complementary products

- GC Solvents
- Sample Preparation
 - SPE, SPME, Extraction
- Standards
 - (Certified) Reference Materials
 - Proficiency testing

Thank you for your attention!



Thank you for your attention!

