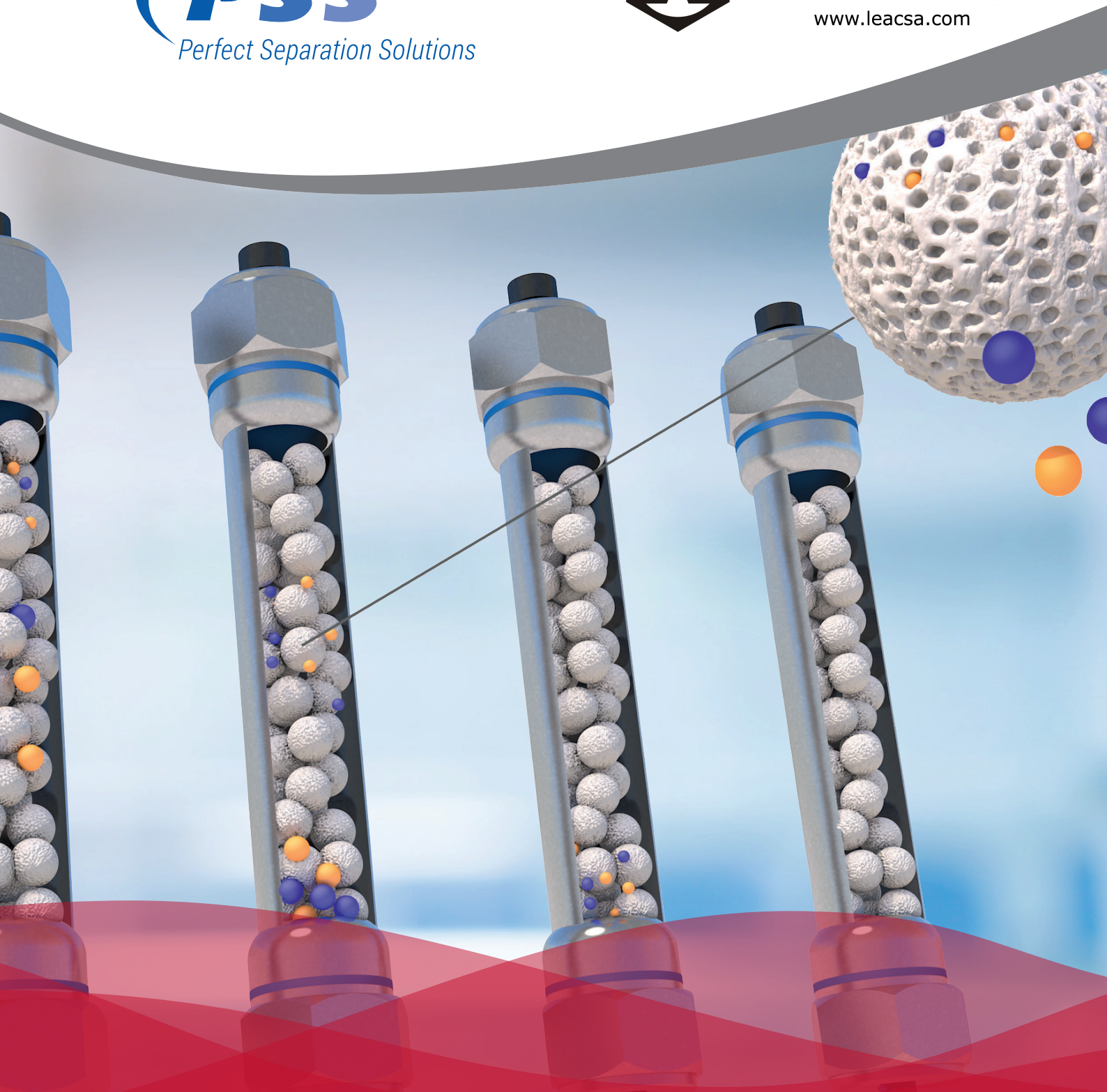
PSS
Perfect Separation Solutions

LEACSA
www.leacsa.com



Reference Materials & LC Columns

PSS
About us

PERFECT SEPARATION SOLUTIONS

We take care of your analytical challenges in Liquid Chromatography of (Bio) Polymers and Proteins:

We at PSS are fully dedicated to the advancement of macromolecular liquid chromatography by means of developing true solutions and providing expert and personal support. Based on excellent products and current research in material science, we create easy-to-use and powerful solutions for QC and R&D.

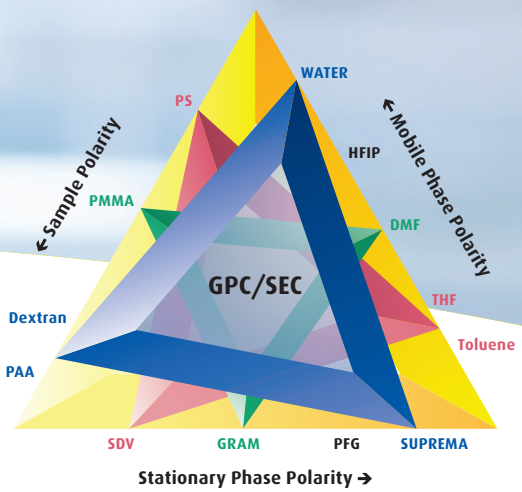
PSS Polymer Standards Service GmbH was founded in 1985 as a spin-off from the University of Mainz, Germany. In 2001 PSS moved to new headquarters in Mainz-Mombach. The subsidiary company, PSS-USA, opened its office in 1994 and serves North and South American customers from Amherst, Massachusetts. Additional technical offices have also been opened in the Netherlands and North-east Germany. Elsewhere, PSS works with distribution partners on a worldwide basis. Our clients today include global corporations, universities, research institutes, petrochemical, and pharmaceutical companies in more than 60 countries.

Certified DIN ISO EN 9001

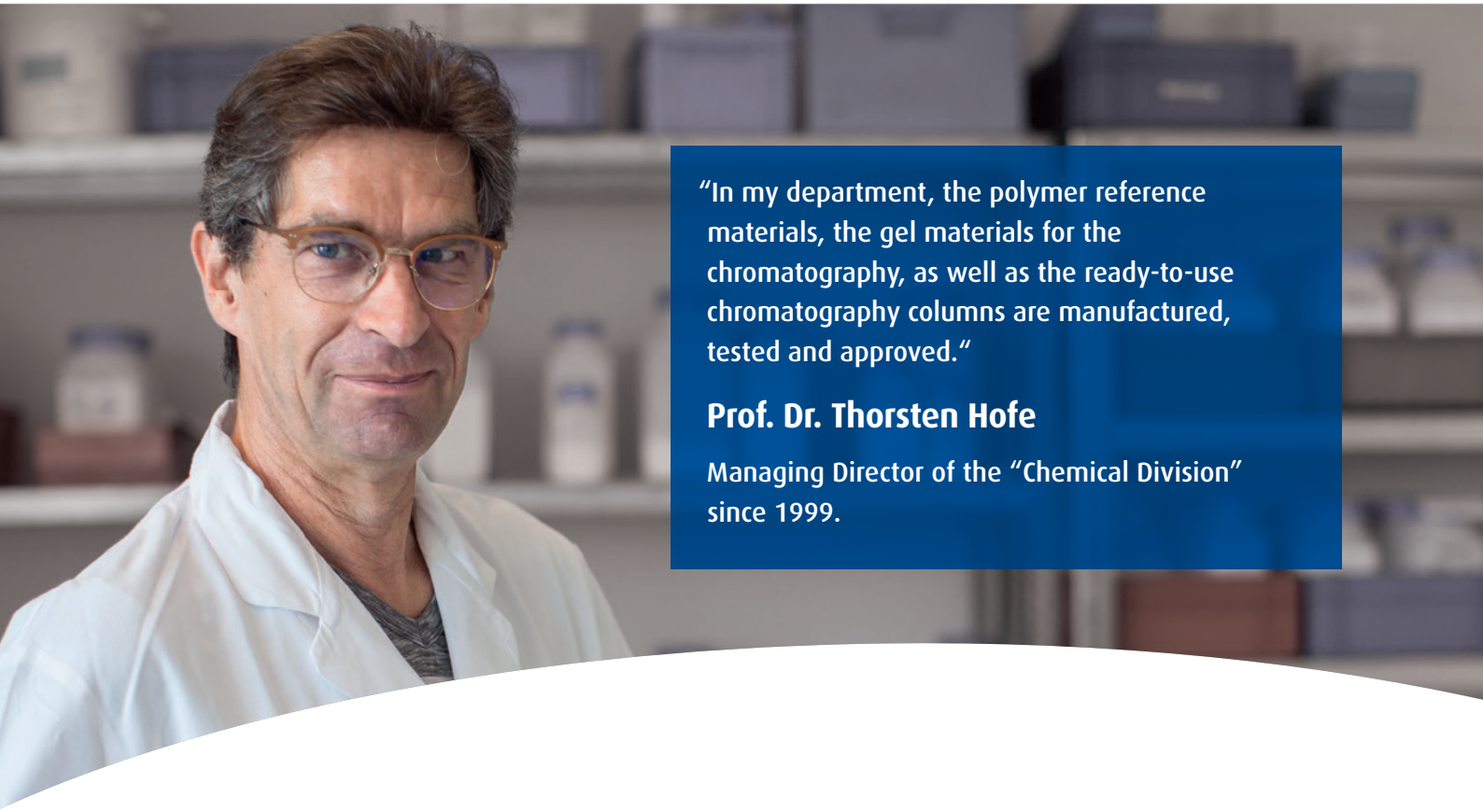
PSS is DIN ISO EN 9001 certified to produce and supply high quality reference polymers, GPC/SEC columns, software, and systems for the characterization of polymers by their molecular weight and their structural characteristics.

PSS operates a manufacturing facility equipped with a state-of-the-art characterization laboratory at its headquarters in Mainz (Germany), fully supporting customers working under stringent regulatory conditions e.g., GLP, DIN, ISO.

Benefit from the unique know-how and extraordinary services of our company.



Contents



"In my department, the polymer reference materials, the gel materials for the chromatography, as well as the ready-to-use chromatography columns are manufactured, tested and approved."

Prof. Dr. Thorsten Hofe

Managing Director of the "Chemical Division" since 1999.

Polymer reference materials and high quality columns

PSS is one of the world's largest manufacturers of organic and aqueous high quality reference materials. An unparalleled selection of polymer types in a wide range of molar masses are available regularly.

PSS performs synthesis ranging from small laboratory scale (5 g) to larger quantities (2 kg or more) to produce multiple kinds of macromolecular reference materials, specialty polymers, polymer particles, and polymer networks.

A wide range of

- Homopolymers with narrow and broad molar mass distributions
- Copolymers (e.g. block copolymers, random copolymers or terpolymers)
- Branched (co) polymers
- End-functionalized (co) polymers and Macromonomers
- Deuterated (co) polymers

are always available.

(See chapters 1.1. To 1.4, **www.pss-polymer.com** or **www.pss-shop.com**)

Many other polymers available upon request. (See also 2 | Specialty Polymers and custom synthesis)

PSS reference materials are used for a wide variety of applications

- Calibration of organic and aqueous GPC/SEC columns
- Calibration and validation of instrumentation, such as light scattering detectors or MALDI-ToF instruments
- GPC/SEC system suitability tests
- Investigation of macroscopic properties and application parameters that are influenced by molar mass, polydispersity, tacticity, end groups or branching
- Investigation of polymer degradation
- Investigation of miscibility behavior of polymer blends
- Investigations of the mixing behavior of polymer blends

PSS reference materials are comprehensively characterized by GPC/SEC, light scattering, viscometry, mass spectrometry and NMR. Each product comes with a quality certificate, which provides the characterization information. The signed quality certificates include important testing parameters, and at least the molecular weight values (M_n, M_w, M_p, PDI) and the chromatographic conditions used to obtain the data.

Our high-performance columns are the result of comprehensive research, delivering more efficient and more robust gel materials for an enhanced product.
Our experts work continuously on new, improved solutions and stationary phases to separate synthetic and natural macromolecules by their hydrodynamic volume.

The PSS product portfolio covers a wide area of different particle sizes and porosities. The recommended column combinations are carefully selected and tested to avoid column mismatch.

Column selection

Although the application of isocratic conditions is sufficient for most tasks in macromolecular liquid chromatography, the selection of the best stationary phase and method development can be challenging.

Our concept for column selection and our recommendations are based on the best practice for GPC/SEC and the proven principle of matching polarities for sample, solvent and stationary phase/column material. PSS offers the widest range of stationary phases of different polarities, optimized for aqueous or organic solvents

Find more information and a product overview in chapter 3 starting at page 27.

"I make sure that our polymers meet the highest quality standards."

Dr. Jasmin Preis

Joined PSS in 2012. Deputy head of chemical production, responsible for quality control of reference materials and special polymers.

1| Reference materials and calibration kits

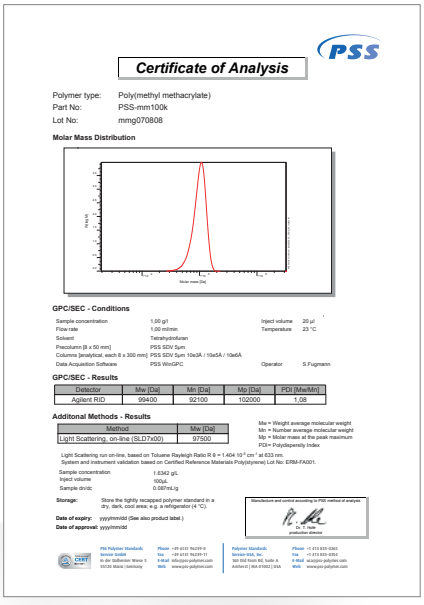
Individual Standards

A

Narrow and broad distributed standards

Narrow standards have narrow molar mass distributions with a low polydispersity index, PDI = M_w/M_n, and are defined by average molar mass values such as M_n (Number average molar mass) and M_w (Weight average molar mass). Due to their sharp and slim chromatogram profile, the M_p value is well defined and independent of the column resolution.

The product certificates contain M_n, M_w, M_p and the polydispersity index. For many of our polymers, there is also absolute M_w data available; typically obtained through light scattering.
Narrow polymer standards are made by controlled/living ionic polymerization techniques or by fractionation of broad standards. They have a wide application range from calibration of a GPC/SEC system to measurement of physical properties.



Certificate of Analysis

Polymer type: Poly(methyl methacrylate)
Part No: PSS-mm100k
Lot No: mmg070808

Molar Mass Distribution

GPC/SEC - Conditions

Sample concentration	1.00 g/l	Inject volume	20 µl
Flow rate	1.00 ml/min	Temperature	23 °C
Solvent	Tetrahydrofuran		
Precolumn (8 x 50 mm)	PSS SDV 5µm		
Columns (analytical, each 8 x 300 mm)	PSS SDV 5µm 10e3Å / 10e5Å / 10e6Å		
Data Acquisition Software	PSS WinGPC	Operator	S.Fugmann

GPC/SEC - Results

Detector	Mw [Da]	Mn [Da]	Mp [Da]	PDI [Mw/Mn]
Agilent RID	99400	92100	102000	1.08

Additonal Methods - Results

Method	Mw [Da]
Light Scattering, on-line (SLD7x00)	97500

Mw = Weight average molecular weight
Mn = Number average molecular weight
Mp = Molar mass at the peak maximum
PDI= Polydispersity Index

Light Scattering run on-line, based on Toluene Rayleigh Ratio R @ = 1.404 10^{-5} cm^{-1} at 633 nm.
System and instrument validation based on Certified Reference Materials Poly(styrene) Lot No. ERM-FA001.

Sample concentration 1.6342 g/L
Inject volume 100µL
Sample dn/dc 0.087mL/g

Storage: Store the tightly recapped polymer standard in a dry, dark, cool area; e.g. a refrigerator (4 °C).

Date of expiry: yyyy/mm/dd (See also product label.)
Date of approval: yyyy/mm/dd

Manufacture and control according to PSS method of analysis

Dr. T. Hahn
production director

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Ashland | MA 01652 | USA
Phone +1 413 835-0363
Fax +1 413 835-0352
E-Mail usa@pss-polymer.com
Web www.pss-polymer.com

GPC/SEC Standards

Broad reference materials are made by radical polymerization, polycondensation or coordinative polymerization (polyolefins). The PDI of broad standards is usually >1.5. For broad standards the M_p value is a function of the column resolution and therefore not defined. Broad standards are characterized by M_w and M_n.

Modern GPC/SEC software packages, such as PSS WinGPC, allow the construction of a calibration curve by the use of M_w, M_n or the intrinsic viscosity [η] of broad standards. Up to 8 different broad standards can be used to cover a wide molar mass range. Only one of the M_n, M_w, or [η] values is required to create the calibration curve.

Broad standards are used
- To validate a chromatographic system
- To determine physical constants such as the Mark-Houwink constants K and α.
- To construct a calibration curve
- To test for column mismatch
- For filtration experiments and sieve curve determination

B

Round Robin Tested Standards

European Reference Materials (ERM) are highly characterized polymers certified by the German Federal Institute for Material Research and Testing (BAM). The reported molar mass results from round robin experiments at certified laboratories. The ERM's quality certificates are full reports with the results of the different characterization methods: GPC/SEC, light scattering and viscometry. Further, the certificate includes additional non-certified data, (MALDI-ToF, NMR, DSC and in some instances rheological data) to provide the most sophisticated set of documentation for a particular polymer available worldwide.

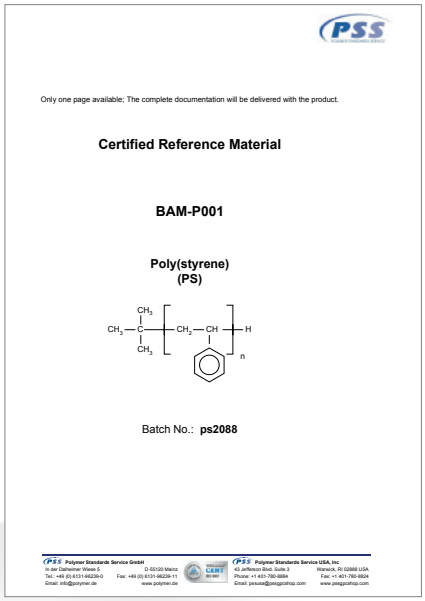
C

Standards for Membrane Characterization

GPC/SEC is a fast and robust method for the characterization of membranes in their native environment. PSS offers products and services to perform automated, fast and simple membrane characterization including cut-off and pore size distribution determination.

The GPC/SEC membrane characterization is accomplished by filtering the membrane standard through the membrane. Depending on the membrane type and quality some smaller molecules can pass through the pores of the membrane while others will be retained. The filtrate and the retentate are then measured on a GPC/SEC system. The average pore size distribution and the cut-off of the membrane are determined automatically by comparing the elution profiles of the retentate to the filtrate.

The PSS membrane standards feature
- A broad molar mass distribution
- The molar mass average M_w and M_n
- The integral molar mass information M_{min}, M_{max}
- The corresponding radii of gyration R_{gmin} and R_{gmax}


Only one page available; The complete documentation will be delivered with the product.

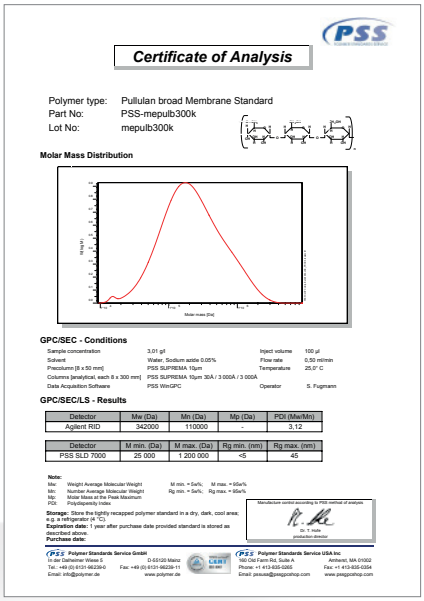
Certified Reference Material

BAM-P001

Poly(styrene)
(PS)

Batch No.: ps2088

European Reference Materials (ERM)


Certificate of Analysis

Polymer type: Pullulan broad Membrane Standard
Part No: PSS-mepulb300k
Lot No: mepulb300k

Molar Mass Distribution

GPC/SEC - Conditions

GPC/SEC/LS - Results

Detector	Mw (Da)	Mn (Da)	Mp (Da)	PDI (Mw/Mn)
Agilent RID	342000	110000	-	3,12

Detector	M min. (Da)	M max. (Da)	Rg min. (nm)	Rg max. (nm)
PSS SLD 7000	25 000	1 200 000	<5	45

Standards for membrane characterization

Assembled Kits of Molecular Weight Standards

A

GPC/SEC Calibration Kits

A calibration kit consists of 8 to 12 well-characterized standards of one polymer type. The kits include a calibration report and quality certificates with all pertinent analytical parameters and molar mass information for every single standard.

Please visit **www.pss-polymer.com** for an updated list.

B

ReadyCal Kits

PSS ReadyCal Standards are a blend of polymers preweight into autosampler vials. Each kit contains several vials of 3 different blends. Each of the 3 different color coded vials contains three or four polymers of the same type with carefully selected differing molar masses.

A ReadyCal Kit allows for the quick and reproducible preparation of a 8 to 12 point calibration curve without the inconvenience of weighing samples. Just add solvent directly into the autosampler vial, let it stand for two hours, shake gently, and inject. ReadyCals are availabe as 1.5 mL or 4.0 mL vials. ReadyCals for high temperature GPC are also available in 10 mL vials (for 4 calibrations).

C

MALDI Validation Kits

PSS provides polymer standard kits that will help you to check, calibrate and validate a Matrix-Assisted-Laser-Desorption-Ionization-Time-of-Flight (MALDI-ToF) instrument. Standards with different molecular weight ranges and different polarities are included. The different molecular weights allow you to determine the resolution of the instrument as a function of the molecular weight, whereas different polymer polarities help you determine the compatibility of your matrix and polymer.

D

Light Scattering/Viscometry Validation Kits

The kit is used to check the instrument performance and the inter-detector delay between the concentration detector(s) and the molar mass-sensitive detector(s). This kit includes a mixture of well-defined light scattering (LS) and/or viscometry reference materials (with narrow and broad distribution) with the relevant light scattering and/or viscometry data. The validation of your light scattering detector or viscometer is simple, fast, and reliable.

Are you looking for a ReadyCal Kit with a different polymer type?

Ask for a quotation!

E

GPC/SEC System Suitability Test with PSS EasyValid Validation Kit

PSS has developed a GPC/SEC system suitability test that evaluates the entire system: equipment, electronics, and analytical operations. Validation with the PSS EasyValid Validation Kit ensures that the system can accurately measure typcial GPC/SEC results.
The PSS EasyValid Validation Kit is designed for the validation of GPC/SEC instrumentation with concentration detectors, independent of brand.

It consists of
- A validation column
- Calibration standards
- Certified reference materials
- WinGPC report layouts
- WinGPC import files
- Comprehensive user documentation.

The Validation Kit EasyValid is ideal for:
- Checking system performance after installation as part of the OQ/PV (Operational Qualification/Performance Verification)
- Performance review after maintenance
- Inter-laboratory consistency checks
- Identifying systematic errors
- Training of new employees

F

End group determination with the LCCCValid Validation Kit

PSS now also offers a validation kit for chromatography under critical conditions. The kit is based on DIN SPEC 91070 and contains a column as well as different standards or standard mixtures that are suitable for the separation of heterogeneously functionalized PEGs. The kit is aimed at customers analyzing such polymers. In addition, it can be used as a learning tool for LCCC separations.

The PSS LCCCValid Validation Kit consists of:
- A suitable separation column
- Unfunctionalized PEG standards for determination of the critical point
- Two different mixtures of heterogeneously functionalized PEGs of known composition
- Detailed user documentation

For individual standards, all molar mass information is based on the nominal weight average molecular weight, M_w, and for GPC/SEC calibration kits on the nominal molecular weights of the peak maxima, M_p. In contrast, the batch molecular weight can be +/- 10% (for PDMS, Dextran and Pullulan +/- 20%). The exact values for the batch can be found on the quality certificate and the label on the bottle. Up-to-date information on the currently sold batches can be found on the PSS website or the PSS online shop.

Overview of Reference Materials

Reference Standard / Solvent	Water	Ethanol / Methanol	Trifluoroethanol	Hexafluoroisopropanol	Dimethylformamide	Dimethylacetamide	Dimethylsulfoxide	Tetrahydrofuran	Acetone	Chloroform	N-Methyl-2-pyrrolidone	Trichlorobenzene	Dichlorobenzene	Toluene	Further Information
Dextran	✓						✓								page 18 / web
Hydroxyethyl starch	✓														web
Poly(2-vinylpyridine)	(✓)							✓							page 16, 22 / web
Poly(2-vinylpyridinium bromide)	✓														web
Poly(acrylic acid) sodium salt	✓														page 21 / web
Poly(alpha-methylstyrene)					✓	✓		✓		✓	✓	✓	✓	✓	page 12 / web
Poly(butadiene-1.2)								✓					✓	✓	web
Poly(butadiene-1.4)								✓					✓	✓	page 15 / web
Poly(carbonate) broad								✓							web
Poly(DADMAC)	✓														web
Poly(dimethyl siloxane)								✓*		✓				✓	page 17 / web
Poly(ethyl methacrylate)					✓	✓		✓	✓	✓				✓	web
Poly(ethylene glycol)	✓				✓	✓		(✓)							page 20 / web
Poly(ethylene oxide)	✓				✓	✓									page 20 / web
Poly(ethylene terephthalate)				✓			(✓)								page 17 / web
Poly(ethylene)												(✓)	(✓)		page 14 / web
Poly(isobutylene)								✓		✓		✓	✓	✓	page 17 / web
Poly(isoprene-1.4)								✓						✓	page 15 / web
Poly(isoprene-3.4)								✓						✓	web
Poly(lactide)			✓	✓						✓					page 17 / web
Poly(methacrylic acid) sodium salt	✓														page 21 / web
Poly(methyl methacrylate)				✓	✓	✓	✓	✓	✓	✓	✓			✓	page 13 / web
Poly(n-butyl methacrylate)					✓	✓		✓	✓	✓	✓			✓	page 14 / web
Poly(propylene glycol)								✓							page 16 / web
Poly(styrene sulfonate) sodium salt	✓														page 22 / web
Poly(styrene)					✓	✓		✓		✓	✓	✓	✓	✓	page 11 / web
Poly(t-butyl acrylate)		✓			✓	✓		✓	✓	✓	✓	✓	✓	✓	web
Poly(t-butyl methacrylate)		✓			✓	✓		✓	✓	✓	✓	✓	✓	✓	page 14 / web
Poly(vinyl alcohol) broad	✓				✓										page 22 / web
Poly(vinyl chloride)								✓				✓	✓		web
Proteins	✓														page 22 / web
Pullulan	✓						✓								page 19 / web

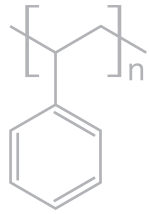
✓ : reference standard soluble in solvent
(✓) : reference standard soluble in solvent under special conditions (higher temperature, additives to solvent, up to a certain molecular weight, etc.)
* isorefractive, not visible with RI detection

Green solvents such as ethyl acetate and heptane are extensively tested at PSS as an alternative to THF.

