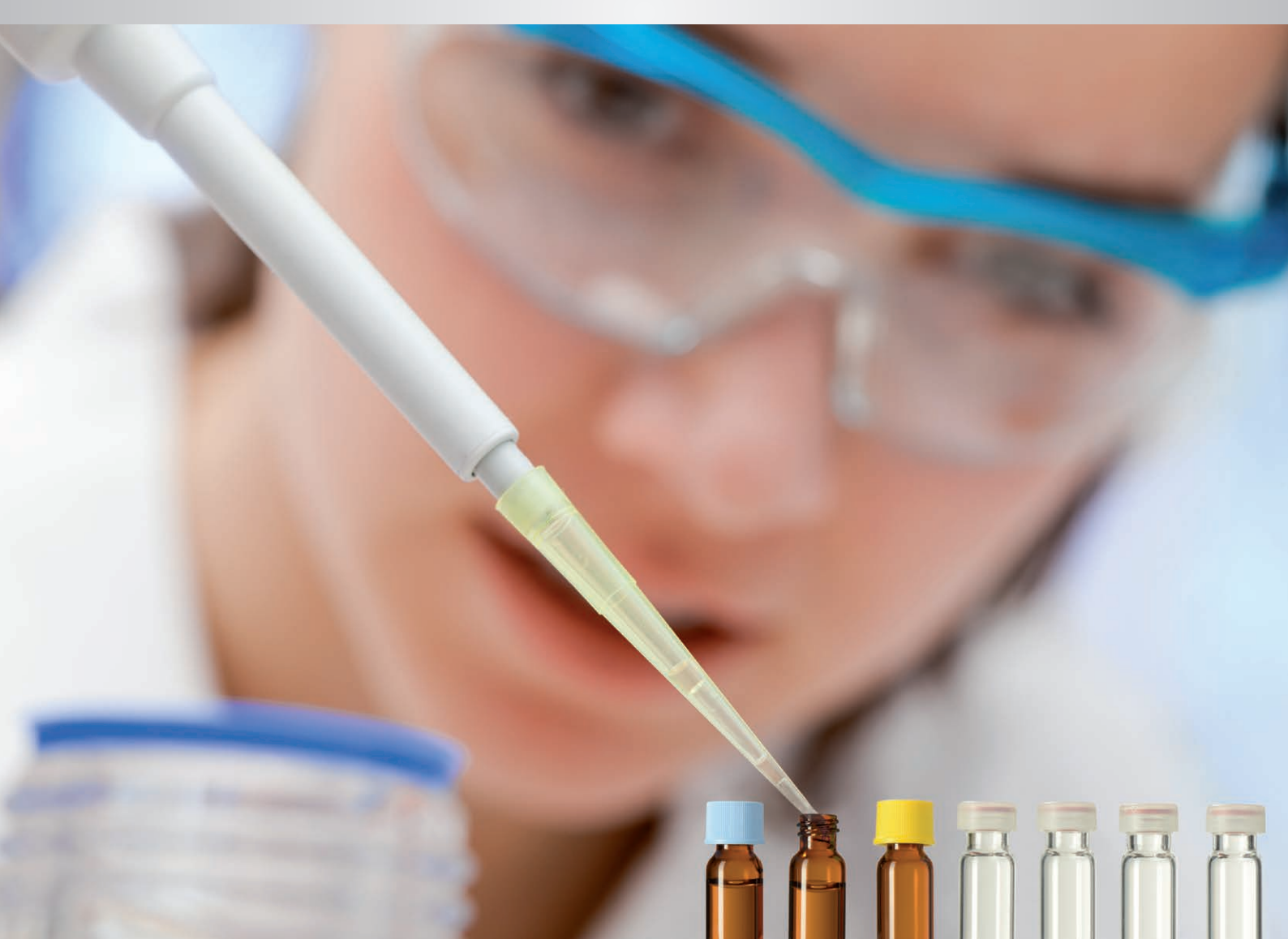




**Driving GPC/SEC Forward**



**Reference Materials  
& LC Columns**

# About PSS

## Driving GPC/SEC Forward

PSS GmbH was founded in 1985 by 2 PhD students at the Physical Chemistry Department, University of Mainz, Germany, producing polymer standards at the University facilities. During the following years PSS expanded staff and also products to include tailor-made polymers, organic and aqueous GPC/SEC columns, GPC/SEC software and moved in 2001 to its own facilities located in Mainz, Germany. PSS-USA opened its office in 1994, operates and serves North and South American customers from Amherst, Massachusetts. To date, PSS has successfully gained leadership in the overall GPC/SEC market, making innovative contributions not only in Germany and the USA, but around the world.