Polymer Standards and Reference Materials

1.1| Organic standards

Poly(styrene) and derivatives



Poly(styrene)

a) Individual Standards

Poly(styrene) narrow

Pack Size 1000 mg

Part Number	Molar Mass [Da]	PDI
PSS-ps162	162	1.00
PSS-ps266	266	1.00
PSS-ps370	370	1.00
PSS-ps560	560	<1.50
PSS-ps1k	1 000	<1.50
PSS-ps1.8k	1 800	<1.50
PSS-ps3.2k	3 200	<1.15
PSS-ps5.6k	5 600	<1.15
PSS-ps10k	10 000	<1.15
PSS-ps18k	18 000	<1.15
PSS-ps33k	33 000	<1.15
PSS-ps56k	56 000	<1.15
PSS-ps100k	100 000	<1.15
PSS-ps180k	180 000	<1.15
PSS-ps320k	320 000	<1.15
PSS-ps560k	560 000	<1.15
PSS-ps1m	1 000 000	<1.50
PSS-ps1.8m	1 800 000	<1.50
PSS-ps3.2m	3 200 000	<1.50
PSS-ps5m	5 000 000	<1.50
PSS-ps10m	10 000 000	<1.50
PSS-ps15m	15 000 000	<1.50

Poly(styrene) broad

Pack Size 1000 mg

Part Number	Molar Mass [Da]	PDI
PSS-psb45k	45 000	>1.50
PSS-psb100k	100 000	>1.50
PSS-psb250k	250 000	>1.50
PSS-psb450k	450 000	>1.50

ERM-Poly(styrene)

Pack Size 1000 mg

Part Number	Molar Mass [Da]	PDI
PSS-eps80k	79 600	1.08
PSS-epsb180k	181 200	2.26

Poly(styrene) Membrane Characterization Standard

Pack Size
50 g, 100 g, 250 g, 500 g

Part Number	Molar Mass [Da]	PDI
PSS-mepsb200k	200 000	<2.00

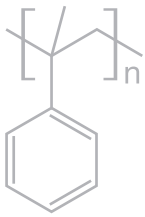
1.1| Organic standards

Poly(styrene) and derivatives

Poly(styrene)

b) Poly(styrene) calibration kits

Description	MP Range [Da]	Number of standards	Part Number
PSS GPC/SEC-calibration kit Poly(styrene) low	162 to 62 000	8 x 1000 mg	PSS-pskitl
PSS GPC/SEC-calibration kit Poly(styrene) mediumlow	162 to 850 000	12 x 1000 mg	PSS-pskitml
PSS GPC/SEC-calibration kit Poly(styrene) high	700 to 2 500 000	12 x 1000 mg	PSS-pskith
PSS ReadyCal Kit Poly(styrene) low	266 to 65 000	3 x 10 Vials-4.0 ml 3 x 10 Vials-1.5 ml	PSS-pskitr4l PSS-pskitr1l
PSS ReadyCal Kit Poly(styrene)	500 to 2 500 000	3 x 10 Vials-4.0 ml 3 x 10 Vials-1.5 ml	PSS-pskitr4 PSS-pskitr1
PSS ReadyCal Kit Poly(styrene) high	1 500 to 7 500 000	3 x 10 Vials-4.0 ml 3 x 10 Vials-1.5 ml	PSS-pskitr4h PSS-pskitr1h
ReadyCal-Kit Poly(styrene) HT	266 to 12 000 000	4 x 5 Vials-10 ml	PSS-pskitr10ht
PSS MALDI-Validation-Kit Poly(styrene)	700 to 67 000	6 x 500 mg	PSS-pskitm
PSS LS/Visko-Validation-Kit Poly(styrene)	9 000 to 560 000	4 x 500 mg	PSS-pskitv



Poly(α-methylstyrene)

a) Individual Standards

Poly(α-methylstyrene) Pack Size 1000 mg

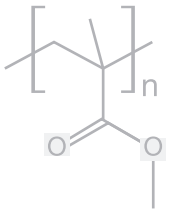
Part Number	Molar Mass [Da]	PDI
PSS-ams1.5k	1 500	<1.50
PSS-ams4k	4 000	<1.15
PSS-ams8k	8 000	<1.15
PSS-ams16k	16 000	<1.15
PSS-ams29k	29 000	<1.15
PSS-ams60k	60 000	<1.15
PSS-ams110k	110 000	<1.15
PSS-ams230k	230 000	<1.15
PSS-ams430k	430 000	<1.15
PSS-ams850k	850 000	<1.15

b) Poly(α-methylstyrene) calibration kits

Description	MP Range [Da]	Number of standards	Part Number
PSS GPC/SEC-calibration kit Poly(α-methylstyrene)	1 500 to 950 000	10 x 1000 mg	PSS-amskit

1.1| Organic standards

Poly(alkyl methacrylates)



Poly(methyl methacrylate)

a) Individual Standards

Poly(methyl methacrylate) narrow Pack Size 1000 mg

Part Number	Molar Mass [Da]	PDI
PSS-mm102	102	1.00
PSS-mm202	202	1.00
PSS-mm600	600	<1.50
PSS-mm1k	1 000	<1.50
PSS-mm2.1k	2 100	<1.15
PSS-mm4.7k	4 700	<1.15
PSS-mm10k	10 000	<1.15
PSS-mm21k	21 000	<1.15
PSS-mm47k	47 000	<1.15
PSS-mm100k	100 000	<1.15
PSS-mm210k	210 000	<1.15
PSS-mm470k	470 000	<1.15
PSS-mm1m	1 000 000	<1.50
PSS-mm2m	2 000 000	<1.50
PSS-mm3m	3 000 000	<1.50

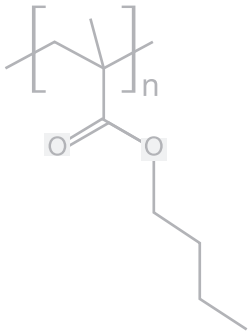
Poly(methyl methacrylate) broad Pack Size 1000 mg

Part Number	Molar Mass [Da]	PDI
PSS-mmb20k	20 000	>1.50
PSS-mmb60k	60 000	>1.50
PSS-mmb100k	100 000	>1.50
PSS-mmb2.2m	2 200 000	>1.50

b) Poly(methyl methacrylate) calibration kits

Description	MP Range [Da]	Number of standards	Part Number
PSS GPC/SEC-calibration kit Poly(methyl methacrylate) low	102 to 62 000	8 x 500 mg	PSS-mmkitl
PSS GPC/SEC-calibration kit Poly(methyl methacrylate) high	600 to 2 200 000	12 x 500 mg	PSS-mmkith
PSS ReadyCal Kit Poly(methyl methacrylate)	800 to 2 200 000	3 x 10 Vials-4.0 ml 3 x 10 Vials-1.5 ml	PSS-mmkitr4 PSS-mmkitr1
PSS ReadyCal Kit Poly(alkyl methacrylate) low	202 to 72 000	3 x 10 Vials-1.5 ml	PSS-mmkitr1l
PSS LS/Visco-Validation-Kit Poly(methyl methacrylate)	8 000 to 900 000	4 x 500 mg	PSS-mmkitv

1.1| Organic standards



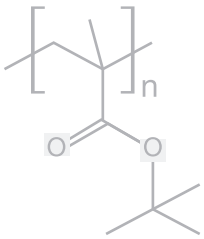
Polyalkylmethacrylate

Poly(n-butyl methacrylate)

Individual Standards

Poly(n-butyl methacrylate) narrow Pack Size 1000 mg

Part Number	Molar Mass [Da]	PDI
PSS-nb1k	1 000	<1.15
PSS-nb2.8k	2 800	<1.15
PSS-nb5.5k	5 500	<1.15
PSS-nb12k	12 000	<1.15
PSS-nb20k	20 000	<1.15
PSS-nb47k	47 000	<1.15
PSS-nb100k	100 000	<1.15
PSS-nb210k	210 000	<1.15
PSS-nb470k	470 000	<1.15
PSS-nb750k	750 000	<1.15



Poly(t-butyl methacrylate)

Individual Standards

Poly(t-butyl methacrylate) narrow Pack Size 1000 mg

Part Number	Molar Mass [Da]	PDI
PSS-tbma1.5k	1 500	<1.50
PSS-tbma2.1k	2 100	<1.15
PSS-tbma4.7k	4 700	<1.15
PSS-tbma10k	10 000	<1.15
PSS-tbma21k	21 000	<1.15
PSS-tbma47k	47 000	<1.15
PSS-tbma100k	100 000	<1.15
PSS-tbma210k	210 000	<1.15
PSS-tbma470k	470 000	<1.15
PSS-tbma1m	1 000 000	<1.50

Poly(olefins)

Poly(ethylene)

a) Individual Standards

Poly(ethylene) Pack Size 250 mg

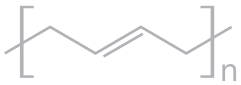
Part Number	Molar Mass [Da]	PDI
PSS-pe800	800	<2.00
PSS-pe2k	2 000	<2.00
PSS-pe13k	13 000	<2.00
PSS-pe28k	28 000	<2.00
PSS-pe56k	56 000	<2.00
PSS-pe100k	100 000	<2.00
PSS-pe120k	120 000	<2.00

b) Poly(ethylene) calibration kits

Description	MP Range [Da]	Number of standards	Part Number
PSS GPC/SEC-calibration kit Poly(ethylene)	338 to 80 000	10 x 250 mg	PSS-pekit

1.1| Organic standards

Polydiene



Poly(butadiene-1.4)

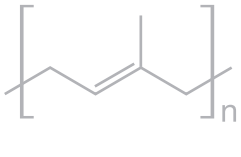
a) Individual Standards

Poly(butadiene-1.4) narrow Pack Size 1000 mg

Part Number	Molar Mass [Da]	PDI
PSS-bdf110	110	1.00
PSS-bdf470	470	<1.50
PSS-bdf1k	1 000	<1.50
PSS-bdf2.1k	2 100	<1.15
PSS-bdf4.7k	4 700	<1.15
PSS-bdf10k	10 000	<1.15
PSS-bdf21k	21 000	<1.15
PSS-bdf47k	47 000	<1.15
PSS-bdf100k	100 000	<1.15
PSS-bdf210k	210 000	<1.15
PSS-bdf470k	470 000	<1.15
PSS-bdf1m	1 000 000	<1.15

b) Poly(butadiene-1.4) calibration kits

Description	MP Range [Da]	Number of standards	Part Number
PSS GPC/SEC-calibration kit Poly(butadiene-1.4)	1 000 to 1 000 000	10 x 1000 mg	PSS-bdfkit



Poly(isoprene-1.4)

a) Individual Standards

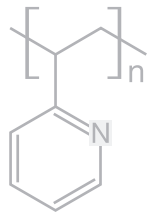
Poly(isoprene-1.4) narrow Pack Size 1000 mg

Part Number	Molar Mass [Da]	PDI
PSS-pio800	800	<1.50
PSS-pio1k	1 000	<1.50
PSS-pio2.1k	2 100	<1.15
PSS-pio4.7k	4 700	<1.15
PSS-pio10k	10 000	<1.15
PSS-pio21k	21 000	<1.15
PSS-pio47k	47 000	<1.15
PSS-pio100k	100 000	<1.15
PSS-pio210k	210 000	<1.15
PSS-pio470k	470 000	<1.15
PSS-pio1m	1 000 000	<1.50

b) Poly(isoprene-1.4) calibration kits

Description	MP Range [Da]	Number of standards	Part Number
PSS GPC/SEC-calibration kit Poly(isoprene-1.4)	1 000 to 1 200 000	10 x 1000 mg	PSS-piokit

1.1| Organic standards



Further Standards

Poly(2-vinylpyridine)

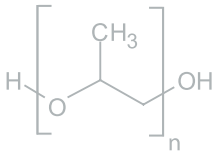
a) Individual Standards

Poly(2-vinylpyridine) narrow Pack Size 1000 mg

Part Number	Molar Mass [Da]	PDI
PSS-pvp1k	1 000	<1.50
PSS-pvp2.1k	2 100	<1.50
PSS-pvp4.7k	4 700	<1.50
PSS-pvp10k	10 000	<1.15
PSS-pvp21k	21 000	<1.15
PSS-pvp47k	47 000	<1.15
PSS-pvp110k	110 000	<1.15
PSS-pvp265k	265 000	<1.15
PSS-pvp470k	470 000	<1.15
PSS-pvp1m	1 000 000	<1.50

b) Poly(2-vinylpyridine) calibration kits

Description	MP Range [Da]	Number of standards	Part Number
PSS GPC/SEC-calibration kit Poly(2-vinylpyridine)	600 to 3 000 000	12 x 500 mg	PSS-pvpokit



Poly(propylene glycol)

a) Individual Standards

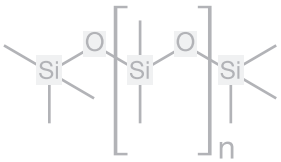
Poly(propylene glycol) Pack Size 1000 mg

Part Number	Molar Mass [Da]	PDI
PSS-ppg76	76	=1.00
PSS-ppg192	192	=1.00
PSS-ppg450	450	<1.15
PSS-ppg790	790	<1.15
PSS-ppg1k	1000	<1.15
PSS-ppg3k	3000	<1.15
PSS-ppg4.5k	4500	<1.15

b) Poly(propylene glycol) calibration kits

Description	MP Range [Da]	Number of standards	Part Number
PSS GPC/SEC-calibration kit Poly(propylene glycol)	76 to 4 200	7 x 1000 mg	PSS-ppgkit

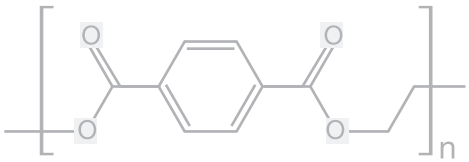
1.1| Organic standards



Poly(dimethylsiloxane)

Poly(dimethylsiloxane) calibration kits

Description	MP Range [Da]	Number of standards	Part Number
PSS GPC/SEC-calibration kit Poly(dimethylsiloxane)	311 to 300 000	8 x 500 mg	PSS-pdmkit



Poly(ethylene terephthalate)

a) Individual Standards

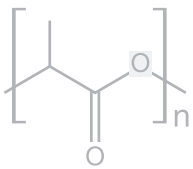
Poly(ethylene terephthalate) Pack Size 250 mg

Part Number	Molar Mass [Da]	PDI
PSS-pet3.5k	3 500	<2.10
PSS-pet10k	10 000	<2.10
PSS-pet18k	18 000	<2.10
PSS-pet25k	25 000	<2.10
PSS-pet35k	35 000	<2.10
PSS-pet40k	40 000	<2.10
PSS-pet50k	50 000	<2.10
PSS-pet75k	75 000	<2.10
PSS-pet120k	120 000	<2.10

Poly(isobutylene)

Poly(isobutylene) calibration kits

Description	MP Range [Da]	Number of standards	Part Number
PSS GPC/SEC-calibration kit Poly(isobutylene)	400 to 700 000	10 x 250 mg	PSS-pibkit



Poly(lactide)

a) Individual Standards

CRM-Poly(lactide) Pack Size 1000 mg

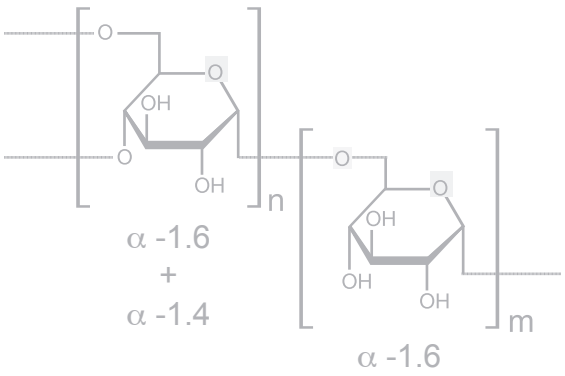
Part Number	Molar Mass [Da]	PDI
PSS-cpla230k	249 400	1.98

b) Poly(L-lactide) calibration kits

Description	MP Range [Da]	Number of standards	Part Number
PSS GPC/SEC-calibration kit Poly(L-lactide)	500 to 70 000	7 x 200 mg	PSS-plakit
PSS GPC/SEC-calibration kit Poly(L-lactide) high	500 to 100 000	7 x 200 mg + 1 (breit) x 500 mg	PSS-plakith

1.2| Aqueous standards

Poly(saccharides)



Dextran

a) Individual Standards

Dextran narrow Pack Size 1000 mg

Part Number	Molar Mass [Da]	PDI
PSS-dxt180	180	1.00
PSS-dxt342	342	1.00
PSS-dxt504	504	1.00
PSS-dxt1.3k	1 300	<1.50
PSS-dxt5k	5 000	<2.00
PSS-dxt10k	10 000	<2.00
PSS-dxt20k	20 000	<2.00
PSS-dxt25k	25 000	<2.00
PSS-dxt40k	40 000	<2.00
PSS-dxt70k	70 000	<2.00
PSS-dxt130k	130 000	<2.00
PSS-dxt200k	200 000	<2.00
PSS-dxt320k	320 000	<2.50

Dextran Membrane Characterization Standard Pack Size 50 g, 100 g, 250 g, 500 g

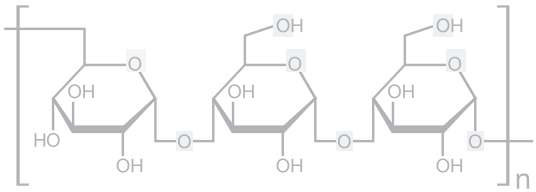
Part Number	Molar Mass [Da]	PDI
PSS-medxtb70k	70 000	<2.00
PSS-medxtb2m	2 000 000	>2.00

b) Dextran calibration kits

Description	MP Range [Da]	Number of standards	Part Number
PSS GPC/SEC-calibration kit Dextran	180 to 225 000	10 x 250 mg	PSS-dxtkit
PSS ReadyCal Dextran	180 to 225 000	3 x 5 Vials 1.5 ml	PSS-dxtkitr1
PSS LS/Visco-Validation-Kit Dextran	10 000 to 225 000	4 x 500 mg	PSS-dxtkitv

1.2| Aqueous standards

Poly(saccharides)



Pullulan

a) Individual Standards

Pullulan Pack Size 100 mg

Part Number	Molar Mass [Da]	PDI
PSS-pul342	342	1.00
PSS-pul1.3k	1 300	<1.30
PSS-pul6k	6 000	<1.20
PSS-pul12k	12 000	<1.20
PSS-pul22k	22 000	<1.20
PSS-pul50k	50 000	<1.20
PSS-pul110k	110 000	<1.20
PSS-pul200k	200 000	<1.30
PSS-pul400k	400 000	<1.30
PSS-pul800k	800 000	<1.30

Pullulan Membrane Characterization Standard Pack Size 50 g, 100 g, 250 g, 500 g

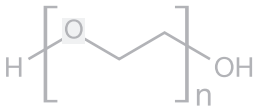
Part Number	Molar Mass [Da]	PDI
PSS-mepulb300k	300 000	>2.00

b) Pullulan calibration kits

Description	MP Range [Da]	Number of standards	Part Number
PSS GPC/SEC-calibration kit Pullulan	342 to 700 000	10 x 100 mg	PSS-pulkit
PSS ReadyCal Pullulan	342 to 700 000	3 x 5 Vials 1.5 ml	PSS-pulkitr1
PSS ReadyCal Pullulan high	342 to 1 000 000	3 x 5 Vials 1.5 ml	PSS-pulkitr1h

1.2| Aqueous standards

Poly(ethylene glycol) and Poly(ethylene oxide)



Poly(ethylene glycol)

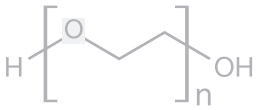
a) Individual Standards

Poly(ethylene glycol) Pack Size 1000 mg

Part Number	Molar Mass [Da]	PDI
PSS-peg106	106	1.00
PSS-peg194	194	1.00
PSS-peg238	238	1.00
PSS-peg330	330	<1.25
PSS-peg400	400	<1.25
PSS-peg600	600	<1.25
PSS-peg1k	1 000	<1.25
PSS-peg1.5k	1 500	<1.25
PSS-peg2k	2 000	<1.25
PSS-peg3k	3 000	<1.25
PSS-peg4k	4 000	<1.25
PSS-peg6k	6 000	<1.25
PSS-peg10k	10 000	<1.25
PSS-peg12k	12 000	<1.25
PSS-peg18k	18 000	<1.25
PSS-peg26k	26 000	<1.30
PSS-peg42k	42 000	<1.30

b) Poly(ethylene glycol) calibration kits

Description	MP Range [Da]	Number of standards	Part Number
PSS GPC/SEC-calibration kit Poly(ethylene glycol)	106 to 44 000	10 x 500 mg	PSS-pegkit
PSS ReadyCal Kit Poly(ethylene glycol)	238 to 44 000	3 x 10 Vials-1.5 ml	PSS-pegkitr1



Poly(ethylene oxide)

a) Individual Standards

Poly(ethylene oxide) Pack Size 1000 mg

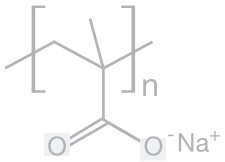
Part Number	Molar Mass [Da]	PDI
PSS-peo42k	42 000	<1.25
PSS-peo110k	110 000	<1.25
PSS-peo220k	220 000	<1.25
PSS-peo500k	500 000	<1.25
PSS-peo1m	1 000 000	<1.25

b) Poly(ethylene oxide) calibration kits

Description	MP Range [Da]	Number of standards	Part Number
PSS GPC/SEC-calibration kit Poly(ethylene oxide)/Poly(ethylene glycol)	192 to 1 000 000	12 x 500 mg	PSS-peokit
PSS ReadyCal Kit Poly(ethylene oxide)/Poly(ethylene glycol)	238 to 1 000 000	3 x 10 Vials-4.0 ml 3 x 10 Vials-1.5 ml	PSS-peokitr4 PSS-peokitr1

1.2| Aqueous standards

Poly(methacrylic acids)



Poly(methacrylic acid) sodium salt

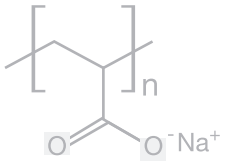
a) Individual Standards

Poly(methacrylic acid) sodium salt Pack Size 500 mg

Part Number	Molar Mass [Da]	PDI
PSS-pma1.2k	1 200	<1.20
PSS-pma3.5k	3 500	<1.20
PSS-pma7.6k	7 600	<1.20
PSS-pma18k	18 000	<1.20
PSS-pma36k	36 000	<1.20
PSS-pma76k	76 000	<1.20
PSS-pma160k	160 000	<1.20
PSS-pma340k	340 000	<1.20
PSS-pma500k	500 000	<1.20

b) Poly(methacrylic acid) sodium salt calibration kits

Description	MP Range [Da]	Number of standards	Part Number
PSS GPC/SEC-calibration kit Poly(methacrylic acid) sodium salt	1 300 to 550 000	8 x 500 mg	PSS-pmakit



Poly(acrylic acid) sodium salt

a) Individual Standards

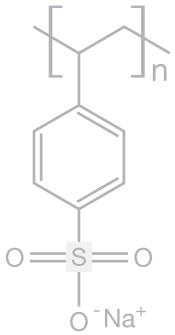
Poly(acrylic acid) sodium salt Pack Size 250 mg

Part Number	Molar Mass [Da]	PDI
PSS-paa2k	2 000	<2.00
PSS-paa4k	4 000	<2.00
PSS-paa8k	8 000	<2.00
PSS-paa18k	18 000	<2.00
PSS-paa50k	50 000	<2.00
PSS-paa150k	150 000	<2.00
PSS-paa350k	350 000	<2.00
PSS-paa550k	550 000	<2.00
PSS-paa1m	1 000 000	<2.00
PSS-paa1.5m	1 500 000	<2.00

b) Poly(acrylic acid) sodium salt calibration kits

Description	MP Range [Da]	Number of standards	Part Number
PSS GPC/SEC-calibration kit Poly(acrylic acid) sodium salt	1 200 to 1 400 000	10 x 250 mg	PSS-paakit

1.2| Aqueous standards



Further Standards

Poly(styrene sulfonate) sodium salt

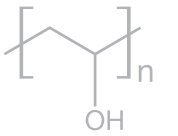
a) Individual Standards

Poly(styrene sulfonate) sodium salt Pack Size 500 mg

Part Number	Molar Mass [Da]	PDI
PSS-pss246	246	<1.20
PSS-pss1k	1 000	<1.20
PSS-pss3.4k	3 400	<1.20
PSS-pss6k	6 000	<1.20
PSS-pss15k	15 000	<1.20
PSS-pss30k	30 000	<1.20
PSS-pss67k	67 000	<1.20
PSS-pss140k	140 000	<1.20
PSS-pss280k	280 000	<1.20
PSS-pss600k	600 000	<1.20
PSS-pss1m	1 000 000	<1.20
PSS-pss2m	2 000 000	<1.20

b) Poly(styrene sulfonate) sodium salt calibration kits

Description	MP Range [Da]	Number of standards	Part Number
PSS GPC/SEC-calibration kit Poly(styrene sulfonate) sodium salt	900 to 1 000 000	10 x 500 mg	PSS-psskit



Poly(vinyl alcohol)

a) Individual Standards

Poly(vinyl alcohol) broad Pack Size 1000 mg

Part Number	Molar Mass [Da]	PDI
PSS-pvo12k	12 000	<3.50
PSS-pvo30k	30 000	<2.50
PSS-pvo40k	40 000	<2.50
PSS-pvo75k	75 000	<2.50
PSS-pvo100k	100 000	<2.50
PSS-pvo120k	120 000	<2.50
PSS-pvo160k	160 000	<2.50

Proteins

Description	MP Range [Da]	Number of standards	Part Number
PSS GPC/SEC-calibration kit Protein	243 to 670 000	10 x 100 mg	PSS-prokit

Poly(2-vinylpyridine)

Description	MP Range [Da]	Number of standards	Part Number
PSS GPC/SEC-calibration kit Poly(2-vinylpyridine)	600 to 3 000 000	12 x 500 mg	PSS-pvpakit

1.3| Validation-Kits

MALDI-Validation-Kits

Description	MP Range [Da]	Number of standards	Part Number
PSS MALDI-Validation-Kit Poly(styrene)	700 to 67 000	6 x 500 mg	PSS-pskitm
PSS MALDI-Validation-Kit mixed (PS, PMMA, PDMS, PEG, PSS)	4 500 to 6 000	5 x 500 mg	PSS-mixkitm

Light Scattering/Viscometry Validation Kits

Description	MP Range [Da]	Number of standards	Part Number
PSS LS/Visco-Validation-Kit Poly(methyl methacrylate)	8 000 to 900 000	4 x 500 mg	PSS-mmkitv
PSS LS/Visco-Validation-Kit Poly(styrene)	9 000 to 560 000	4 x 500 mg	PSS-pskitv
PSS LS-Visco-Validation-Kit Dextran	10 000 to 225 000	4 x 500 mg	PSS-dxtkitv

EasyValid Validation-Kits

Description	Number of standards	Part Number
PSS EasyValid Validation-Kit for organic systems	6 x 5 Vials-1.5 ml	PSS-pskitval
PSS EasyValid Validation-Kit for aqueous systems	6 x 5 Vials-1.5 ml	PSS-dxtkitval

LCCCValid Validation-Kit

Description	Number of standards	Part Number
PSS LCCCValid Validation-Kit	6 x 3 and 3 x 4 Vials-1.5 ml and validation column	LCCCValid

1.4| Particle Standards*

PSS Particle Standards are traceable to the Standard Meter through the National Institute of Standards and Technology (NIST). They are available as uniform spheres of polymer in a range of sizes from 20 nm to 1 000 µm. Each standard comes with a "Certificate of Calibration and Traceability to NIST" which includes a description of the calibration method and its uncertainty, and a table of chemical and physical properties.

Particle	Pack Size	Size	
		Min.	Max.
Nanospheres	15 ml dropper-tipped bottles	20 nm	900 nm
Microspheres	15 ml or 1 g	1 µm	1 000 µm
EZY-CAL	100 ml	2 µm	70 µm

* Only in selected countries.

"In our laboratories we synthesize even the most difficult and complex polymers."

Ralf Leinweber

Managing Director, with PSS since 1986, responsible for the synthesis of reference materials and custom synthesis.

2| Specialty polymers and custom synthesis

2.1| Specialty polymers

In addition to the reference materials shown on the previous pages, PSS also offers a large selection of other products such as copolymers, functionalized polymers and deuterated (co) polymers. This is not a permanent product portfolio, but the available product range is constantly being expanded.

List of all specialty polymers:

▲ Click here

The following types of specialty polymers are available:

- Block copolymers
- Star polymers
- Polymers with functional end groups
- Deuterated polymers
- Deuterated block copolymers

2.2| Custom synthesis

The PSS concept

Not only does PSS produce high quality column material and reference materials, we also specialize in the synthesis of unique polymers according to customer requests. The on-site production covers the range from five grams up to two kilograms. PSS supports and accompanies a project from the implementation of an idea to the analysis of the final product.

The exact specifications of the polymer are defined by the customer's requirements. Then the synthesis is carried out by the PSS specialists. In order to offer the highest quality after the synthesis, the product is adequately characterized. When selecting the analysis method, PSS draws on many years of experience in the field of macromolecular analysis.

With this, we are able to confidently supply a polymer that has been rigorously characterized to ensure that all specifications requested have been met.

Confidentiality is an integral part when working on projects with our customers.

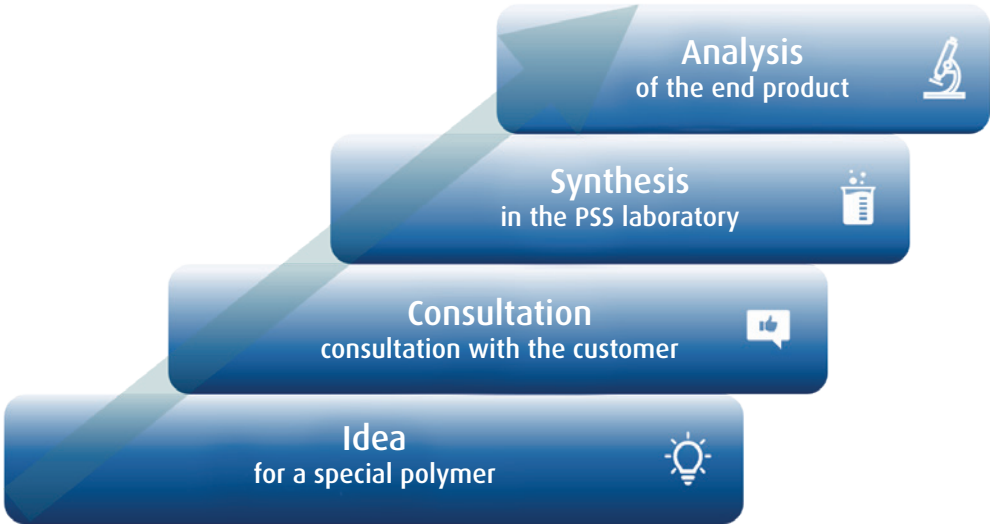
Strengths in synthesis

The advantage of our custom synthesis are the many years of experience of working with a wide variety of polymerization techniques. These include:

- Controlled (living) ionic polymerization
  - Anionic
  - Cationic
  - GTP
- Free radical polymerization
  - ATRP
  - RAFT
  - Conventional
- Suspension polymerization
- Emulsion polymerization

The aforementioned techniques allow for the synthesis of a large number of different homo- and copolymer structures with variable physical and physicochemical properties. The illustration on page 26 gives a schematic overview of the possible structures and compositions.

In addition, PSS also offers products in the field of deuterated (co) polymers or polymer-based particles.

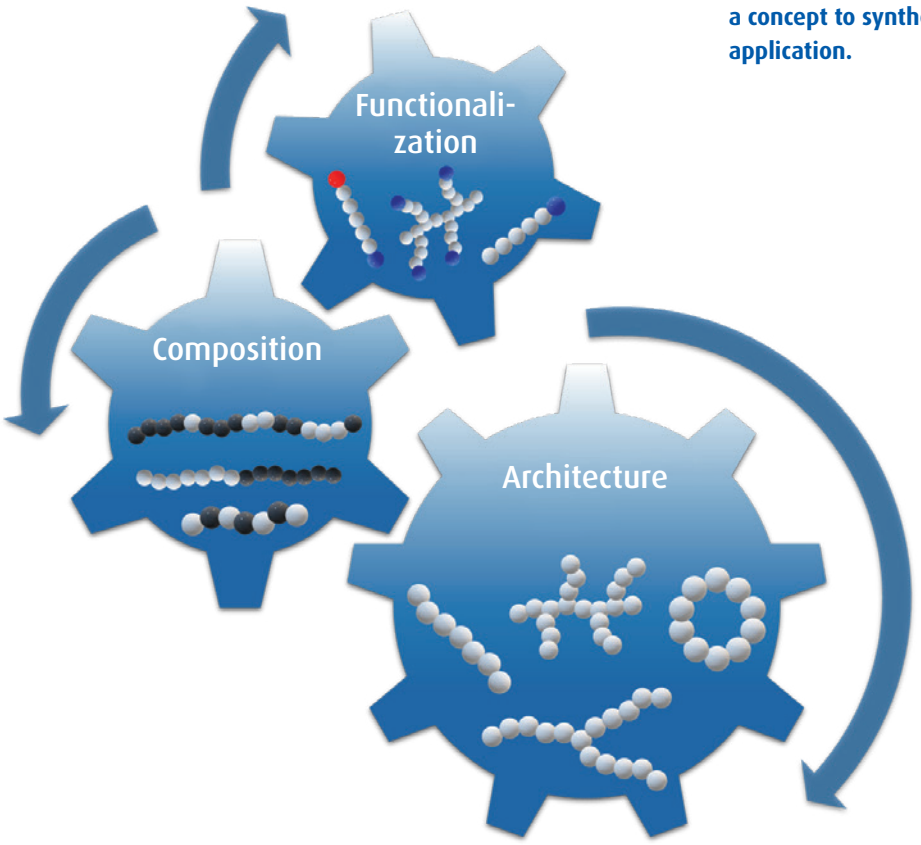


Application examples

PSS has successfully implemented many challenging synthetic designs over the years. One example of such a project was the design and manufacture of a hierarchical structured polymer that displayed both ultrahydrophobicity and superhydrophilicity under variable external conditions.
The final product is shown schematically in the following figure and is based on a silica particle which is coated with an amphiphilic triblock copolymer.

The switching of the properties is controlled by varying the salt content, the temperature or the pH value, as well as by the solvent itself.

Our production is designed to synthesize products of the highest quality for a wide range of applications.



Analysis of the final product

Since PSS stands for quality, we create a certificate of analysis for the finished product, which documents the agreed-upon specifications. With our many years of experience, we are able to select and apply characterization techniques that go beyond pure molar mass determination.

PSS also offers characterization using liquid chromatography under critical conditions (LCCC), 2D analysis with and without coupling to FTIR for copolymer analysis, as well as NMR and mass spectrometry.

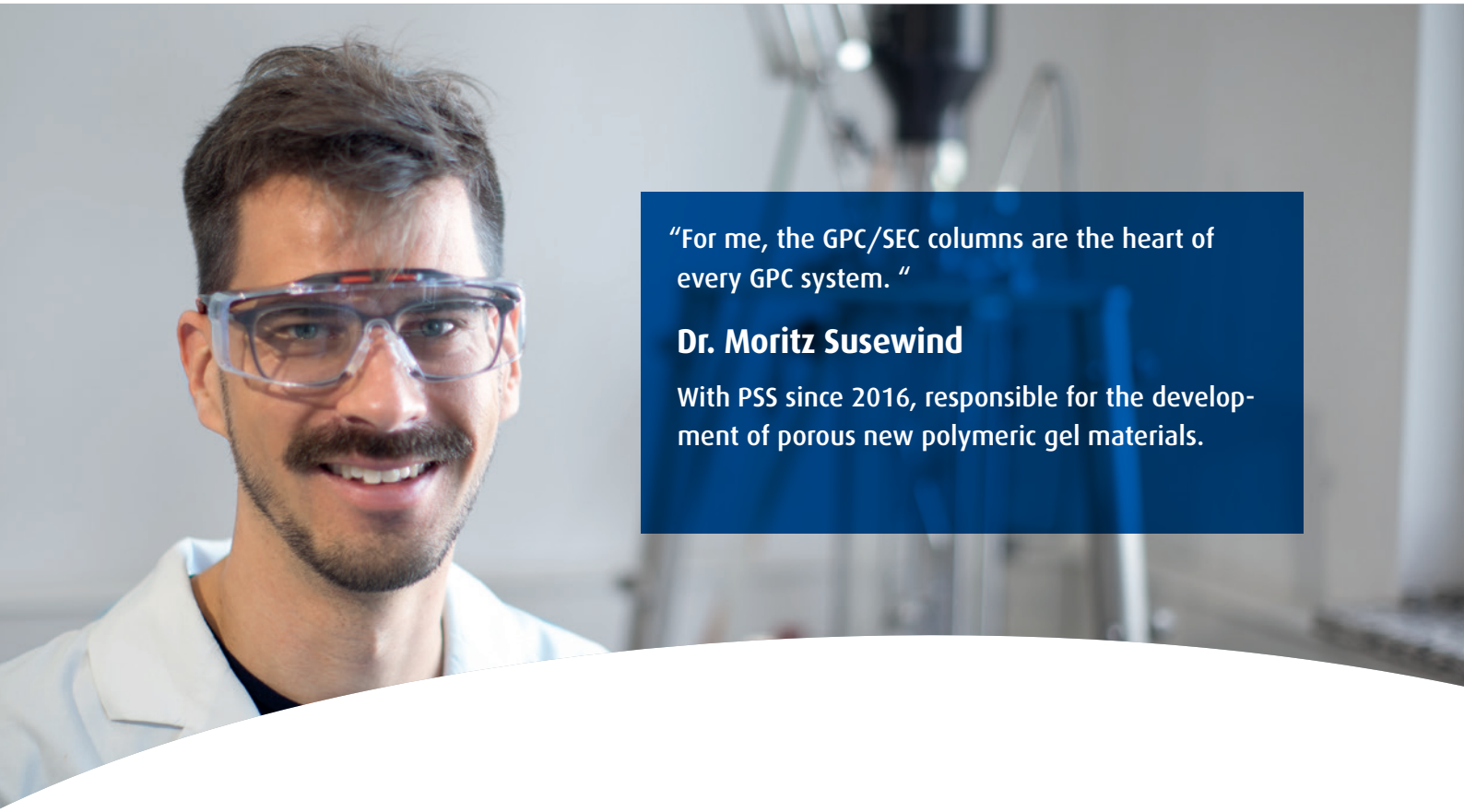
We can also support you carrying out your own analysis and advise you on suitable columns and reference materials, as well as hardware and software solutions.

Do you have a clear idea of the polymer and the properties you are looking for?

We are happy to support you effectively and efficiently in implementation and production.

You know the properties of your end product, but you don't know which polymer and what functionalizations are suitable?

We would be happy to assist you in developing a concept to synthesize a product suitable for your application.



"For me, the GPC/SEC columns are the heart of every GPC system. "

Dr. Moritz Susewind

With PSS since 2016, responsible for the development of porous new polymeric gel materials.

3| Successful Separation with PSS Columns

Proper selection of a GPC/SEC column is dependent on various criteria, influenced by the desired analysis. Our column recommendations are based on the following concept:

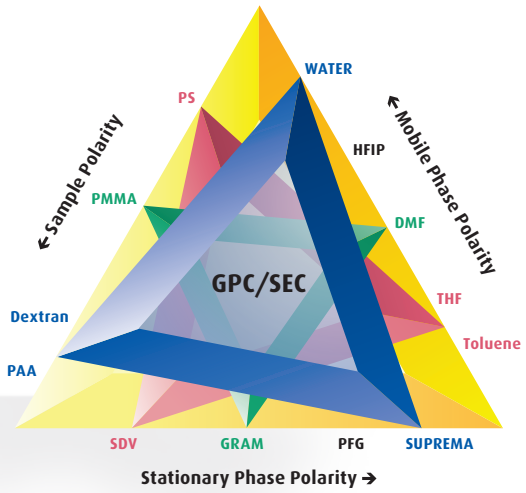
A

Optimum Mobile and Stationary Phase

GPC/SEC requires minimized interactions between sample and stationary phase. The selection of the best mobile and stationary phase is therefore the most critical parameter for successful GPC/SEC.

In general, the sample is the determining factor. The polarity of the sample dictates the polarity of the solvent and therefore also that of the stationary phase.

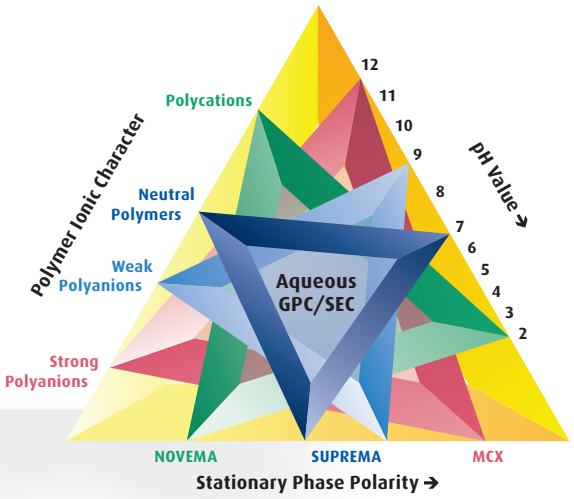
The PSS Magic Triangle provides a quick visual reference for the selection of columns, where the three polarities are balanced. The polarities of sample, mobile phase, stationary phase, are each represented on one of the sides of the Magic Triangle.



PSS Magic Triangle for GPC/SEC applications

Using the PSS Magic Triangle

Construct a smaller triangle inside the Magic Triangle by locating the polarity of sample and mobile phase and linking them with a line to form one side; the position of the opposite angle that completes the new equilateral triangle identifies the correct stationary phase. This concept is also applicable for aqueous GPC/SEC. The magic triangle for aqueous systems takes the pH value instead of the mobile phase polarity into account.



PSS Magic Triangle for aqueous GPC/SEC applications

B

Particle Sizes

PSS GPC/SEC column materials are available in in differing particle sizes, ranging from 3 µm to 20 µm.

The optimum particle size depends on
- Solvent viscosity (higher viscosity requires larger particle size)
- Molar mass of the sample (higher molar masses require larger particle sizes).

C

Porosities

The porosity or the pore size distribution of the column material determines the separation range.

- To separate low molecular weight products, small porosities are ideal.
- For higher molecular weights, the larger porosities are required.

Single porosity columns show a high resolution in a narrow molecular weight range. A wide molecular weight range at constant high resolution can be obtained if columns with different porosities are coupled in series. Single porosities offer the flexibility to alter the molecular weight range according to the sample to be analyzed.

Linear or mixed bed columns are blends of several different pore sizes designed for specific molecular weight ranges. They provide a very wide porosity range and therefore a broad separation range but with a lower resolution. Resolution can be increased by adding columns of **exactly the same type**. However, the separation range is fixed and these columns are not designed to be combined either with individual porosity columns or columns of a different mixed type.

Column combinations and linear columns offered by PSS are already optimized with regard to particle size and porosity for their designated separation range.

D

Laboratory Workflow Requirements/Tasks

Once you know the stationary phase, particle size and porosity, there are different options to optimize the polymer separation, depending on laboratory workflow requirements:

Select	for
HighSpeed columns	Very fast results needed in process control and high throughput screening Analysis time: 2 - 4 min per column
Linear or mixed bed columns	Product screening at constant peak resolution Analysis time: ~ 12 min per column.
Combination of single - porosity columns	Highest resolution and maximum information Analysis time: > 12 min per column

E

Column Dimensions

Our stationary phases are packed in stainless steel columns of standard dimensions that fit any HPLC or GPC/SEC instrument

Column type	I.D. x length [mm]	Field of application
Precolumn	8 x 50 4.6 x 30 20 x 50	Protection
Analytical	8 x 300	Conventional analysis
Micro	4.6 x 250	Solvent saving, small sample amounts
Preparative	20 x 300 40 x 250	Preparative sample fractionation, sample collection
HighSpeed	20 x 50	Ultra-fast analysis

I.D.: internal diameter
Any other column dimension on request

A bio-inert column coating of the V4A steel column body is available in all dimensions.

For additional column dimensions please contact us or your local representative.

Advantages of PSS Column Technology

- Excellent separation efficiency obtained by narrow particle size distribution and optimized frit technology.
- Excellent stability under a wide range of physical, chemical and biological environments.
- High solvent compatibility with organic or aqueous mobile phases.
- Column production under DIN EN ISO 9001 quality standards.
- Quality control: Each column is individually tested using PSS's test criteria.
- Delivered with detailed user documentation and a quality certificate.
- PSS engineered fittings and integrated diffusers provide low dead volume and efficient distribution of the sample across the entire chromatographic bed for optimum sample injection.
- Easy to service: easy to change end frits and replace worn end fittings.
- Dedicated support for technical questions, problems and applicational demands from a team of committed and experienced scientists.

PSS Services and Support

GPC/SEC columns are the heart of any GPC/SEC system. The development of a GPC/SEC method can sometimes be difficult, especially for biopolymers. PSS offers therefore not only columns but provides the widest spectrum of competent services and support for robust method development – to ensure fast, accurate, and precise results.

A

Method Development/Validation/Transfer

GPC/SEC is our passion. PSS experts work with you one-on-one to determine your goals and to establish a sound method for the analysis of your macromolecules. Based on a detailed project plan, we can deliver a complete GPC/SEC solution for your laboratory.

B

Custom Synthesis

Our chemists are able to develop new stationary phases optimized for the needs of your newly designed polymers and biopolymers.

C

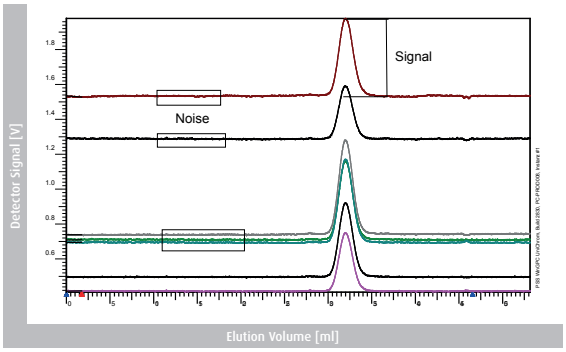
Batch Reservation

Long term reproducibility is always important. PSS can reserve batches for dedicated applications and deliver columns to any location worldwide. This ensures high inter-laboratory consistency and precise, accurate results.

D

Columns Pre-equilibrated for Light scattering (Lux)

PSS offers columns pre-equilibrated for light scattering measurements. The columns are prepared to offer a low noise level and a very good signal-to-noise ratio (<0.1 V) out of the box (please see table with additional options)



Lux columns reach the steady state mode > 20 times faster than conventional columns, and their overall noise reduction is more than 25 times better.

E

Solvent of Choice

PSS delivers the columns in the solvent requested by the customer. Exceptions are eluents with a high freezing point such as DMSO or TCB. The solvent inside the columns can be identified by the color-coded column plugs (see table additional options).

F

Free Column Connectors

PSS ships pre-configured column connectors with every column for fast and trouble-free installation.

G

Bioinert application

A bioinert column coating of the V4A steel column body is available in all dimensions (see table additional options).

H

Environmentally conscious use of resources

In the last few years, more environmentally conscious solutions for analytical processes have become more popular among our customers. At PSS, we also value sustainability and the environmentally conscious use of resources in various areas of the analytical process.

One of our approaches is to save / reduce the consumption of raw materials. That is why PSS offers a refill service for columns within the European Community. This not only protects the environment, but also reduces your costs! After receiving and installing a new column, you send your old column back and we will then refill it.

Another approach is the further development of organic solvents that are less harmful to health and the environment, as the ones commonly used in GPC/SEC. The best-known examples include THF, chloroform and toluene. PSS has successfully implemented the use of DMAc instead of DMF. PSS is also testing the replacement of THF with possible candidates such as n-heptane, ethyl acetate or methylated THF. The use of micro columns also contributes to a more environmentally friendly analysis, since less solvent is consumed overall, which equals fewer costs in the ongoing process.