PSS is fully dedicated to the advancement of macromolecular liquid chromatography, by means of materials design, synthesis, manufacturing, consulting, service, and innovative research, applying the highest standard of expertise and reliability. Our close relationship with our customers has helped us to continuously improve the quality of our products and services. Our high caliber staff, mostly chemists, is experienced, creative and trained in problem solving. Corporations, universities, and organizations in more than 60 countries use our products and profit from our outstanding service and know-how.

## Certified DIN ISO EN 9001

PSS is certified (DIN ISO EN 9001:2008) to produce high quality reference polymers, GPC/SEC columns and software for the characterization of polymers by their molecular weight and their structural characteristics. PSS employs the latest findings in polymer science for the synthesis and characterization of polymers, block copolymers and biopolymers. PSS operates a manufacturing facility equipped with a complete state-of-the-art characterization laboratory at the headquarters in Mainz, Germany, fully supporting customers working under stringent requirements i.e., GLP, DIN, ISO certifications.

## About this catalog

This catalog contains the most frequently ordered consumables.  
Please refer to the website for a comprehensive listing of our products.  
Contact us to inquire about custom materials or services.

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## 1| High Quality Reference Materials

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 is available regularly.

PSS performs synthesis ranging from small laboratory scale (1 g) to larger quantities (5 kg or more) to produce multiple kinds of macromolecular reference materials, specialty polymers, polymer particles and polymer networks.

### **A wide selection of**

- Homopolymers with narrow or broad molar mass distribution
- Copolymers (e.g. block copolymers, random copolymers, terpolymers)
- Branched (co)polymers (e.g. stars, combs, graft copolymers, dendrimers, hyperbranched polymers)
- End-functionalized (co)polymers and macromonomers
- Deuterated (co)polymers
- Tactic polymers
- Polymer networks

**is already available (see chapter 1.1 to 1.4 and [www.pss-polymer.com](http://www.pss-polymer.com)); others can be produced on request.**



**PSS uses all types of polymerization techniques including**

- Controlled (living) ionic polymerization (anionic, cationic, GTP)
- Radical polymerization (ATRP, RAFT, conventional radical)
- Suspension polymerization
- Emulsion polymerization

**PSS materials are used for a large variety of applications including**

- Calibration of organic or aqueous GPC/SEC columns
- Calibration and validation of measuring instruments like light scattering detectors, 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 and its mechanism
- Experimental tests of model calculations
- Investigation of miscibility behavior of polymer blends

The PSS reference materials are characterized extensively by modern analytical methods as e.g. GPC/SEC, laser light scattering, viscometry, mass spectrometry, VPO and NMR. They are available in various characterization levels to address different carefully defined application goals. 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 chromatogram with the parameters (conditions) at which the data was obtained.

## Overview of Reference Materials

Reference Standard	Solvent												Further Information		
	Water	Ethanol / Methanol	Trifluoroethanol	Hexafluoroisopropanol	Dimethylformamide	Dimethylacetamide	Dimethylsulfoxide	Tetrahydrofuran	Acetone	Chloroform	N-Methyl-2-pyrrolidone	Trichlorobenzene		Dichlorobenzene	Toluene
Dextran	✓						✓								page 19 / web
Hydroxyethyl starch	✓														page 21 / web
Nylon 6 broad			✓	✓	(✓)	(✓)									web
Poly(2-vinylpyridine)	(✓)						✓								page 17 / web
Poly(2-vinylpyridinium bromide)	✓														web
Poly(acrylamide) broad	✓														web
Poly(acrylic acid) sodium salt	✓														page 23 / web
Poly(alpha-methylstyrene)					✓	✓	✓		✓	✓	✓	✓	✓	✓	page 13 / web
Poly(butadiene-1.2)							✓					✓	✓		web
Poly(butadiene-1.4)							✓					✓	✓		page 16 / web
Poly(carbonate) broad							✓								web
Poly(DADMAC)	✓														web
Poly(dimethyl siloxane)							✓*		✓					✓	page 18 / web
Poly(ethyl methacrylate)					✓	✓	✓	✓	✓					✓	web
Poly(ethylene glycol)	✓				✓	✓	(✓)								page 21 / web
Poly(ethylene oxide)	✓				✓	✓									page 22 / web
Poly(ethylene terephthalate)				✓			(✓)								page 18 / web
Poly(ethylene)											(✓)	(✓)			page 17 / web
Poly(isobutylene)							✓		✓		✓	✓	✓		page 18 / web
Poly(isoprene-1.4)							✓							✓	page 16 / web
Poly(isoprene-3.4)							✓							✓	web
Poly(lactide)			✓	✓					✓						page 18 / web
Poly(methacrylic acid) sodium salt	✓														page 23 / web
Poly(methyl methacrylate)				✓	✓	✓	✓	✓	✓	✓				✓	page 13 / web
Poly(n-butyl methacrylate)					✓	✓	✓	✓	✓	✓				✓	page 15 / web
Poly(styrene sulfonate) sodium salt	✓														page 24 / web
Poly(styrene)					✓	✓	✓		✓	✓	✓	✓	✓	✓	page 11 / web
Poly(t-butyl acrylate)		✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	web
Poly(t-butyl methacrylate)		✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	page 15 / web
Poly(vinyl acetate) broad		✓			✓		✓	✓	✓					✓	web
Poly(vinyl alcohol) broad	✓				✓										page 24 / web
Poly(vinyl chloride)							✓					✓	✓		web
Poly(vinyl pyrrolidone) broad	✓				✓	✓	✓			✓					web
Proteins	✓														page 24 / web
Pullulan	✓						✓								page 20 / 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