3.1| Columns for Organic Solvents

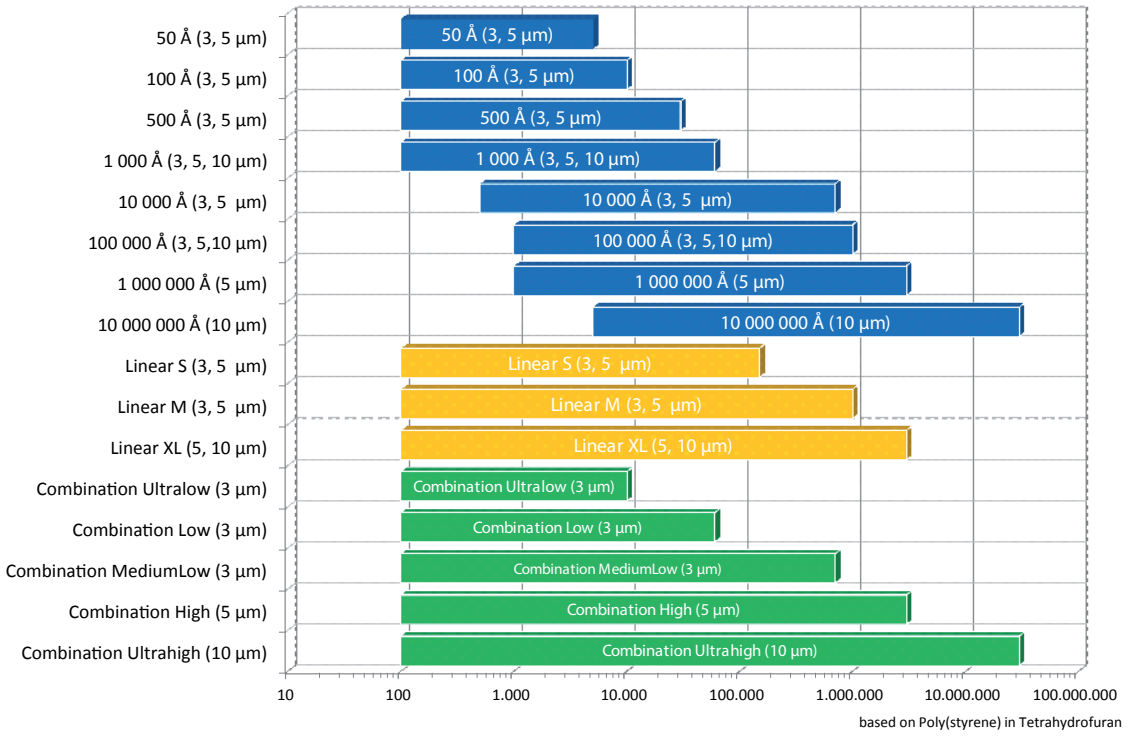
GPC/SEC of Polymers in Nonpolar and Medium Polar Organic Solvents - SDV Columns

▲ Click here

Field of Application	
Applicability	Poly(styrene), Poly(vinyl chloride), Poly(carbonate), Elastomers, Resins and other
Eluents	THF, Toluene, TCM, DCM

Specifications	
Material	Styrene-divinylbenzene-copolymer network
Maximum Pressure	45 - 150 bar (650 – 2180 psi), depending on porosity
Maximum Temperature	100° C
Maximum Flow Rate	3 ml/min (8 mm I.D.; 10 µm)
Particle Size	3 µm, 5 µm, 10 µm
Molecular Weight Range	100 to 30 000 000 Da
Delivered and tested in	THF

Separation Ranges



Part Numbers

a) Preconfigured Analytical Column Sets

Separation range [Da]	Column Set	Description	Part Number
100 - 10 000	PSS SDV combination ultralow	1 x SDV precolumn 3 µm 8x50 mm (P/N sda080503) 3 x SDV column 3 µm 100Å 8x300 mm (P/N sda0830031e2)	201-0004
100 - 60 000	PSS SDV combination low	1 x SDV precolumn 3 µm 8x50 mm (P/N sda080503) 3 x SDV column 3 µm 1000Å 8x300 mm (P/N sda0830031e3)	201-0001
100 - 700 000	PSS SDV combination mediumlow	1 x SDV precolumn 3 µm 8x50 mm (P/N sda080503) 2 x SDV column 3 µm 1000Å 8x300 mm (P/N sda0830031e3) 1 x SDV column 3 µm 10e4Å 8x300 mm (P/N sda0830031e4)	201-0005
100 - 3 000 000	PSS SDV combination high	1 x SDV precolumn 5 µm 8x50 mm (P/N sda080505) 1 x SDV column 5 µm 1000Å 8x300 mm (P/N sda0830051e3) 1 x SDV column 5 µm 10e^{5}Å 8x300 mm (P/N sda0830051e5) 1 x SDV column 5 µm 10e^{6}Å 8x300 mm (P/N sda0830051e6)	201-0003
100 - 30 000 000	PSS SDV combination ultrahigh	1 x SDV precolumn 10 µm 8x50 mm (P/N sda080510) 1 x SDV column 10 µm 1000Å 8x300 mm (P/N sda0830101e3) 1 x SDV column 10 µm 10e^{5}Å 8x300 mm (P/N sda0830101e5) 1 x SDV column 10 µm 10e^{7}Å 8x300 mm (P/N sda0830101e7)	202-0001

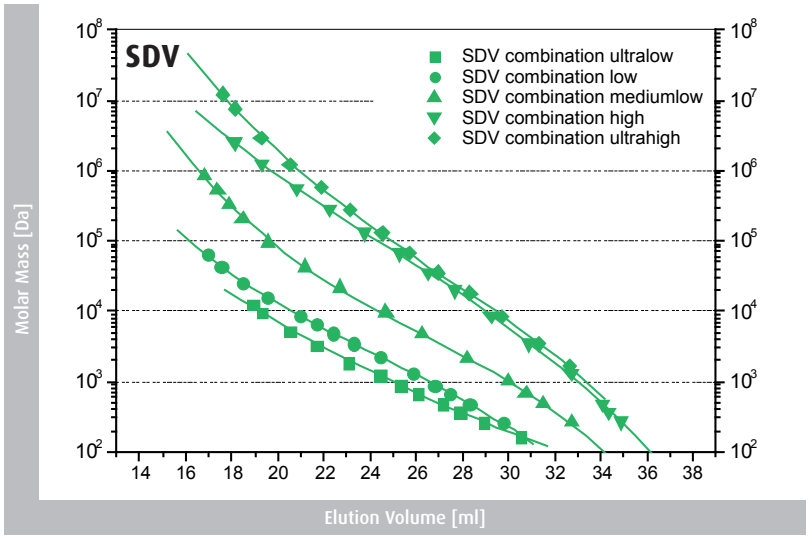
b) Individual Columns

Separation range [Da]	Particle Size [µm]	Porosity [Å]	Analytical Column Dimension: 8*300 mm, pre-column 8*50 mm	Preparative Column Dimension: 20*300 mm, pre-column 20*50 mm	HighSpeed Column Dimension: 20*50 mm	Micro Column Dimension: 4.6*250 mm, pre-column 4.6*30 mm
	3	Precolumn	sda080503			sdm050303
100 - 5 000 Da	3	50	sda0830035e1			sdm0525035e1
100 - 10 000 Da	3	100	sda0830031e2			sdm0525031e2
100 - 30 000 Da	3	500	sda0830035e2			sdm0525035e2
100 - 60 000 Da	3	1 000	sda0830031e3			sdm0525031e3
500 – 700 000 Da	3	10 000	sda0830031e4			sdm0525031e4
1 000 – 1 000 000 Da	3	100 000	sda0830031e5			sdm0525031e5
100 - 150 000 Da	3	Linear S	sda083003lis			sdm052503lis
100 – 1 000 000 Da	3	Linear M	sda083003lim			sdm052503lim
	5	Precolumn	sda080505	sdp2005		
100 – 5 000 Da	5	50	sda0830055e1	sdp20305e1		
100 – 10 000 Da	5	100	sda0830051e2	sdp20301e2		
100 – 30 000 Da	5	500	sda0830055e2	sdp20305e2		
100 – 60 000 Da	5	1 000	sda0830051e3	sdp20301e3		
500 – 700 000 Da	5	10 000	sda0830051e4	sdp20301e4		
1 000 – 1 000 000 Da	5	100 000	sda0830051e5	sdp20301e5	sds2005051e5	
1 000 – 3 000 000 Da	5	1 000 000	sda0830051e6	sdp20301e6		
100 – 150 000 Da	5	Linear S	sda083005lis	sdp2030lis		
100 – 1 000 000 Da	5	Linear M	sda083005lim		sds200505lim	
100 – 3 000 000 Da	5	Linear XL	sda083005lxl		sds200505lxl	
	10	Precolumn	sda080510			
100 – 10 000 Da	10	100	sda0830101e2			
100 – 60 000 Da	10	1 000	sda0830101e3			
1 000 – 1 000 000 Da	10	100 000	sda0830101e5			
5 000 – 30 000 000 Da	10	10 000 000	sda0830101e7			
100 – 3 000 000 Da	10	Linear XL	sda083010lxl			

Calibration Curves

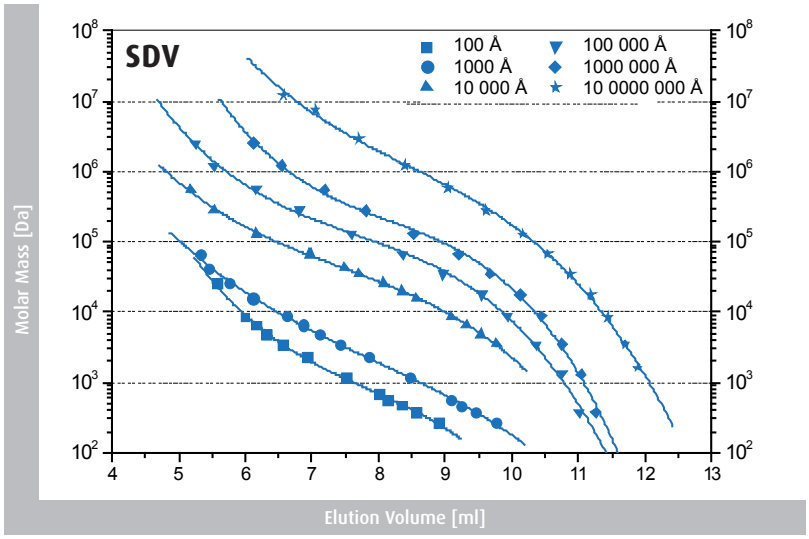
Column Combinations

Eluent: THF
Calibrants: Poly(styrene)



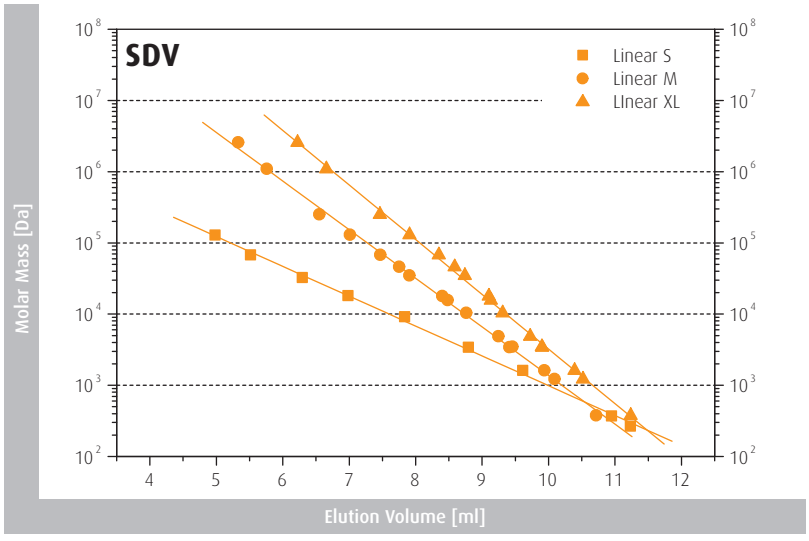
Single Porosity Columns

Eluent: THF
Calibrants: Poly(styrene)



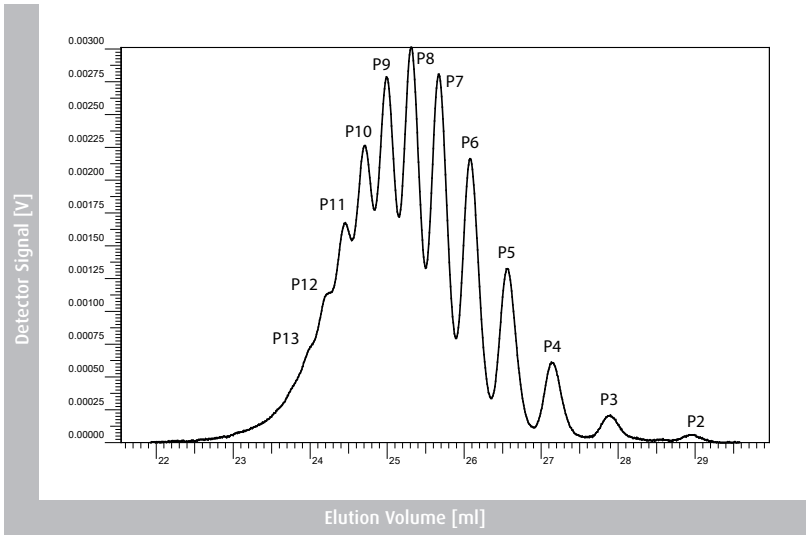
Linear Columns

Eluent: THF
Calibrants: Poly(styrene)



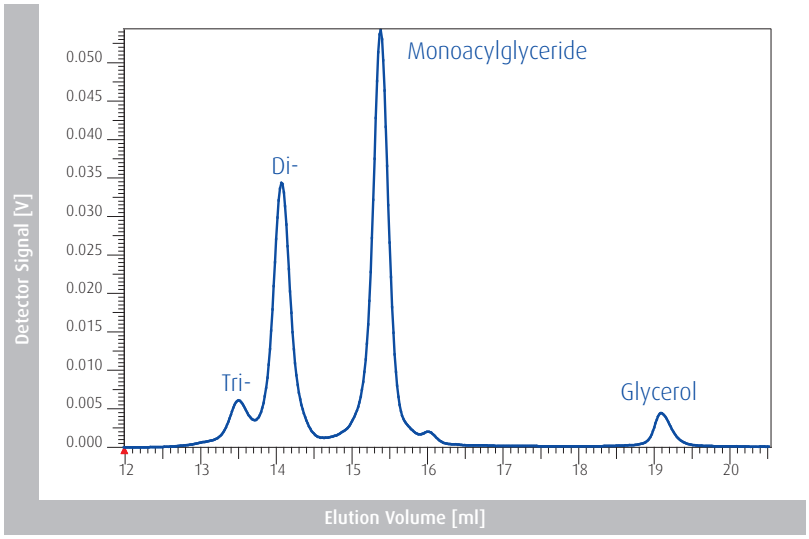
Oligomeric Poly(styrene)

Flow rate: 0.5 ml/min
Loading: 1 g/l, 20 µl
Eluent: THF
Temperature: 25° C
Detector: SECcurity RI
Columns: PSS SDV Combination ultralow
(P/N 201-0004)



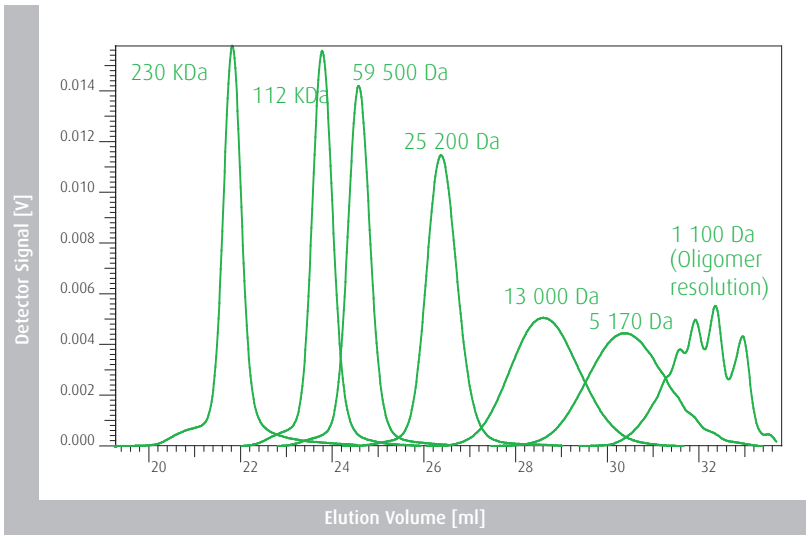
Glyceride acc. EUP

Flow rate: 1 ml/min
Loading: 40 g/l, 40 µl
Eluent: THF
Temperature: 25° C
Detector: SECcurity RI
Columns: PSS SDV 5 µm,
100 Å (8 x 600 mm)
(P/N sda0860051e2, on request)



Poly(dimethyl siloxane)

Flow rate: 1 ml/min
Loading: 2 g/l, 20 µl
Eluent: Toluene
Temperature: 25° C
Detector: SECcurity RI
Columns: PSS SDV Combination high
(P/N 201-0003)



GPC/SEC of Polymers in Polar Organic Solvents: GRAM Columns (Polymer Based)

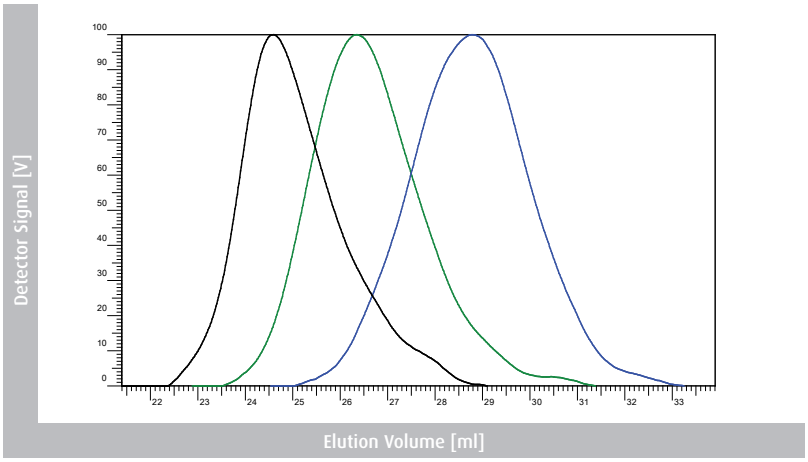
▲ Click here

Field of Application	
Applicability	Polyurethane, Polyimide, Starches, Cellulose, other polar polymers
Eluents	DMF, DMAc, NMP, DMSO

Specifications	
Material	Polyester copolymer network
Maximum Pressure	50 - 120 bar (725 – 1740 psi), depending on porosity
Maximum Temperature	90° C
Maximum Flow Rate	2 ml/min (8 mm I.D.)
Particle Size	10 µm
Molecular Weight Range	100 to 50 000 000 Da
Delivered and tested in	DMAc

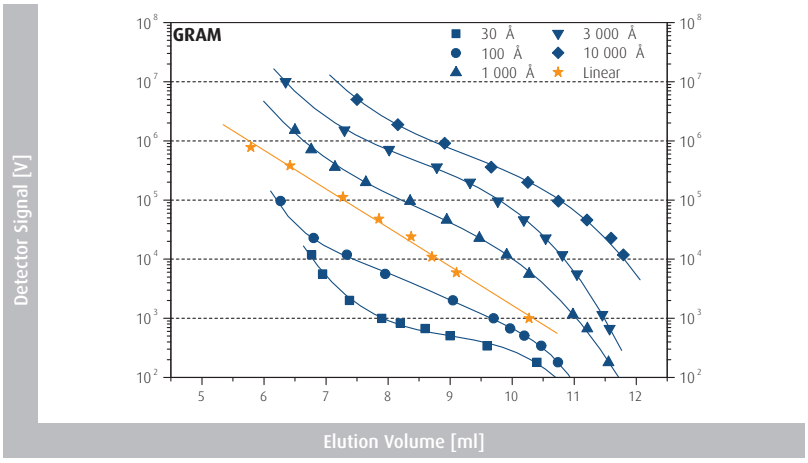
PolyNIPAM

Flow rate: 1.0 ml/min
Loading: 1.0 g/l, 100 µl
Eluent: DMAc, LiBr 5 g/l
Temperature: 60° C
Detector: SECcurity RI1260
Columns: PSS GRAM Combination high (P/N 208-0003)

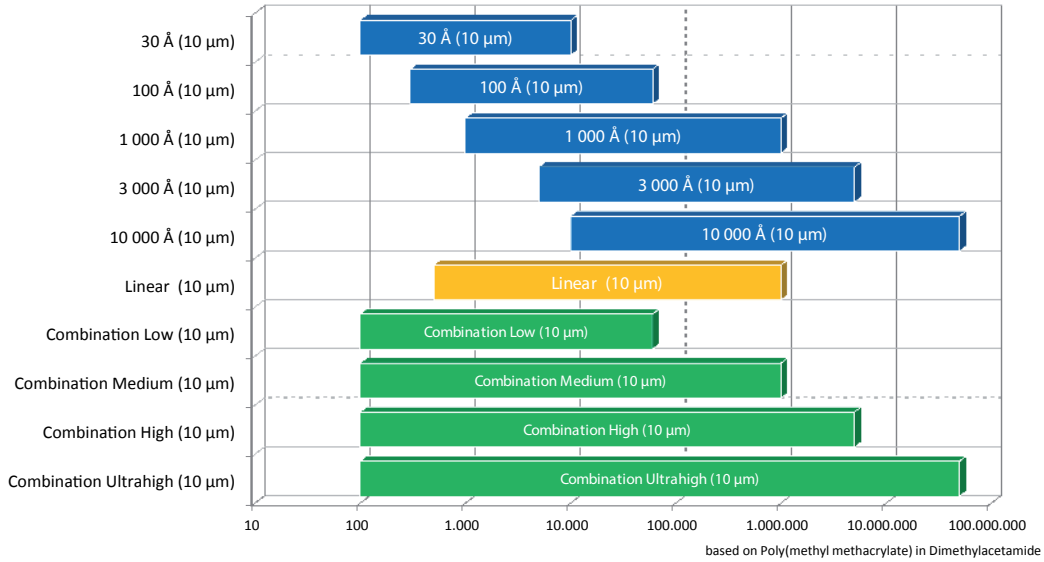


Calibration Curves

Eluent: DMAc
Calibrants: Poly(methyl methacrylate)



Separation Ranges



Part Numbers

a) Preconfigured Analytical Column Sets

Separation range [Da]	Column Set	Description	Part Number
100 - 60 000	PSS GRAM combination low	1 x GRAM precolumn 10µm 8x50mm (P/N ama080510) 3 x GRAM column 10µm 100Å 8x300mm (P/N ama0830101e2)	208-0001
100 - 1 000 000	PSS GRAM combination medium	1 x GRAM precolumn 10µm 8x50mm (P/N ama080510) 1 x GRAM column 10µm 30Å 8x300mm (P/N ama0830103e1) 2 x GRAM column 10µm 1000Å 8x300mm (P/N ama0830101e3)	208-0002
100 - 5 000 000	PSS GRAM combination high	1 x GRAM precolumn 10µm 8x50mm (P/N ama080510) 1 x GRAM column 10µm 100Å 8x300mm (P/N ama0830101e2) 2 x GRAM column 10µm 3000Å 8x300mm (P/N ama0830103e3)	208-0003
100 - 50 000 000	PSS GRAM combination ultrahigh	1 x GRAM precolumn 10µm 8x50mm (P/N ama080510) 1 x GRAM column 10µm 100Å 8x300mm (P/N ama0830101e2) 2 x GRAM column 10µm 10000Å 8x300mm (P/N ama0830101e4)	208-0004

b) Individual Columns

Separation range [Da]	Particle Size [µm]	Porosity [Å]	Analytical Column Dimension: 8*300 mm, precolumn 8*50 mm	Preparative Column Dimension: 20*300 mm, precolumn 20*50 mm	HighSpeed Column Dimension: 20*50 mm
	10	Precolumn	ama080510	amp2005	
100 – 10 000 Da	10	30	ama0830103e1		
300 – 60 000 Da	10	100	ama0830101e2	amp20301e2	
1 000 – 1 000 000 Da	10	1 000	ama0830101e3	amp20301e3	ams2005101e3
5 000 – 5 000 000 Da	10	3 000	ama0830103e3		
10 000 – 50 000 000 Da	10	10 000	ama0830101e4	amp20301e4	
500 – 1 000 000 Da	10	linear	ama083010lin	amp2030lin	ams203010lin

GPC/SEC of Polymers in Polar Organic Solvents: PolarSil Columns (Silica Based)

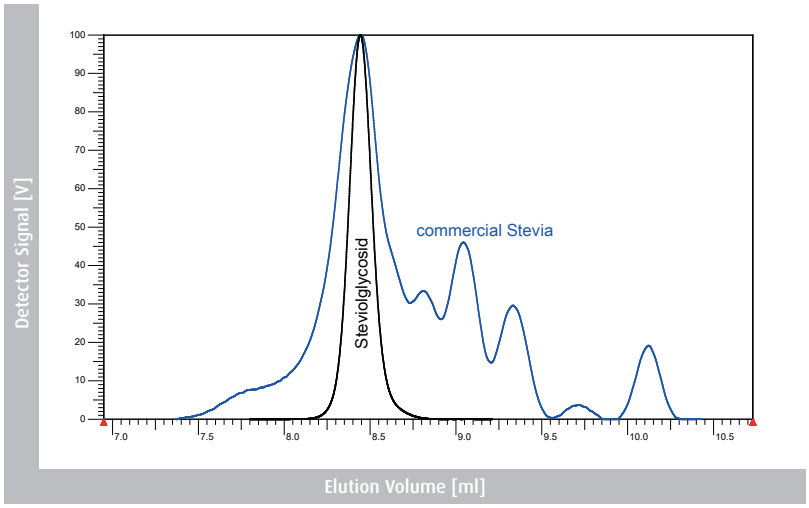
▲ Click here

Field of Application	
Applicability	Low to medium molar mass resins and lignins
Eluents	DMF, DMAc, NMP, DMSO

Specifications	
Material	Polar modified silica
Maximum Pressure	150 - 200 bar (2180 –2900 psi), depending on porosity
Maximum Temperature	90° C
Maximum Flow Rate	3 ml/min (8 mm I.D.)
Particle Size	3 µm, 5 µm
Molecular Weight Range	100 to 1 000 000 Da
Delivered and tested in	DMAc

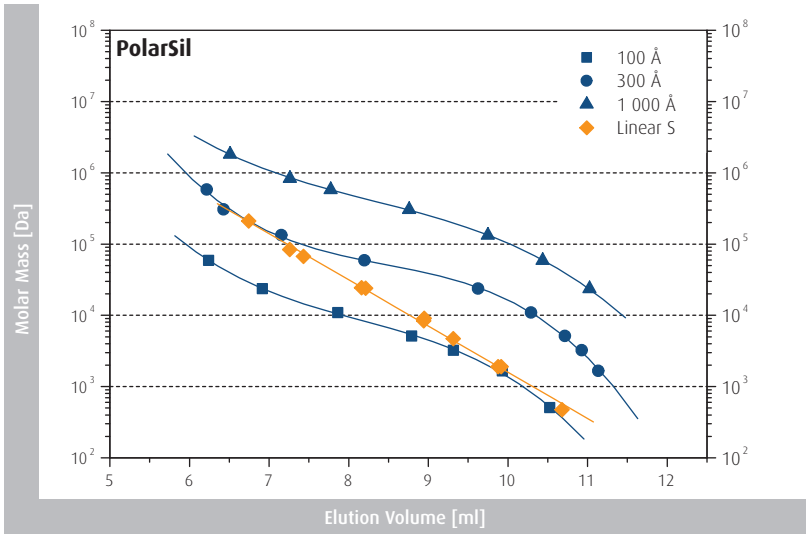
Stevia

Flow rate: 1.00 ml/min
Loading: 1.0 g/l, 50 µl
Eluent: DMAc, LiBr 5 g/l
Temperature: 60° C
Detector: SECcurity RI1260
Columns: PSS PolarSil 5 µm 1 x 100 Å + precolumn (P/N psa080505 and 1 x psa0830051e2)

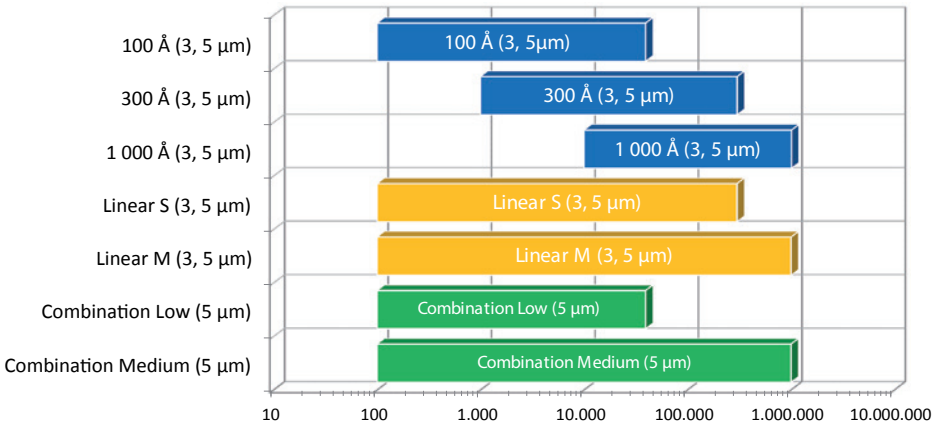


Calibration Curves

Eluent: DMAc
Calibrants: Poly(methyl methacrylate)



Separation Ranges



Part Numbers

a) Preconfigured Analytical Column Sets

Separation range [Da]	Column Set	Description	Part Number
100 - 40 000	PSS PolarSil combination low	1 x PolarSil precolumn 5 µm 8x50 mm (P/N psa080505) 3 x PolarSil column 5 µm 100Å 8x300 mm (P/N psa0830051e2)	214-0001
100 - 1 000 000	PSS PolarSil combination medium	1 x PolarSil precolumn 5 µm 8x50 mm (P/N psa080505) 3 x PolarSil column 5 µm linear M 8x300 mm (P/N psa083005lim)	214-0002

b) Individual Columns

Separation range [Da]	Particle Size [µm]	Porosity [Å]	Analytical Column Dimension: 8*300 mm, precolumn 8*50 mm	Micro Column Dimension: 4.6*250 mm, precolumn 4.6*30 mm
	5	Precolumn	psa080505	
100 – 40 000 Da	5	100	psa0830051e2	
1 000 – 300 000 Da	5	300	psa0830053e2	
10 000 – 1 000 000 Da	5	1000	psa0830051e3	
100 – 300 000 Da	5	linear S	psa083005lis	
100 – 1 000 000 Da	5	linear M	psa083005lim	
	3	Precolumn		psm050303
100 – 40 000 Da	3	100		psm0525031e2
1 000 – 300 000 Da	3	300		psm0525033e2
10 000 – 1 000 000 Da	3	1000		psm0525031e3

GPC/SEC of Crystalline Polymers in Fluorinated Organic Solvents - PFG Columns

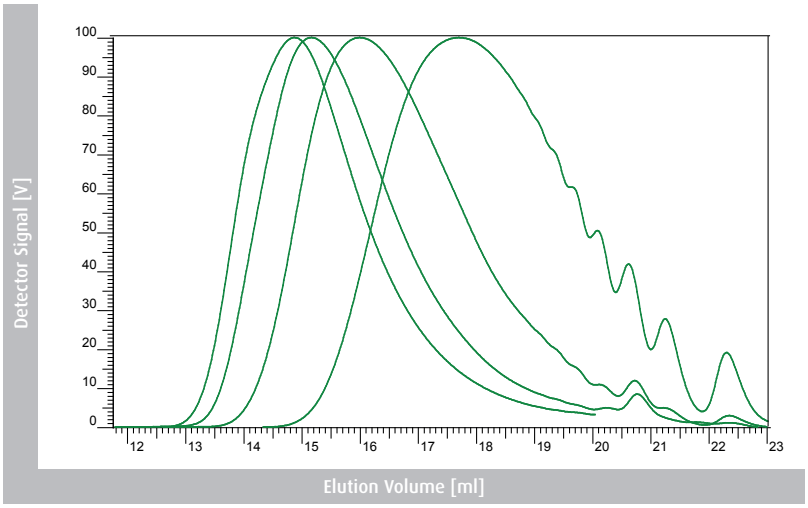
▲ Click here

Field of Application	
Applicability	Crystalline polymers, Polyesters, Polyamids, Poly(lactides), POM, etc.
Eluents	HFIP, TFE, other fluorinated solvents

Specifications	
Material	Polar modified silica
Maximum Pressure	150 - 200 bar (2180 –2900 psi), depending on porosity
Maximum Temperature	90° C
Maximum Flow Rate	3 ml/min (8 mm I.D.)
Particle Size	5 µm, 7 µm
Molecular Weight Range	100 to 3 000 000 Da
Delivered and tested in	THF

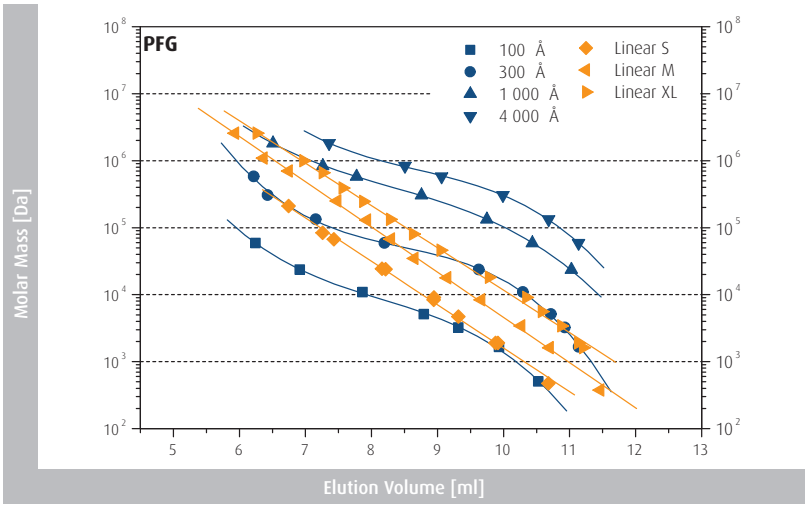
Poly(ethylene terephthalate)

Flow rate: 1.00 ml/min
Loading: 1.5 g/l, 100 µl
Eluent: HFIP, K-TFAc 0.1 M
Temperature: 25° C
Detector: SECcurity RI;
Columns: PFG 7 µm 100 Å, 1 000 Å (8 x 300 mm) + precolumn (P/N pfa0080507, pfa0830071e2, pfa0830071e3)

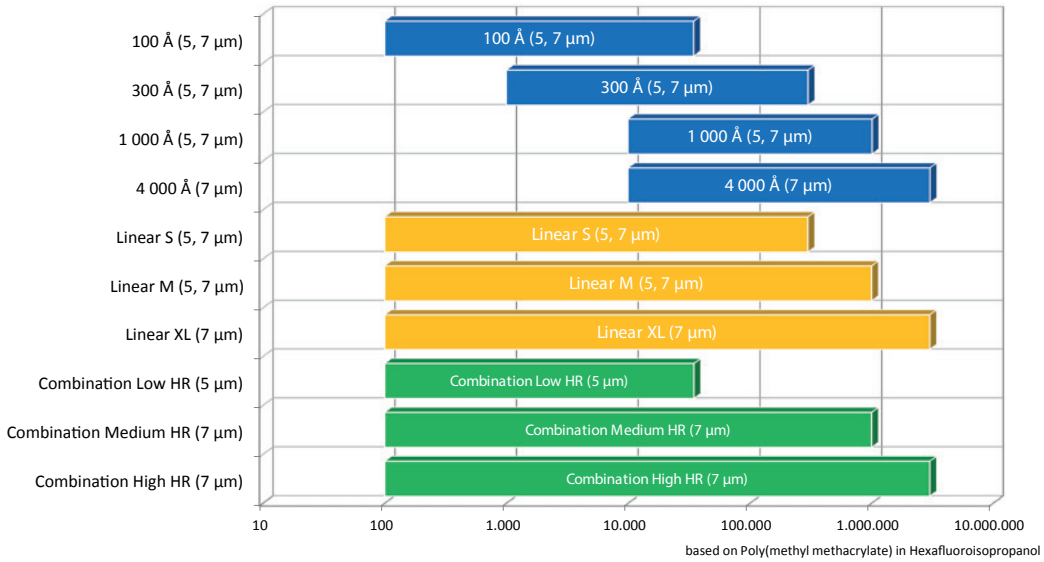


Calibration Curves

Eluent: HFIP
Calibrants: Poly(methyl methacrylate)



Separation Ranges



Part Numbers

a) Preconfigured Analytical Column Sets

Separation range [Da]	Column Set	Description	Part Number
100 - 30 000	PSS PFG combination low HR	1 x PFG precolumn 5 µm 8x50 mm (P/N pfa080505) 3 x PFG columns 5 µm 100Å 8x300 mm (P/N pfa0830051e2)	203-0011
100 - 1 000 000	PSS PFG combination medium HR	1 x PFG precolumn 7 µm 8x50 mm (P/N pfa080507) 3 x PFG columns 7 µm linear M 8x300 mm (P/N pfa083007lim)	203-0012
100 - 3 000 000	PSS PFG combination high HR	1 x PFG precolumn 7 µm 8x50 mm (P/N pfa080507) 3 x PFG columns 7 µm linear XL 8x300 mm (P/N pfa083007lxl)	203-0013

b) Individual Columns

Separation range [Da]	Particle Size [µm]	Porosity [Å]	Analytical Column Dimension: 8*300 mm, pre-column 8*50 mm	Preparative Column Dimension: 20*300 mm, pre-column 20*50 mm	HighSpeed Column Dimension: 20*50 mm	Micro Column Dimension: 4.6*250 mm, pre-column 4.6*30 mm
	5	Precolumn	pfa080505			pfm050305
100 – 30 000 Da	5	100	pfa0830051e2			pfm0525051e2
1 000 – 300 000 Da	5	300	pfa0830053e2			pfm0525053e2
10 000 – 1 000 000 Da	5	1 000	pfa0830051e3			pfm0525051e3
100 – 300 000 Da	5	linear S	pfa083005lis			pfm052505lis
100 – 1 000 000 Da	5	linear M	pfa083005lim			pfm052505lim
	7	Precolumn	pfa080507	pfp2005		
100 – 30 000 Da	7	100	pfa0830071e2	pfp20301e2		
1 000 – 300 000 Da	7	300	pfa0830073e2			
10 000 – 1 000 000 Da	7	1 000	pfa0830071e3	pfp20301e3	pfs2005071e3	
10 000 – 3 000 000 Da	7	4 000	pfa0830074e3	pfp20304e3		
100 – 300 000 Da	7	linear S	pfa083007lis	pfp2030lis		
100 – 1 000 000 Da	7	linear M	pfa083007lim	pfp2030lim	pfs200507lim	
100 – 3 000 000 Da	7	linear XL	pfa083007lxl	pfp2030lxl	pfs200507lxl	

High Temperature GPC/SEC of Polyolefins - POLEFIN Columns

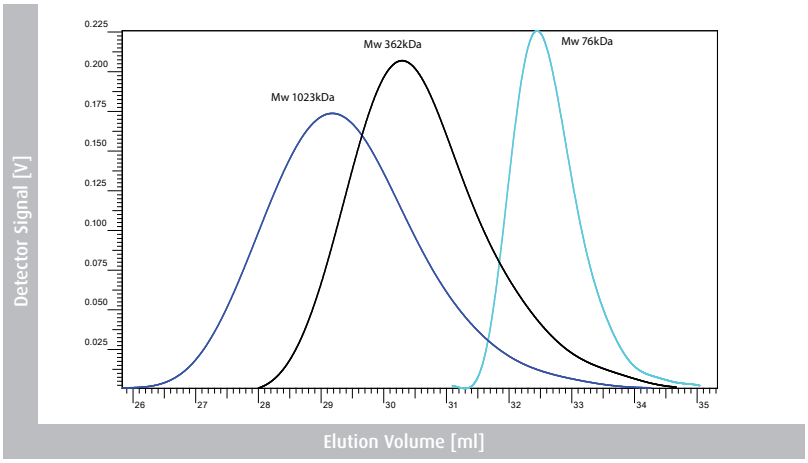
▲ Click here

Field of Application	
Applicability	Poly(ethylene), Poly(propylene), other polyolefins
Eluents	TCB, o-DCB, Decalin

Specifications	
Material	Modified styrene-divinylbenzene copolymer network
Maximum Pressure	100 - 150 bar (1450 –2180 psi), depending on porosity
Maximum Temperature	200° C
Maximum Flow Rate	2 ml/min (8 mm I.D.)
Particle Size	10 µm, 20 µm
Molecular Weight Range	100 to 30 000 000 Da
Delivered with silver-titanium frits and tested in	Xylene

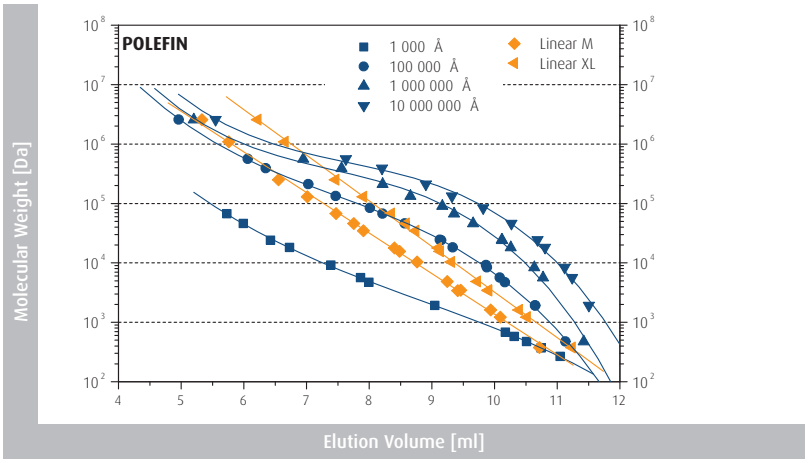
Polyethylene broad distribution

Flow rate: 0.50 ml/min
Loading: 3.0 g/l, 200 µl
Eluent: TCB
Temperature: 170° C
Detector: GPC-IR4-CH_2
Columns: PSS POLEFIN 4 x Linear XL 20µm (P/N poa080520 and 4 x poa083020lxl)

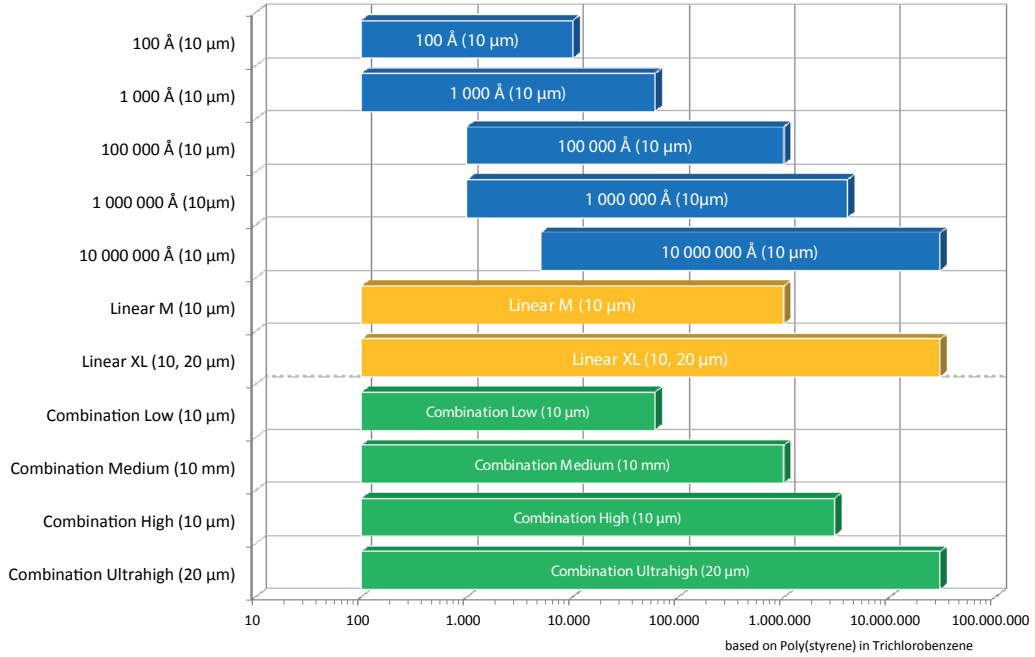


Calibration Curves

Eluent: TCB
Calibrants: Poly(styrene)



Separation Ranges



Part Numbers

a) Preconfigured Analytical Column Sets

Separation range [Da]	Column Set	Description	Part Number
100 - 60 000	PSS POLEFIN combination low	1 x POLEFIN precolumn 10 µm 8x50 mm (P/N poa080510) 3 x POLEFIN column 10 µm 1000Å 8x300 mm (P/N poa0830101e3)	210-0001
100 - 1 000 000	PSS POLEFIN combination medium	1 x POLEFIN precolumn 10 µm 8x50 mm (P/N poa080510) 1 x POLEFIN column 10 µm 1000Å 8x300 mm (P/N poa0830101e3) 1 x POLEFIN column 10 µm $10e^5$Å 8x300 mm (P/N sda0830101e5)	210-0002
100 - 3 000 000	PSS POLEFIN combination high	1 x POLEFIN precolumn 10 µm 8x50 mm (P/N poa080510) 1 x POLEFIN column 10 µm 1000Å 8x300 mm (P/N poa0830101e3) 1 x POLEFIN column 10 µm $10e^5$Å 8x300 mm (P/N poa0830101e5) 1 x POLEFIN column 10 µm $10e^6$Å 8x300 mm (P/N poa0830101e6)	210-0003
100 - 30 000 000	PSS POLEFIN combination ultrahigh	1 x POLEFIN precolumn 20 µm 8x50 mm (P/N poa051020) 3 x POLEFIN column 20 µm linear XL 8x300 mm (P/N poa083020lxl)	210-0004

b) Individual Columns

Separation range [Da]	Particle Size [µm]	Porosity [Å]	Analytical Column Dimension: 8*300 mm, precolumn 8*50 mm	HighSpeed Column Dimension: 20*50 mm
	10	Precolumn	poa080510	
100 – 10 000 Da	10	100	poa0830101e2	
100 – 60 000 Da	10	1 000	poa0830101e3	pos2030101e3
1 000 – 1 000 000 Da	10	100 000	poa0830101e5	
1 000 – 4 000 000 Da	10	1 000 000	poa0830101e6	
5 000 – 30 000 000 Da	10	10 000 000	poa0830101e7	
100 – 1 000 000 Da	10	linear M	poa083010lim	pos203010lim
1 000 – 30 000 000 Da	10	linear XL	poa083010lxl	pos203010lxl
	20	Precolumn	poa080520	
1 000 – 30 000 000 Da	20	linear XL	poa083020lxl	

3.2| Columns for Aqueous Solvents

3.2.1 Columns for Aqueous Polymers

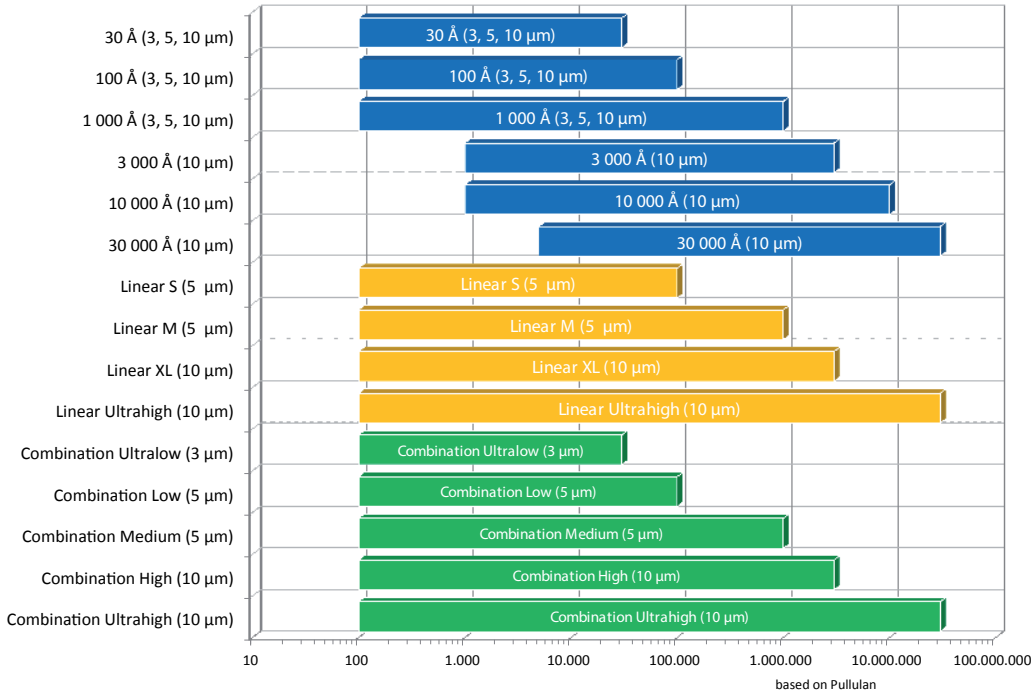
Aqueous GPC/SEC of Neutral and Anionic Polymers - SUPREMA Columns

▲ Click here

Field of Application	
Applicability	Neutral and anionic polymers (PEO, PEG, Pullulan, Dextran, Poly(acrylamide), Hyaluronic acid, Poly(acrylic acid), Carboxymethyl cellulose, etc.)
Eluents	water (with salts/buffers, MeOH, ACN) pH: 2 – 12

Specifications	
Material	Modified acrylate copolymer network
Maximum Pressure	50 - 80 bar (725 - 1160 psi), depending on porosity
Maximum Temperature	80° C
Maximum Flow Rate	2 ml/min (8 mm I.D.)
Particle Size	5 µm, 10 µm
Molecular Weight Range	100 to > 30 000 000 Da

Separation Ranges



Part Numbers

a) Preconfigured Analytical Column Sets

Separation range [Da]	Column Set	Description	Part Number
100 - 30 000	PSS SUPREMA combination ultralow	1 x SUPREMA precolumn 3 µm 8x50 mm (P/N sua080503) 3 x SUPREMA column 3 µm 30Å 8x300 mm (P/N sua0830033e1)	206-0010
100 - 100 000	PSS SUPREMA combination low	1 x SUPREMA precolumn 5 µm 8x50 mm (P/N sua080505) 3 x SUPREMA column 5 µm 100Å 8x300 mm (P/N sua0830051e2)	206-0001
100 - 1 000 000	PSS SUPREMA combination medium	1 x SUPREMA precolumn 5 µm 8x50 mm (P/N sua080505) 1 x SUPREMA column 5 µm 30Å 8x300 mm (P/N sua0830053e1) 2 x SUPREMA column 5 µm 1000Å 8x300 mm (P/N sua0830051e3)	206-0002
100 - 3 000 000	PSS SUPREMA combination high	1 x SUPREMA precolumn 10 µm 8x50 mm (P/N sua080510) 1 x SUPREMA column 10 µm 100Å 8x300 mm (P/N sua0830101e2) 2 x SUPREMA column 10 µm 3000Å 8x300 mm (P/N sua0830103e3)	206-0003
100 - 30 000 000	PSS SUPREMA combination ultrahigh	1 x SUPREMA precolumn 10 µm 8x50 mm (P/N sua080510) 3 x SUPREMA column 10 µm ultrahigh 8x300 mm (P/N sua083010luh)	206-0004

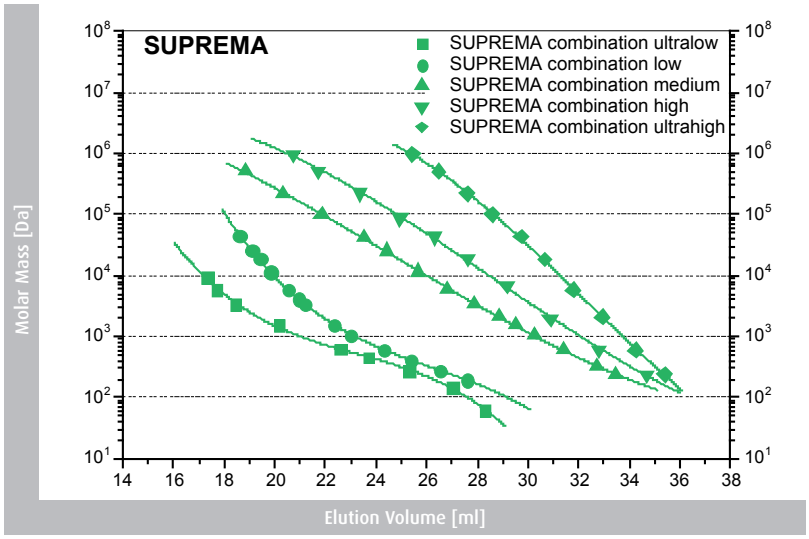
b) Individual Columns

Separation range [Da]	Particle Size [µm]	Porosity [Å]	Analytical Column Dimension: 8*300 mm, pre-column 8*50 mm	Preparative Column Dimension: 20*300 mm, pre-column 20*50 mm	HighSpeed Column Dimension: 20*50 mm	Micro Column Dimension: 4.6*250 mm, pre-column 4.6*30 mm
	3	Precolumn	sua080503			sum050303
100 – 30 000 Da	3	30	sua0830033e1			sum0525033e1
100 – 100 000 Da	3	100	sua0830031e2			sum0525031e2
100 – 1 000 000 Da	3	1 000	sua0830031e3			sum0525031e3
	5	Precolumn	sua080505			sum050305
100 – 30 000 Da	5	30	sua0830053e1			sum0525053e1
100 – 100 000 Da	5	100	sua0830051e2			sum0525051e2
100 – 1 000 000 Da	5	1 000	sua0830051e3		sus2005051e3	sum0525051e3
100 – 100 000 Da	5	linear S	sua083005lis		sus200505lis	sum052505lis
1 000 – 1 000 000 Da	5	linear M	sua083005lim			
	10	Precolumn	sua080510	sup2005		
100 – 30 000 Da	10	30	sua0830103e1	sup20303e1		
100 – 100 000 Da	10	100	sua0830101e2	sup20301e2		
100 – 1 000 000 Da	10	1 000	sua0830101e3	sup20301e3		
1 000 – 3 000 000 Da	10	3 000	sua0830103e3	sup20303e3		
1 000 – 1 000 000 Da	10	linear M	sua083010lim	sup2030lim	sus200510lim	
5 000 – 3 000 000 Da	10	linear XL	sua083010lxl	sup2030lxl	sus200510lxl	
100 – 30 000 000 Da	10	ultrahigh	sua083010luh			