## Polymer Reference Standards – Classification and Applications

Reference polymers are available as individual standards or as carefully selected assembled kits with a variety of materials.

Reference Standard Class	Characterization Method	Applications	Available as:	
			Individual Standard	Kit
Standards (narrow and broad)	Comprehensive GPC/SEC	<ul style="list-style-type: none"> <li>· Molar mass determination with GPC/SEC or GPC/SEC viscometry</li> <li>· Creation of calibration curves (e.g. conventional, universal, broad)</li> <li>· Pore size determination using inverse GPC/SEC</li> <li>· Model polymers for physical measurements</li> <li>· Light scattering detector normalization</li> <li>· Determination of inter detector delay for multi detection systems</li> <li>· Determination of sieve curves</li> <li>· Degradation and stability studies</li> <li>· Investigation of property-molar mass relationships</li> <li>· Determination of structure-property-function relationship</li> </ul>	✓	✓
Certified standards (narrow and broad)	GPC/SEC + Absolute method (depending on applicability of the absolute methods)	<ul style="list-style-type: none"> <li>· See individual standards and kits</li> <li>· Certified standards are used in regulated labs or if extended certificates of analysis (CoA) are required</li> </ul>	✓	✓
European Reference Materials (ERM)	GPC/SEC + Light Scattering + Viscometry and physical constants (round robin test)	<ul style="list-style-type: none"> <li>· See individual standards and kits and visco/light scattering standards</li> <li>· Round robin certified standards are used in regulated labs, for pharmaceutical applications and for product registration</li> </ul>	✓	
Validation standards	GPC/SEC + Light Scattering + Viscometry	<ul style="list-style-type: none"> <li>· Validation of GPC/SEC systems also with light scattering/viscometry/triple detection</li> <li>· Validation of light scattering instruments, viscometers, and osmometers</li> </ul>		✓
MALDI-ToF Validation standards	GPC/SEC + MALDI-ToF + Absolute method	<ul style="list-style-type: none"> <li>· Validation of MALDI-ToF instruments</li> </ul>		✓
Speciality polymers: Deuterated, Highly tactic, etc.	Depending on type	<ul style="list-style-type: none"> <li>· Scattering experiments</li> <li>· NMR</li> <li>· Dielectric measurements</li> <li>· Spectroscopic methods</li> <li>· Viscometry</li> <li>· Light Scattering</li> </ul>	✓	

All molar masses in this catalog reflect the nominal “Weight Average Molecular Weight” of the polymer batch. Unless otherwise specified, the actual molecular weight of a delivered polymer may vary from the nominal value given in the catalog or on the website within a range of +/-10%. Exact molecular weight values are given on the label of the vial and the quality certificate.

**Our goal is to provide the products you need:**

Please contact us if you need specialty polymers or if you require material from a dedicated batch!

## Individual Standards

### A Narrow and Broad 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.

PSS narrow standards are analyzed via GPC/SEC, yielding  $M_n$ ,  $M_w$ ,  $M_p$  and the polydispersity ( $PDI = M_w / M_n$ ).