Calibration Curves

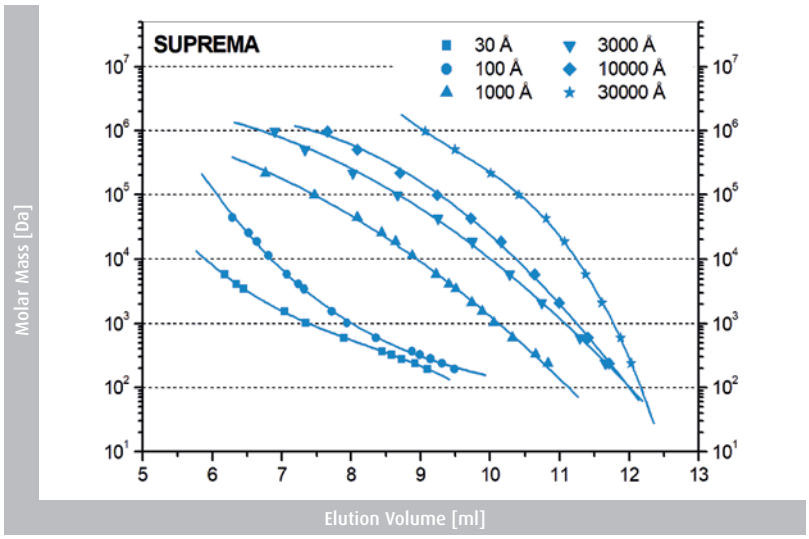
Column combinations

Eluent: aqueous buffer
Calibrants: PEG/PEO



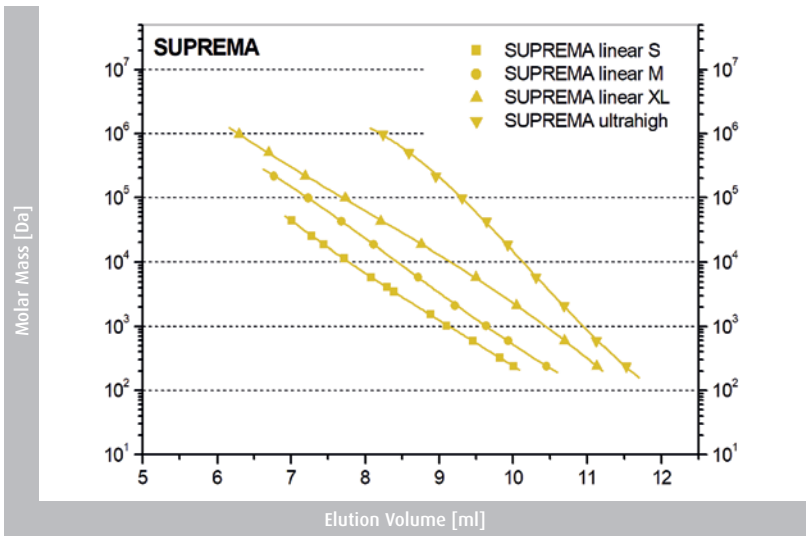
Single Porosity Columns

Eluent: aqueous buffer
Calibrants: PEG/PEO



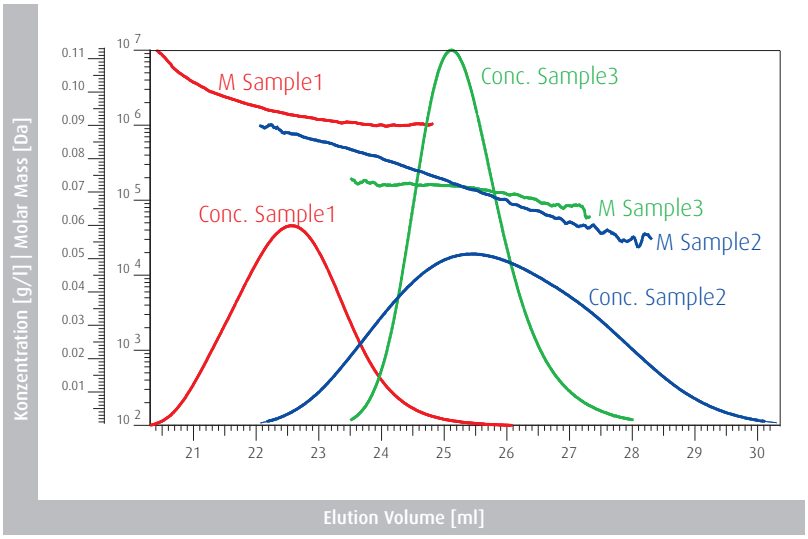
Mixed Bed/Linear Columns

Eluent: aqueous buffer
Calibrants: PEG/PEO



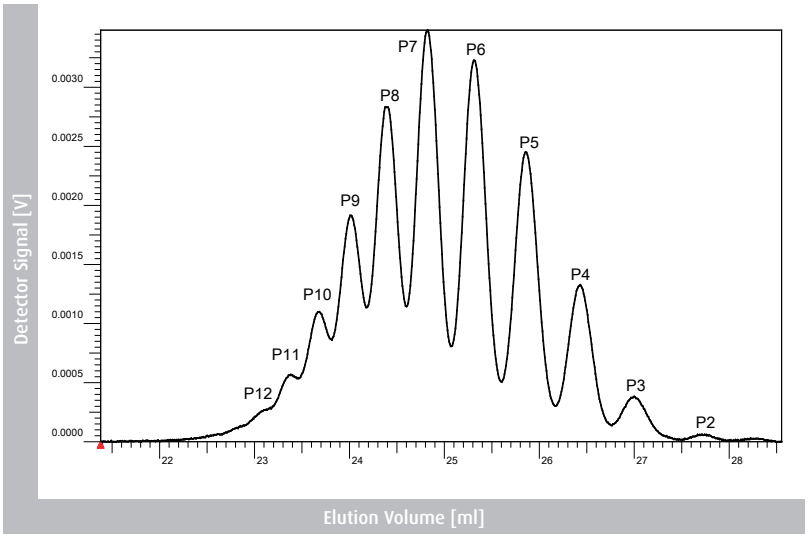
Hydroxyethyl starch GPC/SEC-MALLS acc. EUP

Flow rate: 1 ml/min
Loading: 3 g/l, 100 µl
Eluent: water, NaN_3 0.1 g/l
Temperature: 25° C
Detector: SECcurity RI, SLD7000 MALLS
Columns: PSS SUPREMA Combination high (Lux) (P/N 206-0003)



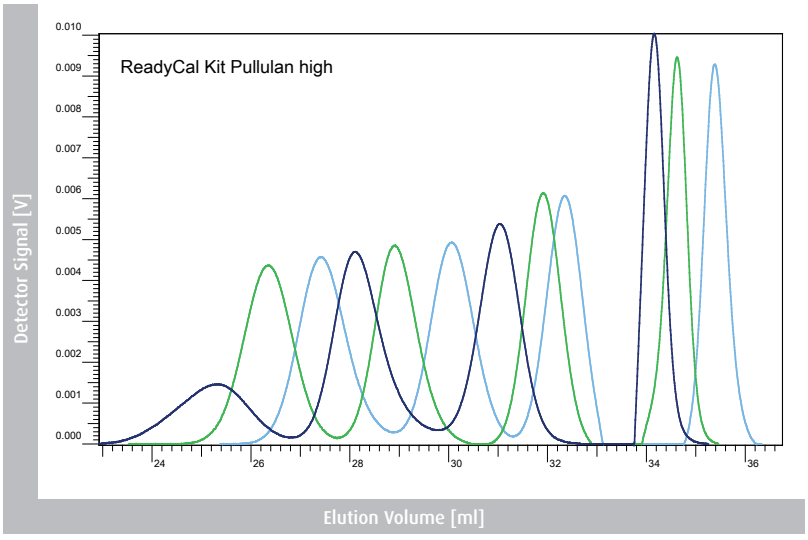
Poly(ethylene glycol) (PEG)

Flow rate: 0.5 ml/min
Loading: 1.0 g/l, 20 µl
Eluent: water, NaN_3 0.5 g/l
Temperature: 30° C
Detector: SECcurity RI1260
Columns: PSS SUPREMA Combination ultralow (P/N 206-0004)



Pullulan

Flow rate: 1 ml/min
Loading: 0.5 g/l, 20 µl
Eluent: water, NaN_3 0.2 g/l
Temperature: 30° C
Detector: SECcurity RI1260
Columns: PSS SUPREMA Combination ultrahigh (P/N 206-0004)



Aqueous GPC/SEC of Polycations - NOVEMA Max Columns

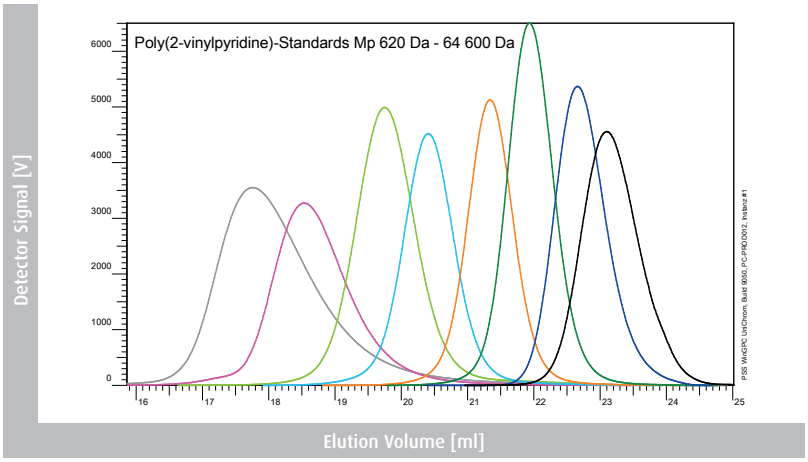
▲ Click here

Field of Application	
Applicability	Cationic polymers, (Polymeric Quarternary Ammonium Compounds, Poly (DADMAC), Poly(vinylpyridine), Chitosan, Poly(ethylene imine), etc.)
Eluents	Water, water with salt/buffer, MeOH, ACN, TFA; pH: 2 – 12

Specifications	
Material	NH-functionalized acrylate copolymer network
Maximum Pressure	50 - 80 bar (725 - 1160 psi), depending on porosity
Maximum Temperature	80° C
Maximum Flow Rate	2 ml/min (8 mm I.D.)
Particle Size	10 µm
Molecular Weight Range	100 to > 30 000 000 Da

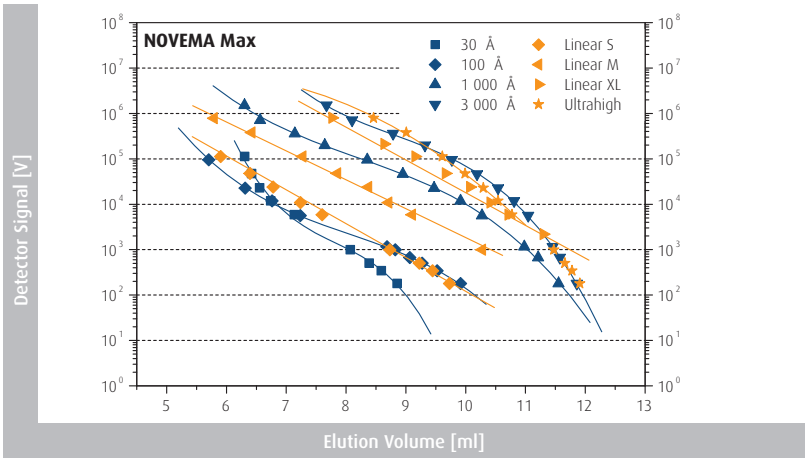
Poly(2-vinylpyridine)

Flow rate: 1.00 ml/min
Loading: 1.0 g/l, 20 µl
Eluent: water, NaCl 0.1 M + formic acid 0.3%
Temperature: 30° C
Detector: SECcurity RI1260
Columns: PSS NOVEMA Max Combination low HR (P/N 212-011)

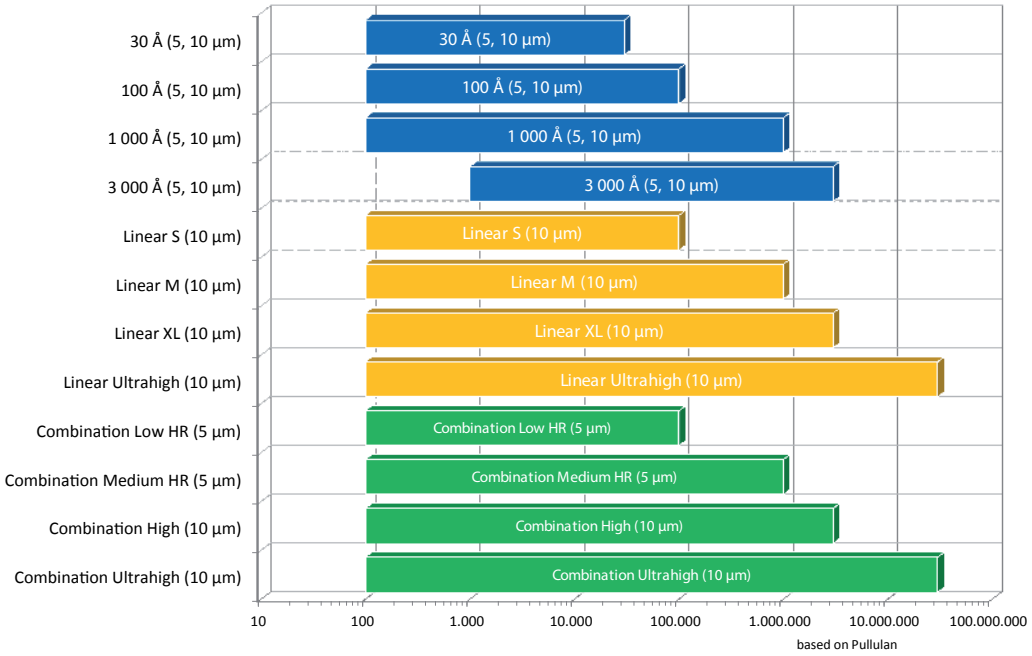


Calibration Curves

Eluent: aqueous buffer
Calibrants: Pullulan



Separation Ranges



Part Numbers

a) Preconfigured Analytical Column Sets

Separation range [Da]	Column Set	Description	Part Number
100 - 100 000	PSS NOVEMA Max combination low HR	1 x NOVEMA Max precolumn 5 µm 8x50mm (P/N nma080505) 3 x NOVEMA Max column 5 µm 100 Å 8x300 mm (P/N nma0830051e2)	212-0011
100 - 1 000 000	PSS NOVEMA Max combination medium HR	1 x NOVEMA Max precolumn 5 µm 8x50 mm (P/N nma080505) 1 x NOVEMA Max column 5 µm 30 Å 8x300 mm (P/N nma0830053e1) 2 x NOVEMA Max column 5 µm 1000 Å 8x300 mm (P/N nma0830051e3)	212-0012
100 - 3 000 000	PSS NOVEMA Max combination high	1 x NOVEMA Max precolumn 10 µm 8x50 mm (P/N nma080510) 1 x NOVEMA Max column 10 µm 100 Å 8x300 mm (P/N nma0830101e2) 2 x NOVEMA Max column 10 µm 3000 Å 8x300 mm (P/N nma0830103e3)	212-0003
100 - 30 000 000	PSS NOVEMA Max combination ultrahigh	1 x NOVEMA Max precolumn 10 µm 8x50 mm (P/N nma080510) 3 x NOVEMA Max column 10 µm ultrahigh 8x300 mm (P/N nma083010luh)	212-0004

b) Individual Columns

Separation range [Da]	Particle Size [µm]	Porosity [Å]	Analytical Column Dimension: 8*300 mm, precolumn 8*50 mm	Preparative Column Dimension: 20*300 mm, precolumn 20*50 mm	HighSpeed Column Dimension: 20*50 mm
	5	Precolumn	nma080505		
100 – 30 000 Da	5	30	nma0830053e1		
100 – 300 000 Da	5	100	nma0830051e2		
1 000 – 1 000 000 Da	5	1 000	nma0830051e3		
	10	Precolumn	nma080510	nmp2005	
100 – 300 000 Da	10	100	nma0830101e2	nmp20301e2	
1 000 – 1 000 000 Da	10	1 000	nma0830101e3	nmp20301e3	nms2005101e3
1 000 – 2 000 000 Da	10	3 000	nma0830103e3	nmp20303e3	
100 – 100 000 Da	10	linear S	nma083010lis	nmp2030lis	nms200510lis
1 000 – 1 000 000 Da	10	linear M	nma083010lim	nmp2030lim	nms200510lim
5 000 – 3 000 000 Da	10	linear XL	nma083010lxl	nmp2030lxl	nms200510lxl
100 – 30 000 000 Da	10	ultrahigh	nma083010luh		

Aqueous GPC/SEC of Sulfonated Polymers - MCX Columns

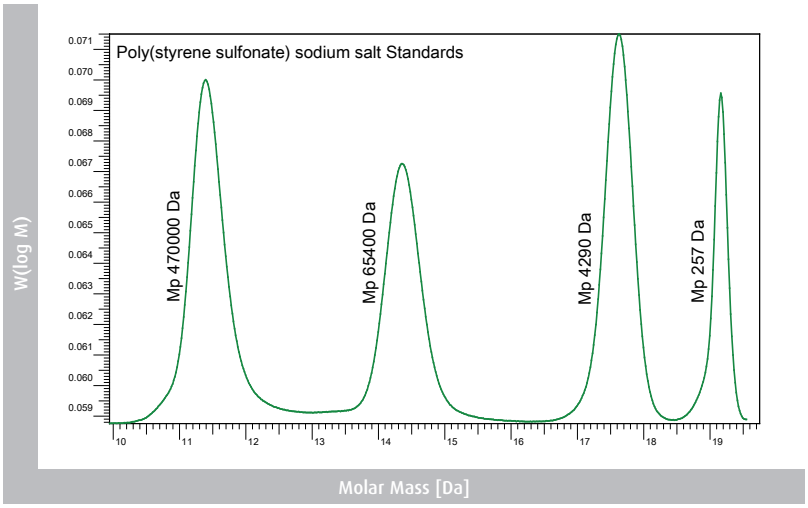
▲ Click here

Field of Application	
Applicability	Sulfonated Polyanions, Poly(styrene sulfonate), Lignin sulfonate, Modified Starches, Acids, Alcohols, pectins, etc.)
Eluents	Water, water with salt/buffer, MeOH, ACN; pH: 1 – 13

Specifications	
Material	Sulfonated styrene-divinylbenzene copolymer-network
Maximum Pressure	100 - 150 bar (1450 - 2180 psi), depending on porosity
Maximum Temperature	80° C
Maximum Flow Rate	2 ml/min (8 mm I.D.)
Particle Size	5 µm, 10 µm
Molecular Weight Range	100 to > 5 000 000 Da

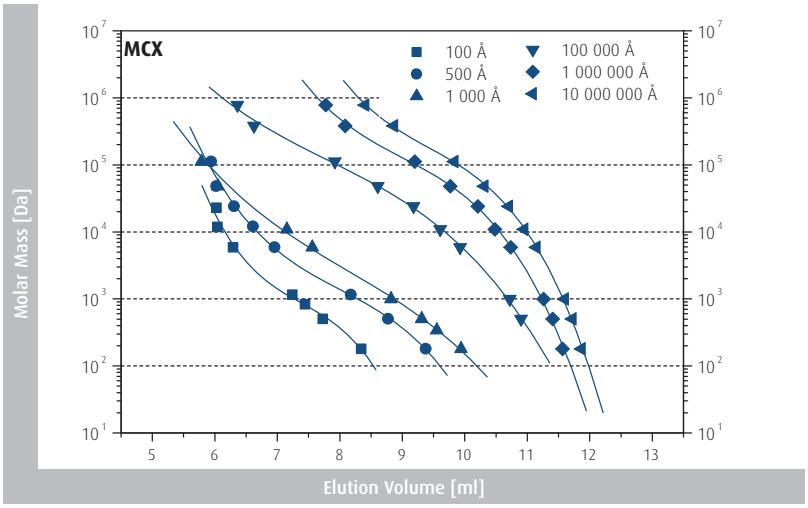
Poly(styrene sulfonate)

Flow rate: 1.00 ml/min
Loading: 4 g/l, 20 µl
Eluent: water, 0.067M Na_2HPO_4
Temperature: 25° C
Detector: SECcurity RI;
Columns: PSS MCX
Combination medium HR
(P/N 212-0012)

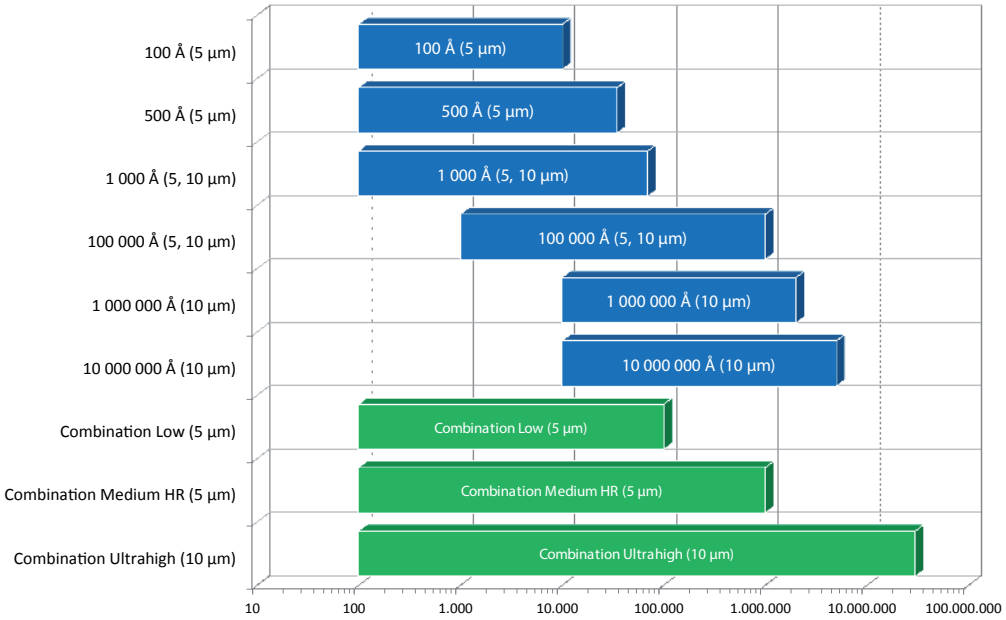


Calibration Curves

Eluent: aqueous buffer
Calibrants: Poly(styrene sulfonate) sodium salt



Separation Ranges



Part Numbers

a) Preconfigured Analytical Column Sets

Separation range [Da]	Column Set	Description	Part Number
100 - 100 000	PSS MCX combination low	1 x MCX precolumn 5µm 8x50mm (P/N mca080505) 3 x MCX column 5µm 1000Å 8x300mm (P/N mca0830051e3)	211-0001
100 - 1 000 000	PSS MCX combination medium HR	1 x MCX precolumn 5 µm 8x50 mm (P/N mca080505) 1 x MCX column 5 µm 1000Å 8x300 mm (P/N mca0830051e3) 1 x MCX column 5 µm 10e^{5}Å 8x300 mm (P/N mca0830051e5)	211-0012
100 - 5 000 000	PSS MCX combination ultrahigh	1 x MCX precolumn 10µm 8x50mm (P/N mca080510) 1 x MCX column 10µm 1000Å 8x300mm (P/N mca0830101e3) 1 x MCX column 10µm 10e^{5}Å 8x300mm (P/N mca0830101e5) 1 x MCX column 10µm 10e^{7}Å 8x300mm (P/N mca0830101e7)	211-0004

b) Individual Columns

Separation range [Da]	Particle Size [µm]	Porosity [Å]	Analytical Column Dimension: 8*300 mm, precolumn 8*50 mm	Preparative Column Dimension: 20*300 mm, precolumn 20*50 mm	HighSpeed Column Dimension: 20*50 mm
	5	Precolumn	mca080505		
100 – 10 000 Da	5	100	mca0830051e2		
100 – 35 000 Da	5	500	mca0830055e2		
100 – 70 000 Da	5	1 000	mca0830051e3		mcs2005051e3
1 000 – 1 000 000 Da	5	100 000	mca0830051e5		
	10	Precolumn	mca080510	mcp2005	
100 – 70 000 Da	10	1 000	mca0830101e3	mcp20301e3	
1 000 – 1 000 000 Da	10	100 000	mca0830101e5	mcp20301e5	
10 000 – 2 000 000 Da	10	1 000 000	mca0830101e6		
10 000 – 5 000 000 Da	10	10 000 000	mca0830101e7	mcp20301e7	

3.2.2 Columns for Life Science

Aqueous GPC/SEC of Proteins - PROTEEMA Columns

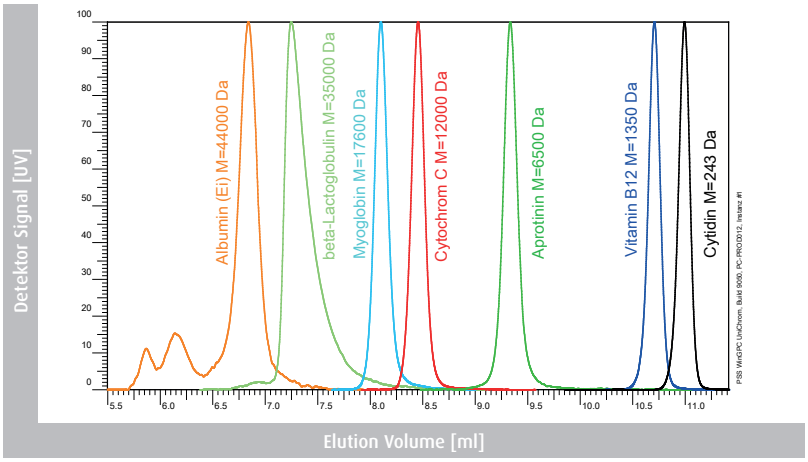
▲ Click here

Field of Application	
Applicability	Natural and synthetic Proteins, Peptides, Enzymes, Gelatins/Collagens
Eluents	Water, water with salt/buffer, MeOH, ACN; pH: 2 – 8

Specifications	
Material	Special modified silica
Maximum Pressure	150 - 200 bar (2180 - 2900 psi), depending on porosity
Maximum Temperature	70° C
Maximum Flow Rate	3 ml/min (8 mm I.D.)
Particle Size	3 µm, 5 µm
Molecular Weight Range	100 to > 7 500 000 Da*

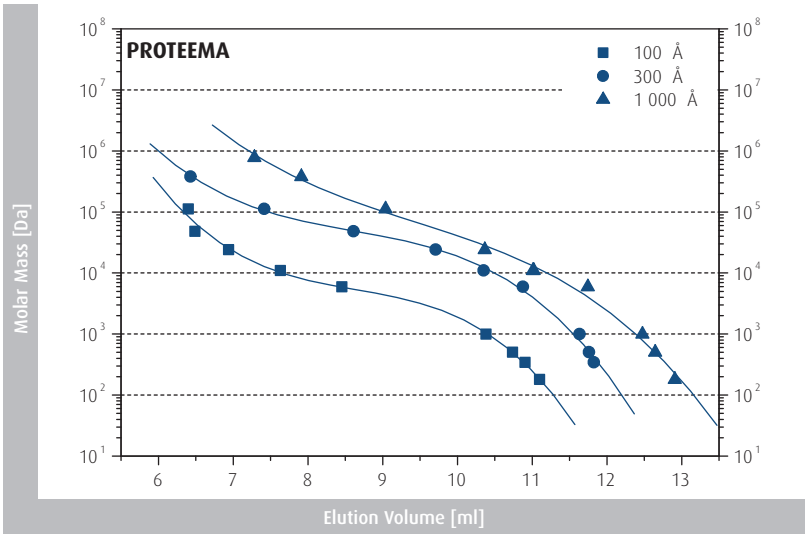
Protein Mixture

Flow rate: 1.0 ml/min
Loading: 1.0 g/l, 20 µl
Eluent: water, NaCl 0.3 M
Temperature: 25° C
Detectors: SECcurity UV (280 nm)
Columns: PSS PROTEEMA 3 µm 100 Å (8 x 300 mm) + precolumn (P/N pra080503, pra0830031e2)