Narrow polymer standards are made by controlled/living ionic polymerization techniques or by fractionation of very broad standards. They have a wide application range from calibration of a GPC/SEC system to measurement of physical properties.

**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  $[\eta]$  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  $[\eta]$  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  $\alpha$ .
- To construct a calibration curve
- To test for column mismatch
- For filtration experiments for sieve curve determination

### B Certified Standards

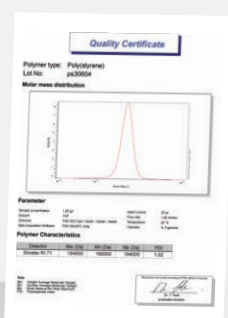
PSS supplies certified standards that meet the requirements of DIN 55672 and ISO/EN 13885. Also the PSS Quality Certificates fulfill all DIN and ASTM requirements.

PSS measures the molecular weight using GPC/SEC and additional methods such as light scattering, MALDI-ToF, NMR, viscometry, or VPO.

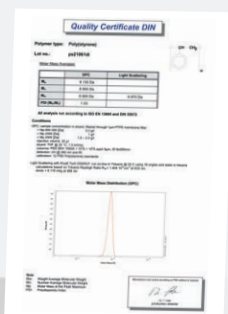
### C Round Robin Tested Standards

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 rheology data) to provide the most sophisticated set of documentation for a particular polymer available worldwide.

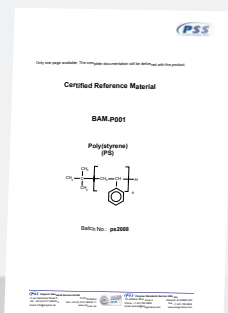
GPC/SEC  
Standards



Certified  
Standards



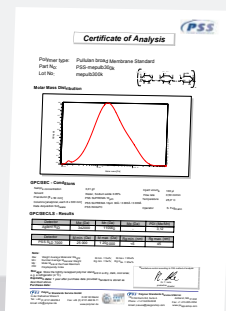
Certified  
Reference  
Materials  
CRM





## Individual Standards

### Membrane Characterization Standards



## D Standards for Membrane Characterization

GPC/SEC is a fast, robust and significant method for the characterization of membranes, especially 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 filtered and the unfiltered solution 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 unfiltered sample to the filtered fraction.

These new 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  $R_{gmax}$ .

## 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.

The composition of a kit may change.

Please visit [www.pss-polymer.com](http://www.pss-polymer.com) for an updated list.



### B ReadyCal Kits

PSS ReadyCal Standards are polymer cocktails pre-weight into autosampler vials. Each kit contains 3 x 10 autosampler vials sufficient for at least 10 calibration curves. Each of the 3 different color coded vials contains three or four polymers of the same type with carefully selected different molar masses.

A ReadyCal Kit allows you to prepare quickly and reproducibly 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 available as 1.5 mL or 4.0 mL vials.

ReadyCals for high temperature GPC come in 10 mL vials (for 4 calibrations).



## Validation Kits

### A GPC/SEC System Suitability Test with PSS EasyValid Validation Kit

PSS has developed a dedicated GPC/SEC system suitability test that evaluates the entire system: equipment, electronics, and analytical operations. A passed validation with the PSS EasyValid Validation Kit ensures that the system can measure typical 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
- A comprehensive user documentation.

The Validation Kit EasyValid is ideal

- For checking the system performance after installation as part of the OQ/PV (Operational Qualification/Performance Verification)
- For performance review after maintenance
- For inter-laboratory consistence checks
- For identifying systematic errors
- For training new employees

### B Light Scattering/Viscometry Validation Kits

The kit is used to check the instrument performance 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 reference materials (narrow and broad distributed) with the relevant light scattering and/or viscometry data. The validation of your light scattering or viscometry instrument is simple, fast, and reliable.

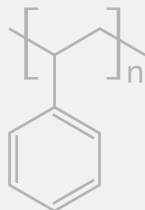
### C MALDI Validation Kits

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.