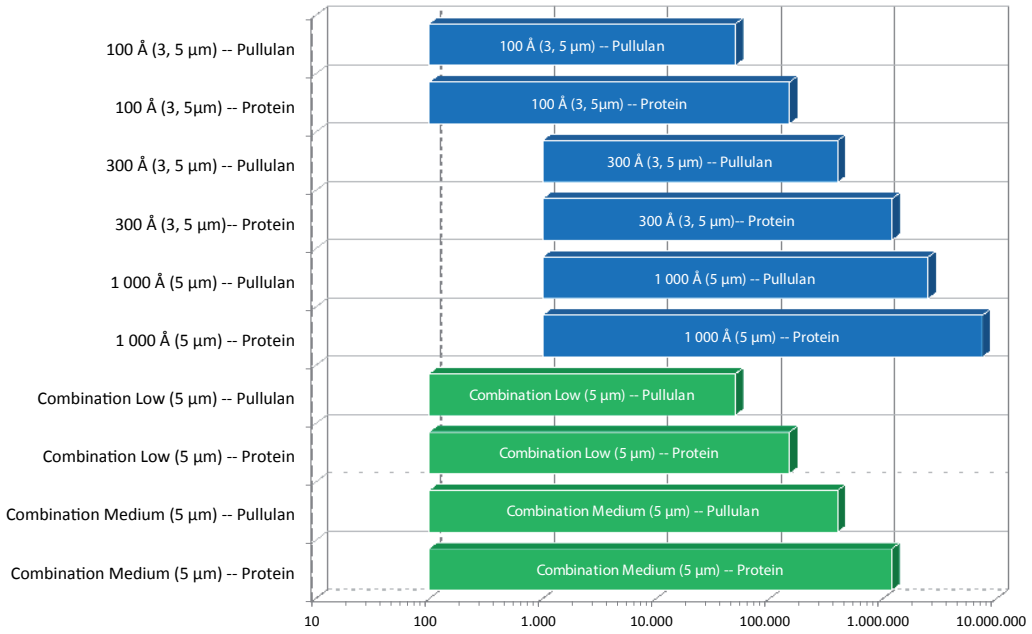


Calibration Curves

Eluent: aqueous buffer
Calibrants: Pullulan



Separation Ranges



Part Numbers

a) Preconfigured Analytical Column Sets

Separation range [Da]	Column Set	Description	Part Number
100 - 150 000	PSS PROTEEMA combination low	1 x PROTEEMA precolumn 5 µm 8x50 mm (P/N pra080505) 3 x PROTEEMA column 5 µm 100Å 8x300 mm (P/N pra0830051e2)	213-0001
100 - 1 200 000	PSS PROTEEMA combination medium	1 x PROTEEMA precolumn 5 µm 8x50 mm (P/N pra080505) 3 x PROTEEMA column 5 µm 300Å 8x300 mm (P/N pra0830053e2)	213-0002

b) Individual Columns

Separation range [Da]*	Particle Size [µm]	Porosity [Å]	Analytical Column Dimension: 8*300 mm, precolumn 8*50 mm	Micro Column Dimension: 4.6*250 mm, precolumn 4.6*30 mm
	3	Precolumn	pra080503	prm050303
100 – 150 000 Da	3	100	PRA0830031e2	prm0525031e2
1 000 – 1 200 000 Da	3	300	PRA0830033e2	prm0525033e2
	5	Precolumn	pra080505	
100 – 150 000 Da	5	100	pra0830051e2	
1 000 – 1 200 000 Da	5	300	pra0830053e2	
1 000 – 7 500 000 Da	5	1 000	pra0830051e3	

* Based on protein molecular weights

Aequeous GPC/SEC of monoclonal antibodies – MAB columns

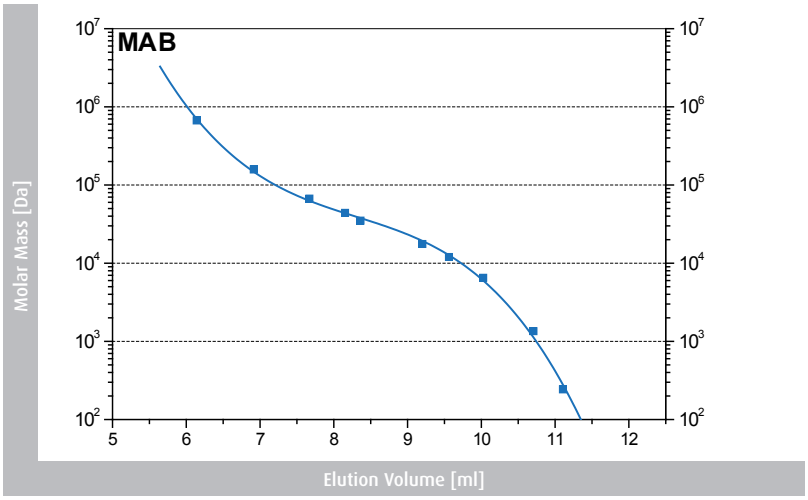
▲ Click here

Field of Application	
Applicability	monoclonal antibodies
Eluents	Water, water with salt/buffer, MeOH, ACN; pH: 2 - 8

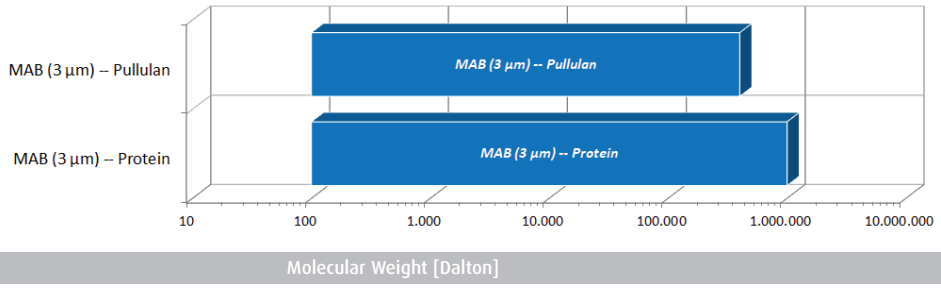
Specifications	
Material	Special modified silica
Maximum Pressure	150 bar (2180 psi)
Maximum Temperature	70° C
Maximum Flow Rate	3 ml/min (8 mm I.D.)
Particle Size	3 µm, 5 µm
Molecular Weight Range	100 to > 1 000 000 Da (protein), [100 – 400 000 (Pullulan)]
Remark	optimized and pre-equilibrated for light scatterig detection

Calibration Curve

Eluent: aqueous buffer
Calibrants: protein



Separation Ranges



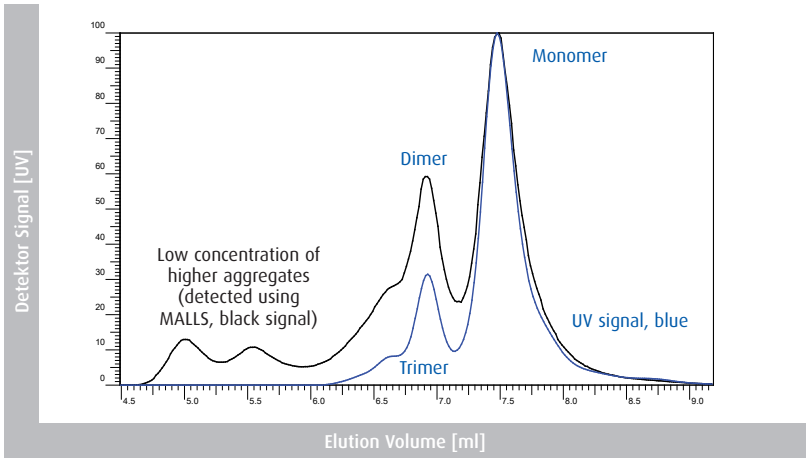
Part Numbers

Individual Columns

Separation range [Da]	Particle Size [µm]	Porosity [Å]	Analytical Column Dimension: 8*300 mm, precolumn 8*50 mm	Micro Column Dimension: 4.6*250 mm, precolumn 4.6*30 mm
	3	Precolumn	maa080503	mam050303
100 – 1 000 000 Da	3	Main column	maa083003mc	mam052503mc

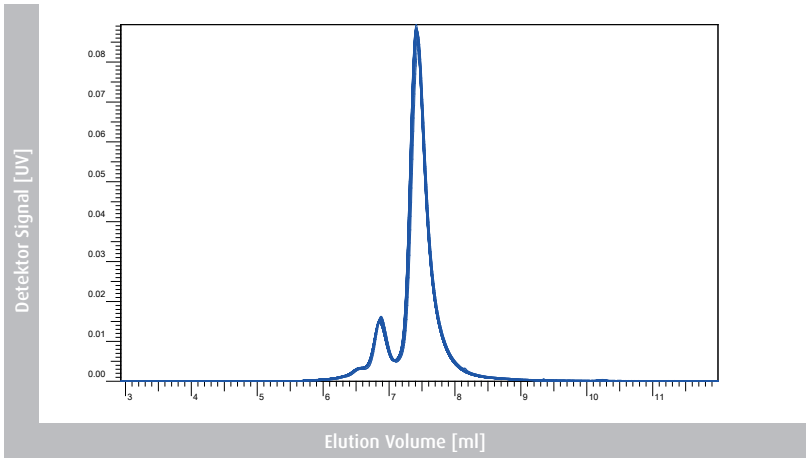
Immunglobulin G IgG

Flow rate: 1.0 ml/min
Loading: 2.5 g/l, 20 µl
Eluent: Phosphate buffer 34mM pH6.4 + 0.3M NaCl
Temperature: 23° C
Detektors: SECcurity² UV (280 nm), MALLS SLD2020 (1 Signal)
Columns: PSS MAB 3µm (8x300mm) (P/N maa083003mc)



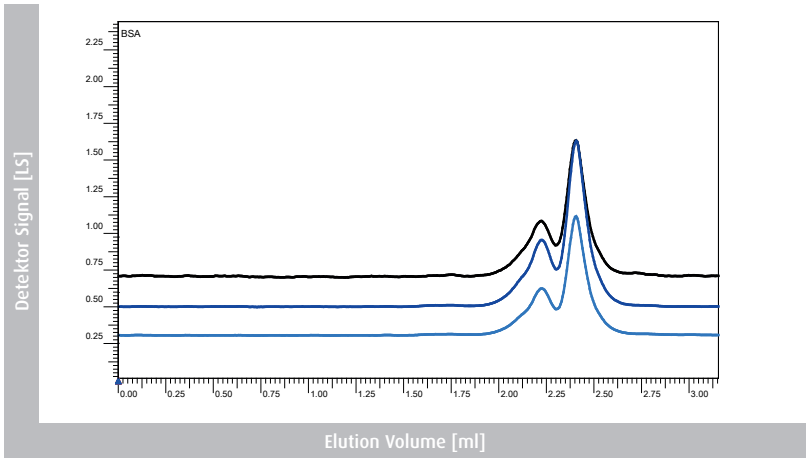
Reproducibility of Imunglobulin G IgG: 250 Injects (overlay of each 10th inject)

Flow rate: 1.0 ml/min
Loading: 1.5 g/l, 20 µl
Eluent: Phosphate buffer 34mM pH6.4 + 0.3M NaCl
Temperature: 23° C
Detektors: SECcurity UV (280 nm),
Columns: PSS MAB 3µm (8x300mm) (P/N maa083003mc)



Optimized for quick use with light scattering detection

Flow rate: 0.33 ml/min
Loading: 3.0 g/l, 20 µl
Eluent: Phosphate buffer 34mM pH6.4 + 0.3M NaCl
Temperature: 23° C
Detektors: MALLS SLD7100 (3 Signals)
Columns: PSS MAB 3µm (4.6x250mm) (P/N mam052503mc)



Overview of PSS Columns and Their Applications

Organic GPC/SEC

	Calibration Standards	Applications	Solvents
SDV	Poly(styrenes), all Poly(methacrylates) and Poly(acrylates), Polydienes, Poly(dimethysiloxanes), Poly(2-vinylpyridine), Poly(isobutylene), Poly(vinylchloride)	Poly(styrene), Poly(vinylchloride), Poly(carbonate), Elastomers, Resins, etc.	THF, Toluene, TCM, DCM
GRAM	Poly(styrene), Poly(methyl methacrylate)	Polyurethanes, Polyimide, Starches, Cellulosics, other polar polymers	DMF, DMAc, NMP, DMSO
PolarSil	Poly(styrene), Poly(methyl methacrylate)	Resins, Lignins	DMF, DMAc, NMP, DMSO
PFG	Poly(methyl methacrylate), Poly(lactides), Poly(ethylene terephthalate)	Crystalline polymers, Polyesters, Nylons, Polylactides, POM, etc.	HFIP, TFE, other fluorinated solvents
POLEFIN	Poly(styrene), Poly(ethylene)	Poly(ethylene), Poly(propylene), other Polyolefins	TCB, oDCB, Decalin

Aqueous GPC/SEC

	Calibration Standards	Applications	Solvents
SUPREMA	Pullulan, Dextran, Poly(ethylene glycol), Poly(ethylene oxide), Poly(vinylalcohol), Poly(methacrylic acid) sodium salts	Neutral and anionic polymers, (PEO, PEG, Pullulan, Dextran, Poly(acrylamide), Hyaluronic acid, Poly(acryl acid), Carboxymethyl cellulose, etc.)	water (with salts/buffers, MeOH, ACN) pH: 2 – 12
NOVEMA Max	Pullulan, Dextran, Poly(2-vinylpyridine)	Cationic polymers, (Polymeric Quaternary Ammonium Compounds, PolyDADMAc, Poly(vinyl pyridines), Chitosan, Poly(ethylene imine), etc.)	water (with salts/buffers, MeOH, ACN, TFA)pH: 2 – 12
MCX	Poly(styrene sulfonate) sodium salt, Pullulan, Dextran	Sulfonated Polyanions (Poly(styrene sulfonate), Lignin (sulfonates), Modified Starches, Acids, Alcohols, Pectins, etc.	water (with salts/buffers, MeOH, ACN) pH: 1 – 13

Life Science

	Calibration Standards	Applications	Solvents
PROTEEMA	Pullulan, Dextran, Proteins	Natural and synthetic Proteins, Peptides, Enzymes, Gelatins/Collagens	water (with salts/buffers) pH: 2 - 8
MAB	Pullulan, Proteins	Proteins, Monoclonale antibodies	water (with salts/buffers) pH: 2 - 8

Options GPC/SEC Columns

Description	Column dimension	Part Number
Delivered in Chloroform and with PEEK-titanium frits	4.6 x 30 mm, 8 x 50 mm, 20 x 50 mm	299-2112
Delivered in Chloroform and with PEEK-titanium frits	4.6 x 250 mm, 8 x 300 mm, 20 x 300 mm	299-2113
Delivered in DMAc	4.6 x 30 mm, 8 x 50 mm, 20 x 50 mm	299-2116
Delivered in DMAc	4.6 x 250 mm, 8 x 300 mm, 20 x 300 mm	299-2117
Delivered in DMF	4.6 x 30 mm, 8 x 50 mm, 20 x 50 mm	299-2132
Delivered in DMF	4.6 x 250 mm, 8 x 300 mm, 20 x 300 mm	299-2133
Delivered in Ethylacetate	4.6 x 30 mm, 8 x 50 mm, 20 x 50 mm	299-2134
Delivered in Ethylacetate	4.6 x 250 mm, 8 x 300 mm, 20 x 300 mm	299-2135
Delivered in Heptane	4.6 x 30 mm, 8 x 50 mm, 20 x 50 mm	299-2130
Delivered in Heptane	4.6 x 250 mm, 8 x 300 mm, 20 x 300 mm	299-2131
Delivered in HFIP and with PEEK-titanium frits	4.6 x 30 mm	299-2106
Delivered in HFIP and with PEEK-titanium frits	8 x 50 mm	299-2100
Delivered in HFIP and with PEEK-titanium frits	20 x 50 mm	299-2103
Delivered in HFIP and with PEEK-titanium frits	4.6 x 250 mm	299-2107
Delivered in HFIP and with PEEK-titanium frits	8 x 300 mm	299-2101
Delivered in HFIP and with PEEK-titanium frits	20 x 300 mm	299-2104
Delivered in TFE and with PEEK-titanium frits	4.6 x 30 mm	299-2128
Delivered in TFE and with PEEK-titanium frits	8 x 50 mm	299-2124
Delivered in TFE and with PEEK-titanium frits	20 x 50 mm	299-2126
Delivered in TFE and with PEEK-titanium frits	4.6 x 250 mm	299-2129
Delivered in TFE and with PEEK-titanium frits	8 x 300 mm	299-2125
Delivered in TFE and with PEEK-titanium frits	20 x 300 mm	299-2127
Delivered in THF	4.6 x 30 mm, 8 x 50 mm, 20 x 50 mm	299-2120
Delivered in THF	4.6 x 250 mm, 8 x 300 mm, 20 x 300 mm	299-2121
Delivered in Toluene	4.6 x 30 mm, 8 x 50 mm, 20 x 50 mm	299-2110
Delivered in Toluene	4.6 x 250 mm, 8 x 300 mm, 20 x 300 mm	299-2111
Pre-equilibrated for use with light scattering detection	4.6 x 30 mm, 8 x 50 mm	299-2200
Pre-equilibrated for use with light scattering detection	4.6 x 250 mm, 8 x 300 mm	299-2201
Bio-inert Hardware	4.6 x 30 mm, 4.6 x 250 mm, 8 x 50 mm, 8 x 300 mm	299-2301

4| Good Practice in GPC/SEC

Gel Permeation Chromatography (GPC), Size Exclusion Chromatography (SEC), and Gel Filtration Chromatography (GFC) are names used interchangeably for a liquid chromatography technique that separates according to molecular dimensions.

The following information should help you to successfully install GPC/SEC in your laboratory.

Contrary to LAC (Liquid Adsorption Chromatography) methods like HPLC, that rely on interactions between sample and stationary phase (column material), GPC/SEC must operate free of interactions. Under these conditions, a separation based on the size of the molecules is ensured. Ideally, only entropic effects should influence this type of separation.

A

Method Development and Operation

1. Select a mobile phase that is a good solvent for your sample. Take into account that this solvent should be non-toxic, non-corrosive, and also allow detection (cf. dn/dc or dA/dc). If required, incorporate modifiers (aqueous GPC/SEC, medium polar solvents) and/or something to prevent algae growth (e.g. NaN_3, aqueous GPC/SEC).
2. Select an appropriate stationary phase (column material) that suits your sample/solvent combination and ensures interaction free separation.
3. Select the correct particle size and the appropriate pore size distribution.
4. Use precolumns to increase the overall column life time.
5. To improve the resolution and/or widen the molecular weight separation range, PSS recommends using multiple columns in series.

Tip: PSS pre-configured column sets are optimized with respect to particle size using a mismatch-free porosity combination taking the molar mass range and the solvent viscosity into account. This ensures an efficient separation with highest resolution.

6. Maintain a flow rate and a temperature that is appropriate for the column diameter and viscosity of the solvent to prevent sample shearing and high backpressure.
7. Determine the plate count, asymmetry and resolution of your column(s) regularly and monitor their ongoing performance. Keep an eye on the pressure of the system with and without the columns installed, to detect potential problems.

B

Storage of Polymer Standards

1. Store the standards in a dry, dark, cool area; e.g. a refrigerator (4°C), and tightly capped. This keeps excessive moisture away and increases the shelf-life of the standard.
2. To prevent sample degradation over time, do not store standards in locations exposed to direct sunlight (e.g. on a window sill or near windows). This is critical for Poly(isoprene), Poly(butadiene) and other temperature and/or light sensitive polymers.

C

Samples Preparation for GPC/SEC Analysis

1. Use only freshly prepared solutions to ensure accurate concentrations and use them up within two days. Do not freeze standards in solution; freezing can destroy the sample.
2. If you use an internal standard for flow rate monitoring, mix it first with some mobile phase in a separate container. Then use this marked solvent to prepare your standards. Do not add it into the general solvent bottle.
3. Select an appropriate clean dissolution container (autosampler vial, bottle, flask, etc.).
4. Select your working concentration based on detection type and number of columns in use.
5. When using light scattering, viscometry or triple detection systems precisely weigh in the appropiate amount of sample and solvent. For conventional GPC/SEC weighing the sample and adding the solvent using a syringe is sufficient.
6. Close or seal the dissolution container and leave at room temperature for complete dissolution. Polymers of M_w < 200 000 Da, require 3-4 hours. Ultra High Molecular weight standards and samples >2 000 000 Da may require 1-3 days to dissolve completely.
7. Do not use stirrer bars, ultrasonic baths, microwave heating or harsh shaking as this can cause sample degradation.
8. Gently swirl the vials to ensure a homogeneous solution.
9. Inject each solution separately. Start with the guideline below (Table 3) to determine the optimum injection volume.

Suggested sample concentrations and injection volumes

Sample, Molecular Weight	Conc.(g/l)	Flow Rate	Inj. Vol. (µl) Column Set		
			Column dimensions mm (L x ID)		
			250 x 4.6	300 x 8.0 50 x 20	300 x 20
Plate Count	1	Optimum	5	20	50
Narrow Stds < 1M Da	1	Optimum	5	20	<1000
Narrow Stds > 1M < 3M Da	< 0.5	Optimum	5	20	<1000
Narrow Stds > 3M Da	< 0.5	½ Optimum	5	20	<1000
Broad Stds, samples < 1M Da	1-3	Optimum	10	50	<1000
Broad Stds, samples > 1M Da	< 1	½ Optimum	10	50	<1000

Tips:

Standard Mixes:

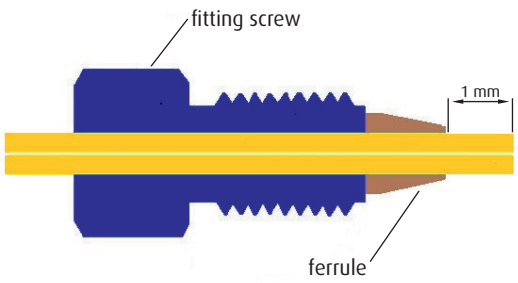
It is possible to dissolve several standards of the same type in a given dissolution container. If you make a mixture, the individual standard's molecular weight must be separated by orders of magnitude to avoid co-elution; e.g. Poly(styrene): 5 000 Da, 50 000 Da, 500 000 Da.
PSS offers pre-made mixtures or kits that avoid co-elution (see ReadyCal-Kits) and allow fast calibration.

Ultra High Molecular Weight Samples:

Samples with M_w > 1 000 000 Da elute best in low concentrations, using columns with large particle (10µm, 20µm) and pore sizes.
Work at reduced flow rates (0.5 – 0.3 ml/min) and if necessary with an increased injection volume. This reduces the probability of sample degradation. Example: Inject 100 µl of a solution of 0.1 g/l in preference to 20 µl of a solution of 0.5 g/l.

Column Installation Tips

1. Purge the system with mobile phase first. Pump solvent through the system to remove air to prevent air from entering the columns. Don't forget to flush the injection loop.



2. Check the column flow direction. Operate with the flow rate in the reverse direction only when troubleshooting or operating after a long storage time.
3. Use the column connectors supplied from PSS to connect the columns in series.

WARNING: Make sure that the connecting tubing protrudes a maximum of 1 mm inside the column head (see Figure).

4. Thread the column fittings finger tight into the system. Do not over tighten the fitting. Over tightening may damage the column and the column head. Do not connect to the detectors but go directly to waste.
5. Turn on the pump. Eluent should come out after 2-3 minutes at 0.2 ml/min flow rate. If not, see "Recovering partially dry columns".
6. Flush the column with 10 times of the column volume at 1/5th of the recommended flow rate.
7. When the solvent exchange is completed, connect to the detector(s).
8. Slowly increase the flow rate to the typical operating flow rate which depends on the column dimensions.

Recommended flow rate

Flow	I.D. 8 mm	I.D. 4.6 mm	I.D. 20 mm
Operating	1 ml/min	0.33 ml/min	6.25 ml/min
Reduced	0.25 ml/min	0.1 ml/min	1.5 ml/min
Idle	0.1 ml/min	0.03 ml/min	0.6 ml/min

9. Check the column pressure. The maximum pressure should never exceed twice the pressure specified in the column certificate.

10. Give the columns time to equilibrate.
11. Check the plate count of the whole chromatographic system including the column set (see column user documentation). If this test fails, check each column separately and if this does not reveal the problem then contact PSS or a PSS representative.

D

Tips for Multiple Columns use

- Use only column combinations recommended by PSS to avoid porosity mismatch.
- Do not combine linear and single porosity columns.
- Do not combine different particle sizes.
- Do not combine linear columns with different separation ranges.

E

Cleaning

When columns lose efficiency (Resolution (R_{sp}), Asymmetry) or you suspect the presence of foreign material adsorbed on the column, PSS recommends the following procedures:

- Remove the column from the detector.
- Install the column in reverse direction for clean-up.
- Flush the column at 0.1 ml/min flow rate with a solvent that dissolves the suspect impurities and is fully compatible with your system, until the impurities are removed.

TIP: To clean aqueous columns, use variation of pH, buffer concentration, or mixtures of organic and aqueous eluents. Organic columns are best cleaned by varying the eluent polarity. Use mixtures of appropriate solvents (e.g. THF in toluene resp. chloroform) or solvent additives (TFAc in THF).

F

Storage

PSS recommends storing the columns in the solvent used during shipment; i.e. columns shipped in DMF should be stored in DMF.

1. Replace salt solutions with pure solvent, disconnect the column from the GPC/SEC system and tightly plug with the original end plugs.
2. It is a good practice to store columns with volatile mobile phases in a refrigerator (4°C) to prevent solvent evaporation.

WARNING: Never let the column temperature fall below the freezing point of the storage solvent. This will destroy the stationary phase.

Further GPC/SEC Tips und Tricks

▲ Click here

5| GPC/SEC column selection

▲ Click here

5.1| GPC/SEC column selection app

The column selection app is a free website that allows customers and potential customers to find a set of columns suitable for their needs. The user simply enters the information about their sample, solvent, or current set of columns; and the app does the rest. The app can be found at www.psscolumnselector.com.

There are the following categories:

- **Find a replacement for a column:** In this section, you can find a suitable PSS replacement for your existing columns.When selecting several columns, they are also checked for potential mismatch of the combination.
- **Column recommendation:** Based on the mobile phase and specifying the desired separation range, a suitable recommendation for a column (set) will be displayed.

Typically the recommendations are divided into

- "Column(s) with the highest resolution"
- "Column with the lowest price"
- "Column for product screening (fast analysis time)"
- "Columns with linear calibration curve"
- "Columns with low solvent consumption"

This gives the user the ability to choose the set that best fits their unique needs. The selected recommendation can be turned into a quote in a few easy clicks.

USP (United States Pharmacopeia) Methods: For a selection of different USP methods, PSS recommends a GPC / SEC column or the corresponding column type if the porosity has to be selected on the basis of the analyte.

EP (European Pharmacopoeia) Methods: The appropriate GPC/SEC column(s) or column type can be found in accordance with the EP methods.

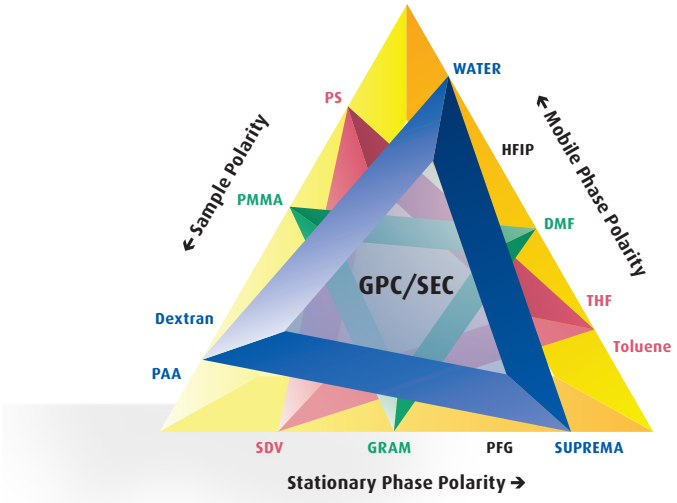
Search for applications: Search for an application and receive not only a suitable proposal for separation columns, but also recommendations for the solvent to be used and suitable calibration standards.

You will also find further useful information and notes on the subject of GPC/SEC columns and size exclusion chromatography.

In the PSS online shop www.pss-shop.com you can order GPC/SEC columns directly.

If you are logged in to our shop, you can instantly create quotes yourself.
Of course, if you have any questions, PSS will still be happy to assist you in the selection of columns, reference materials and complete applications.

5.2| GPC/SEC column selection service



PSS Magic Triangle for GPC/SEC applications

When choosing suitable columns or the right application, PSS offers a column selection service. A suitable stationary and mobile phase for your analysis problem is determined based on your samples.

Costs are only incurred if a suitable combination is found for your specific separation problem. Once the recommended column is purchased, the cost of the selection will be applied as a credit towards the purchase of the recommended column(s).

6| GPC Application Guide

Polymer	Column Type	Solvent	Temp [°C]	Calibration Standards
Acrylic acid-methyl methacrylate copolymer	GRAM	DMAc, LiBr 3 g/l + acetic acid 6 g/l	70	Poly(methyl methacrylate)
Acrylic acid-methacrylate copolymer	GRAM	DMAc, LiBr 3 g/l + acetic acid 6 g/l	70	Poly(methyl methacrylate)
Alginate sodium salt	SUPREMA	Na_2HPO_4 0.07 M	25	Pullulan
Amino resin	PolarSil	DMAc LiCl 0.1 M	70	Poly(methyl methacrylate)
Amylodextrine	MCX	Na_2HPO_4 0.07 M	25	Poly(styrene sulfonate) sodium salt
Antibody	MAB	Phosphate buffer 34 mM pH 6.4 + 0.3 M NaCl	25	Protein
Bitumen	SDV	THF	25	Poly(styrene)
BSA	PROTEEMA	Phosphate buffer pH = 6.6 + NaCl 0.3 M	25	Pullulan
Butyl methacrylate-styrene copolymer	SDV	THF	25	Poly(styrene)
Carboxymethyl cellulose	SUPREMA	Na_2HPO_4 0.07 M	25	Pullulan
Carboxymethyl starch	SUPREMA	$NaNO_3$ 0.1 M	25	Pullulan
Carragenan	SUPREMA	$LiNO_3$ 0.1 M	25	Pullulan
Cellulose acetate	GRAM	DMAc LiBr 5 g/l	70	Poly(styrene)
Cellulose nitrate	SDV	THF	25	Poly(styrene)
Cellulose triacetate	SDV	THF	25	Poly(styrene)
Chitosan	NOVEMA Max	NaCl 0.1 M + formic acid 0.3 %	25	Pullulan
Collagen	PROTEEMA	Phosphate buffer pH = 6.6 + NaCl 0.3 M	25	Pullulan
Dextran	SUPREMA	$NaNO_3$ 0.1 M	25	Dextran
Dextran, oligomer	MCX	NaN_3 0.05 %	25	Dextran
Dextran sulfate	SUPREMA	$NaNO_3$ 0.1 M	35	Pullulan
Dextrine	SUPREMA	$NaNO_3$ 0.1 M	25	Pullulan
Dimethylaminoethyl methacrylate-methacrylic ester copolymer	GRAM	DMAc, LiBr 3 g/l + acetic acid 6 g/l	70	Poly(methyl methacrylate)
Epoxy resin	SDV	THF	25	Poly(styrene)
Ethylene-methacrylate copolymer	SDV	THF	25	Poly(styrene)
Ethylene-propylene copolymer	POLEFIN	TCB	145	Poly(styrene)
Ethylene-vinyl acetate copolymer	SDV	THF	25	Poly(styrene)
Ferritin	PROTEEMA	Phosphate buffer pH = 6.6 + NaCl 0.3 M	25	Protein Mixture
Gelatin	PROTEEMA	Phosphate buffer pH = 6.6 + NaCl 0.3 M	25	Pullulan
Glyceride	SDV	THF	25	Poly(styrene)
Glycoprotein	PROTEEMA	Phosphate buffer pH = 6.6 + NaCl 0.3 M	25	Protein Mixture
Guar gum	SUPREMA	$NaNO_3$ 0.1 M	25	Pullulan
Gum arabic	SUPREMA	$NaNO_3$ 0.1 M	25	Pullulan

Polymer	Column Type	Solvent	Temp [°C]	Calibration Standards
Heparin	SUPREMA	$NaNO_3$ 0.1 M	25	Pullulan
Heparin (Pharmaeuropa, low molar mass)	PROTEEMA	Na_2SO_4 28.4 g/L pH = 5	25	Heparin CRS 2
Heparin sulfate	SUPREMA	$NaNO_3$ 0.1 M	25	Pullulan
Humic acid	MCX	Na_2HPO_4 0.07 M	25	Poly(styrene sulfonate) sodium salt
Hyaluronic acid	SUPREMA	Na_2HPO_4 0.07 M	25	Pullulan
Hydraulic oil	SDV	THF	25	Poly(styrene)
Hydroxyethyl starch	SUPREMA	$NaNO_3$ 0.1 M	25	Hydroxy ethylstarch
Hydroxypropyl cellulose	GRAM	DMSO, LiBr 5 g/l	70	Poly(methyl methacrylate)
Hydroxypropyl cellulose ester	SDV	THF	25	Poly(methyl methacrylate)
Hydroxypropyl cellulose ether	SDV	THF	25	Poly(methyl methacrylate)
Immunglobulin	MAB	Phosphate buffer 34 mM pH 6.4 + 0.3 M NaCl	25	Protein
Insulin	PROTEEMA	L-Arginin, Water, Acetic acid and ACN	25	Protein Mixture
Iron Dextran	SUPREMA	$NaNO_3$ 0.1 M	25	Dextran
Isocyanate	SDV	THF	25	Poly(styrene)
Isopropyl methacrylate	SDV	THF	25	Poly(methyl methacrylate)
Lignin	PolarSil	DMSO, LiBr 5 g/l	70	Poly(methyl methacrylate)
Lignin sulfonate	MCX	Na_2HPO_4 0.07 M	25	Pullulan
Maltodextrin	MCX	NaN_3 0.05 %	25	Pullulan
Melamin formaldehyde resin (MF)	PolarSil	NMP	70	Poly(methyl methacrylate)
Methacrylic acid-methacrylate copolymer	GRAM	DMAc, LiBr 3 g/l + acetic acid 6 g/l	70	Poly(methyl methacrylate)
Methyl cellulose	GRAM	DMSO, LiBr 5g/l	70	Poly(methyl methacrylate)
Methyl methacrylate-styrene copolymer	SDV	THF	25	Poly(styrene)
Monoclonal antibody	MAB	Phosphate buffer 34 mM pH 6.4 + 0.3 M NaCl	25	Protein
Naphthalin sulfonate	MCX	Na_2HPO_4 0.07 M	25	Pullulan
Norbenyl-cyclodextrine copolymer	GRAM	DMAc LiBr 5 g/l	70	Poly(methyl methacrylate)
Oleate	SDV	THF	25	HPLC calibration
Olive oil	SDV	THF	25	Poly(styrene)
Paraformaldehyde	PFG	HFIP, K-TFAc 0.05 M	25	Poly(methyl methacrylate)
Pectin	SUPREMA	$NaNO_3$ 0.1 M	25	Pullulan
Peptide	PROTEEMA	Phophate buffer pH = 6.6 + NaCl 0.3 M	25	Protein Mixture
Phenylene ether-sulfone copolymer	SDV	THF	25	Poly(styrene)
Poly(2-vinylpyridine)	SDV	NaCl 0.1 M + formic acid 0.3 %	25	Poly(2-vinylpyridine)

Polymer	Column Type	Solvent	Temp [°C]	Calibration Standards
Poly(2-vinylpyridine)	NOVEMA Max	NaCl 0.1 M + TFAc 0.3 %	25	Poly(2-vinylpyridine)
Poly(acrylamide)	SUPREMA	$NaNO_3$ 0.1 M	25	Pullulan/ Poly(acrylamide) broad
Poly(acrylic acid)	SUPREMA	Na_2HPO_4 0.07 M	25	Poly(acrylic acid) sodium salt
Poly(acrylonitrile)	GRAM	DMAc, LiBr 5 g/l	70	Poly(methyl methacrylate)
Poly(allylamine hydrochloride)	NOVEMA Max	NaCl 0.1 M + formic acid 0.3 %	25	Poly(2-vinylpyridine)
Poly(butadiene) (1.2 /1.4)	SDV	THF	25	Poly(butadiene 1.4)
Poly(butylene terephthalate) (PBT)	PFG	HFIP, K-TFAc 0.1 M	25	Poly(methyl methacrylate)
Poly(carbonate)	SDV	THF	25	Poly(styrene)
Poly(DADMAC)	NOVEMA Max	NaCl 0.1 M + formic acid 0.3 %	25	Poly(2-vinylpyridine)
Poly(dimethyl siloxane)	SDV	Toluene	25	Poly(dimethyl siloxane)
Poly(ether sulfone)	GRAM	DMAc, LiBr 5 g/l	70	Poly(methyl methacrylate)
Poly(ethyl methacrylate)	SDV	THF	35	Poly(methyl methacrylate)
Poly(ethylene glycol)	SDV	THF	25	Poly(ethylene glycol) (< 20 KDA)
Poly(ethylene glycol)	SUPREMA	NaN_3 0.05 %	25	Poly(ethylene glycol)
Poly(ethylene imide)	GRAM	DMAc LiBr 2 g/l + TRIS 2 g/l	70	Poly(styrene)
Poly(ethylene imine)	NOVEMA Max	NaCl 0.1 M + formic acid 0.3 %	25	Poly(2-vinylpyridine)
Poly(ethylene imine)	PFG	HFIP, K-TFAc 0.1 M	25	Poly(methyl methacrylate)
Poly(ethylene oxide)	SUPREMA	NaN_3 0.05 %	25	Poly(ethylene oxide)
Poly(ethylene terephthalate) (PET)	PFG	HFIP, K-TFAc 0.1 M	25	Poly(methyl methacrylate)
Poly(ethylene)	POLEFIN	TCB	145	Poly(styrene)
Poly(isobutylene)	SDV	THF	25	Poly(isobutylene)
Poly(isoprene) (1.4 / 3.4)	SDV	THF	25	Poly(isoprene 1.4)
Poly(L-lactide)	PFG	TFE, K-TFAc 0.1 M	25	Poly(L-lactide)
Poly(L-lactide-glycolide)	PFG	TFE, K-TFAc 0.1 M	25	Poly(L-lactide)
Poly(methacrylic acid)	SUPREMA	Na_2HPO_4 0.07 M	25	Poly(methacrylic acid)
Poly(methyl methacrylate)	SDV	THF	25	Poly(methyl methacrylate)
Poly(n-butyl acrylate)	SDV	THF	25	Poly(t-butyl-acrylate)
Poly(n-butyl methacrylate)	SDV	THF	25	Poly(n-butyl-methacrylate)
Poly(n-propyl methacrylate)	SDV	THF	25	Poly(methyl methacrylate)
Poly(oxymethylene)	PFG	HFIP, K-TFAc 0.1 M	25	Poly(methyl methacrylate)
Poly(phenyl acetylene)	SDV	THF	25	Poly(styrene)
Poly(propylene) (PP)	POLEFIN	TCB	150	Poly(styrene)
Poly(styrene sulfonic acid)	MCX	Na_2HPO_4 0.07 M	25	Poly(styrene sulfonate) sodium salt
Poly(styrene)	SDV	THF	25	Poly(styrene)

Polymer	Column Type	Solvent	Temp [°C]	Calibration Standards
Poly(styrene-b-butadiene-1.4)	SDV	THF	25	Poly(styrene)
Poly(styrene-b-glycidyl methacrylate)	SDV	THF	25	Poly(styrene)
Poly(t-butyl acrylate)	SDV	THF	25	Poly(t-butyl-acrylate)
Poly(t-butyl methacrylate)	SDV	THF	25	Poly(t-butyl methacrylate)
Poly(vinyl acetate)	SDV	THF	25	Poly(styrene)/Poly(vinyl acetate) broad
Poly(vinyl alcohol)	SUPREMA	$NaNO_3$ 0.1 M / MeOH (10 - 30 %)	25	Pullulan / Poly(vinyl alcohol) broad
Poly(vinyl chloride)	SDV	THF	25	Poly(styrene)
Poly(vinylpyridinium bromide)	NOVEMA Max	NaCl 0.1 M + formic acid 0.3 %	25	Poly(2-vinylpyridine)
Poly(vinyl pyrrolidone) broad	GRAM	DMAc, LiBr 0.1 %	70	Poly(methyl methacrylate)
Polyamide	PFG	HFIP, K-TFAc 0.1 M	25	Poly(methyl methacrylate)
Polyaminoamide	GRAM	DMAc LiBr 5g/l	70	Poly(styrene)
Polycarbonate urethane (PCU)	SDV	THF	25	Poly(styrene)
Polyester	PFG	HFIP, K-TFAc 0.1M	25	Poly(methyl methacrylate)
Polyether, perfluorinated	PFG	HFIP, K-TFAc 0.1M	25	Poly(methyl methacrylate)
Polylactide	PFG	TFE, K-TFAc 0.1M	25	Poly(L-lactide)
Polyol	SDV	THF	25	Poly(styrene)
Polyolefin	POLEFIN	TCB	150	Poly(styrene)
Polysuccinamide	GRAM	NMP, LiCl 0.1 M	70	Poly(methyl methacrylate)
Polysulfone	GRAM	DMAc, LiBr 5 g/l	70	Poly(methyl methacrylate)
Polyurethane	SDV	THF	25	Poly(styrene)
Protein	PROTEEMA	Phophate buffer pH = 6.6 + NaCl 0.3 M	25	Protein-Mixture
Pullulan	SUPREMA	NaN_3 0.05 %	25	Pullulan
Silicone- / Motor oils	SDV	Toluene	25	Polydimethylsiloxan
Styrene-butyl acrylate copolymer	SDV	THF	25	Poly(styrene)
Styrene-isoprene copolymer	SDV	THF	25	Poly(styrene)
Trimethylammonium-ethyl methacrylate-methacrylicester-Cl copolymer	GRAM	DMAc, LiBr 0.1%	70	Poly(methyl methacrylate)
Urea formaldehyde resin (UF)	GRAM	NMP	70	Poly(styrene)
Urea-melamin formaldehyde resin (UMF)	GRAM	NMP	70	Poly(styrene)
Virus	SUPREMA	Phosphate buffer pH 7.4	25	Pullulan
Xanthan	SUPREMA	Na_2HPO_4 0.07 M	25	Pullulan

In doubt?
Use our column selection service!
For more applications register at
www.pss-polymer.com

7| Frequently Asked Questions

How can I make sure that an application is robust and offers long-term stability?

PSS offers development and reservation of stationary phase batches as well as support for method development. We can fine-tune column materials and column combinations to provide the best results for your application. We also reserve dedicated batches to guarantee that we can deliver the required quality for several years.

Can I order PSS columns with other dimensions (length / inner diameter)?

The catalog summarizes the most important column types and part numbers. However, PSS also delivers columns with other dimensions. Please contact us for further details.

Does PSS have a column selection service?

Yes, PSS facilitates column selection when clients are researching alternative GPC/SEC columns or are looking for columns for new products, which have not yet been the subject of a PSS GPC/SEC application. For a small fee, which is refundable, if the recommended columns are purchased, PSS identifies the most suitable stationary phase and solvent combination for 1-3 customer samples. The results are provided in a recommendation report.

Do I need special hardware to use PSS columns on my GPC/SEC system?

No, PSS columns use standard fittings and can be used on most GPC/SEC systems. Although PSS usually ships connection fittings with the column, you may use Valco ferrules and nuts to replace the fittings. However don't use existing tubing with fixed fitting screws and ferrules, especially when replacing columns from other manufacturers with PSS columns. Every vendor has

different requirements for the distance between the end of the tubing and the end of the ferrule. Applying already existing connections can either damage the frit inside the column head or create an additional void volume and will lead to band broadening.

Which porosity do I need for my polymers? What is the separation range of the columns?

Higher porosities are used for higher molecular weights; and smaller porosities for lower molecular weights. The separation range depends on the porosity of the columns (see pages 29). If you want to use column combinations, we suggest using the recommended combinations as they have been thoroughly tested to guarantee the highest resolution, while avoiding chromatographic artifacts.

What is the difference between linear/mixed-bed and single porosity columns? What column type is best suited for which application?

A linear/mixed-bed column has a wider molecular weight separation range but a lower overall resolution than a single porosity column. To receive a similar separation range you have to combine different single porosity columns. The advantage of the linear columns is the analysis times for linear columns are much shorter, which makes them suitable for rapid product screening. For a precise analysis with a higher resolution combinations of single porosity columns are a more suitable option.

How can GPC/SEC columns be tested?

A good measure for the performance of the column is the plate count and the specific resolution. There are several standards (e.g. ISO 13885, DIN 55672, ASTM D 5296-05 and others) that provide criteria for plate count, asymmetry and resolution. On each column's Certificate of Analysis the plate count , asymmetry and analytical conditions are noted.

What standards should I use for calibrating a GPC/SEC system?

Your calibration standards must be soluble in the mobile phase you plan to use. GPC/SEC stationary phase materials and standards classified as either aqueous for water-based GPC/SEC, or as organic for GPC/SEC in organic solvents. There are a few standards that can be used for both applications.

To receive accurate molar masses it is best to use standards that are chemically alike to the samples being analyzed.
Check "Standards Sorted by Type" to find the list of available PSS standards for aqueous and organic GPC/SEC or filter in our shop with respect to Type ‚Organic' or ‚Aqueous'.
The most commonly used reference standards in GPC/SEC are Polystyrene (PS) or Polymethyl methacrylate (PMMA) for nearly all organic GPC/SEC separations including High temperature GPC (PS). Polyethylene oxide (PEO), Polyethylene glycol (PEG), Pullulan or Dextran are used for aqueous GPC/SEC.

What is the shelf life of the molecular weight standards?

Shelf life will vary depending on the chemistry and the storage conditions. Solid standards, especially synthetic standards, generally are stable when handled according to the instructions and procedures described in the Users Manual delivered with every shipment. The shelf life of each PSS batch is continously monitored based on the requirements of each individual chemistry. Products are regularly quality-checked and re-certified.

What standard can be used in aqueous phase if I only have a UV/DAD/PDA detector?

Polystyrene Sulfonate Sodium Salt may be used with ultraviolet detector in aqueous environment (254 nm). You can use them with our MCX columns without organic modifiers or with SUPREMA columns using Methanol as an organic modifier. Poly(2-vinyl pyridine) and proteins are also available.

Where can I find certificates and safety data sheets for the standards?

With every delivery you will receive a printed certificate of analysis for each standard with information on the molar mass mean values and the molar mass distribution curve. In the case of kits, an overview page with the composition and calibration curve is also supplied. You can download the required safety data sheets (SDS) for the respective polymer type from the PSS webshop and from the website. You will also find the electronic certificates of the individual standards, each stored with your order numbers. With ReadyCal Kits, the PSS Shop also offers the option of downloading a WinGPC import file so that you have to type in the sample name and molar mass information for you.

Glossary and Abbreviations

GPC	Gel permeation chromatography
SEC	Size exclusion chromatography
GFC	Gel filtration chromatography
HDPE	High density Polyethylene
mL	Milliliter /Millilitre
min	Minute(s)
M	Molar mass
M_n	Number average molar mass
M_w	Weight average molar mass
M_p	molar mass at the peak maximum
THF	Tetrahydrofuran
PDI / D=M_w / M_n	Polydispersity index
Å	angstrom (units)
η	viscosity
$[\eta]$	Intrinsic viscosity
c	concentration
nm	nanometer /nanometre
V_e	Elution volume
LC	Liquid chromatography
MALDI-TOF	Matrix-assisted laser desorption/ionization – Time of Flight
PVC	Polyvinyl chloride
MWD	Molecular weight distribution
2D	Two-dimensional
µL	Micro liter /litre
PMMA	Poly(methyl methacrylate)
BHT	Butylhydroxytoluene
V_p	Elution volume at the peak maximum
L	Length (length of the column)
N	Plate count
dn/dc	refractive index increment
DMF	Dimethylformamide
LiBr	Lithium bromide
V_h	hydrodynamic volume
NaN_3	Sodium azide
PS	Polystyrene
PAA	Polyacrylic acid
Da	Dalton
DCB	Dichlorobenzene
TCB	Trichlorobenzene
DMF	Dimethylformamide
DMAc	Dimethylacetamide
DMSO	Dimethylsulfoxide
HFIP	Hexafluoroisopropanol
TFE	Trifluoro acetic acid (TFA) / Trifluoroethanol
PET	Polyethylene terephthalate
Poly(DADMAC)	Polydiallyldimethylammonium chloride
H_2O	water
RI	Refractive index (detector)
UV	Ultraviolet (detector)
cm	Centimeter / centimetre
PEO	Polyethylene oxide
LS	Light scattering
PI	Polyisoprene
MMA	Methyl methacrylate
tBMA	tert-Butyl methacrylate
^{1}H-NMR	Proton nuclear magnetic resonance
3D	three-dimensional / tridimensional
MALLS	Multi-angle Laser Light Scattering
R_H	hydrodynamic radius
K	Mark–Houwink parameter
α	Mark–Houwink parameter
Exclusion Limit (of a column)	Molecules larger than the exclusion limit can't enter the pores and so they pass through the column without hindrance
ReadyCal Kit	PSS ReadyCal Standards are polymer cocktails pre-weighed into autosampler vials. Each vial has three or four polymers of the same type with different molar masses
GPC/SEC Calibration Kit	A kit consists of 8 to 12 well-characterized (single) standards of one polymer type
MALDI Validation Kit	Polymer Standard Kits that will help you to check calibrate and validate a Matrix-Assisted-Laser-Desorption-Ionization-Time-of-Flight measurement (MALDI-ToF) instrument. Standards with different molecular weight ranges and different polarities are included
Light Scattering/ Viscometry Validation Kit	Kit to check the instrument calibration and the delay volume between the concentration detector and the molar mass detector. This kit includes a mixture of well-defined Light Scattering (LS) and/or Viscometry (Visco) reference materials

Supplies and Services For Comprehensive Characterization of Natural and Synthetic Macromolecules

Polymer Standard and Reference Materials

- GPC/SEC Standards and Kits
- Certified Reference Materials
- MALDI Kits
- Viscosity & Light Scattering Validation Kits
- ReadyCal Kits
- Deuterated Polymers
- Tailor made Polymers and Copolymers

GPC/SEC Columns

- For all Organic Eluents
- For all Aqueous Eluents
- For High and Low Molecular Weight Synthetic and Bio-polymers
- From Micro GPC/SEC to Preparative Scale
- HighSpeed Columns for fast Analysis

Software

- WinGPC UniChrom Macro-moleculare Chromatography Data System:
  Light Scattering Modules for LALLS, RALLS, TALLS, MALLS Viscosity Module
  Mass Spectrometry Module Copolymer Module
  End Group Analysis Module 2D-Chromatography Module Heparin Module Compliance Pack
  LAN/Server Solutions
- PoroCheck Software for In-verse GPC/SEC and Pore Size Determination

Systems and Detectors

- (Bio)SECcurity² Systems and Components
- Light Scattering Detectors
- Viscometers

Analytical Services

- Molar Mass Determination
- Branching and Structure Analysis
- Method Transfer
- Product Deformulation
- Consulting
- Installation, Training, IQ/OQ, Maintenance and Service Contracts

GPC/SEC Training and Support

- Classroom Style Trainings and Software Courses
- Inhouse Trainings
- User Meetings
- NetCommunity with Applications
- GPC/SEC Tips&Tricks, Troubleshooting

PSS
Perfect Separation Solutions

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