# 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

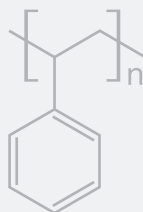
Part Number	Molar Mass [Da]	PDI
PSS-ps162	162	1.00
PSS-ps266	266	1.00
PSS-ps370	370	1.00
PSS-ps560	560	<1.50
PSS-ps1k	1 000	<1.50
PSS-ps1.8k	1 800	<1.50
PSS-ps3.2k	3 200	<1.15
PSS-ps5.6k	5 600	<1.15
PSS-ps10k	10 000	<1.15
PSS-ps18k	18 000	<1.15
PSS-ps33k	33 000	<1.15
PSS-ps56k	56 000	<1.15
PSS-ps100k	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-ps20m	20 000 000	<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

## 1.1| Organic standards



### Poly(styrene)

#### a) Individual Standards

DIN-Poly(styrene)		Pack Size 1000 mg
Part Number	Molar Mass [Da]	PDI
PSS-dps162	162	1.00
PSS-dps700	700	<1.20
PSS-dps1.4k	1 400	<1.20
PSS-dps3.2k	3 200	<1.05
PSS-dps9k	9 000	<1.05
PSS-dps18k	18 000	<1.05
PSS-dps32k	32 000	<1.05
PSS-dps100k	100 000	<1.05
PSS-dps250k	250 000	<1.05
PSS-dps560k	560 000	<1.05
PSS-dps800k	800 000	<1.05
PSS-dps1.8m	1 800 000	<1.20

ERM-Poly(styrene)		Pack Size 1000 mg
Part Number	Molar Mass [Da]	PDI
PSS-eps80k	79 600	1.08

ERM-Poly(styrene) broad		Pack Size 1000 mg
Part Number	Molar Mass [Da]	PDI
PSS-epsb180k	181 200	2.26
PSS-epsb330k	311 800	2.25

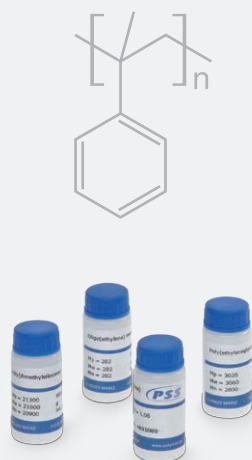
Poly(styrene) Membrane Characterization Standard		Pack Sizes 50 g, 100 g, 250 g, 500 g
Part Number	Molar Mass [Da]	PDI
PSS-mepsb200k	200 000	<2.00

#### b) Assembled Kits of Molecular Weight Standards of Poly(styrene)

Description	MW 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) high	560 to 2 500 000	12 x 1000 mg	PSS-pskitH
PSS ReadyCal Kit Poly(styrene) low	266 to 62 000	3 x 10 Vials-4.0mL 3 x 10 Vials-1.5mL	PSS-pskitr4l PSS-pskitr1l
PSS ReadyCal Kit Poly(styrene)	560 to 2 500 000	3 x 10 Vials-4.0mL 3 x 10 Vials-1.5mL	PSS-pskitr4 PSS-pskitr1
PSS ReadyCal Kit Poly(styrene) high	1 600 to 6 500 000	3 x 10 Vials-4.0mL 3 x 10 Vials-1.5mL	PSS-pskitr4h PSS-pskitr1h
PSS DIN Kit Poly(styrene)	162 to 1 800 000	12 x 1000 mg	PSS-pskitd
PSS MALDI Kit Poly(styrene)	700 to 65 000	6 x 500 mg	PSS-pskitm
PSS LS-Visco Kit Poly(styrene)	9 000 to 560 000	4 x 500 mg	PSS-pskitv



## 1.1| Organic standards



### Poly(alpha-methylstyrene)

#### a) Individual Standards

##### Poly(alpha-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) Assembled Kits of Molecular Weight Standards of Poly(alpha-methylstyrene)

Description	MW Range [Da]	Number of standards	Part Number
PSS GPC/SEC Calibration Kit Poly(alpha-methylstyrene)	1 500 to 850 000	10 x 1000 mg	PSS-amskit

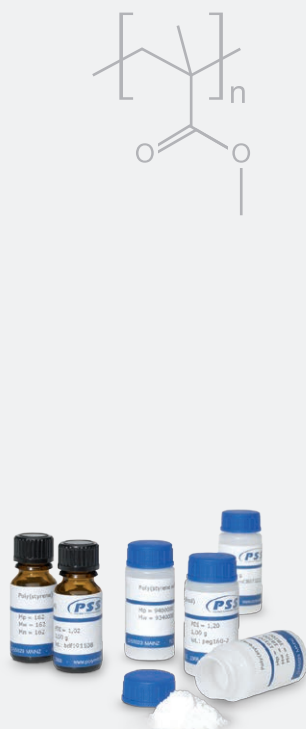
## Poly(alkyl methacrylates)

### Poly(methyl methacrylate)

#### a) Individual Standards

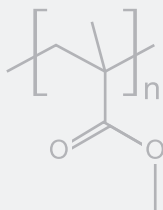
##### Poly(methyl methacrylate) narrow

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

## 1.1| Organic standards



### 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

### DIN-Poly(methyl methacrylate)

Pack Size 1000 mg

Part Number	Molar Mass [Da]	PDI
PSS-dmm450	450	<1.30
PSS-dmm3.5k	3 500	<1.10
PSS-dmm5k	5 000	<1.10
PSS-dmm14k	14 000	<1.05
PSS-dmm23k	23 000	<1.05
PSS-dmm45k	45 000	<1.05
PSS-dmm65k	65 000	<1.05
PSS-dmm90k	90 000	<1.05
PSS-dmm170k	170 000	<1.05
PSS-dmm350k	350 000	<1.05
PSS-dmm600k	600 000	<1.05
PSS-dmm850k	850 000	<1.10

### ERM-Poly(methyl methacrylate)

Pack Size 1000 mg

Part Number	Molar Mass [Da]	PDI
PSS-emm350k	365 900	1.25

### ERM-Poly(methyl methacrylate) broad

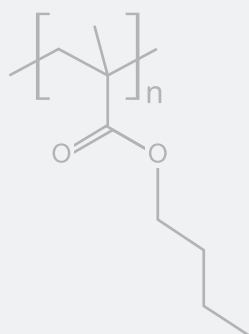
Pack Size 1000 mg

Part Number	Molar Mass [Da]	PDI
PSS-emmb100k	101 100	2.15
PSS-emmb350k	366 400	2.23

## b) Assembled Kits of Molecular Weight Standards of Poly(methyl methacrylate)

Description	MW Range [Da]	Number of standards	Part Number
PSS GPC/SEC Calibration Kit Poly(methyl methacrylate) low	102 to 60 000	8 x 500 mg	PSS-mmkitl
PSS GPC/SEC Calibration Kit Poly(methyl methacrylate) high	600 to 2 500 000	12 x 500 mg	PSS-mmkitH
PSS ReadyCal Kit Poly(methyl methacrylate)	600 to 2 500 000	3 x 10 Vials-4.0mL 3 x 10 Vials-1.5mL	PSS-mmkitr4 PSS-mmkitr1
PSS DIN Kit Poly(methyl methacrylate)	450 to 850 000	12 x 500 mg	PSS-mmkitd
PSS MALDI Kit Poly(methyl methacrylate)	450 to 60 000	6 x 500 mg	PSS-mmkitm
PSS LS-Visco Kit Poly(methyl methacrylate)	8 000 to 850 000	4 x 500 mg	PSS-mmkitv

## 1.1| Organic standards



### Poly(n-butyl methacrylate)

#### a) 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

#### b) Assembled Kits of Molecular Weight Standards of Poly(n-butyl methacrylate)

Description	MW Range [Da]	Number of standards	Part Number
PSS GPC/SEC Calibration Kit Poly(n-butyl methacrylate)	1 500 to 700 000	9 x 1000 mg	PSS-nbkit

### Poly(t-butyl methacrylate)

#### a) Individual Standards

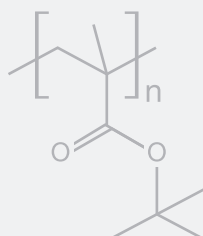
##### Poly(t-butyl methacrylate) narrow

Pack Size 1000 mg

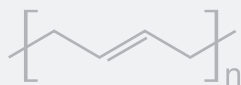
Part Number	Molar Mass [Da]	PDI
PSS-tbma1.5k	1 500	<1.50
PSS-tbma2.1k	2 100	<1.15
PSS-tbma4.7k	4 700	<1.15
PSS-tbma10k	10 000	<1.15
PSS-tbma21k	21 000	<1.15
PSS-tbma47k	47 000	<1.15
PSS-tbma100k	100 000	<1.15
PSS-tbma210k	210 000	<1.15
PSS-tbma470k	470 000	<1.15
PSS-tbma1m	1 000 000	<1.50

#### b) Assembled Kits of Molecular Weight Standards of Poly(t-butyl methacrylate)

Description	MW Range [Da]	Number of standards	Part Number
PSS GPC/SEC Calibration Kit Poly(t-butyl methacrylate)	1 500 to 1 000 000	10 x 1000 mg	PSS-tbmakit



## 1.1| Organic standards



### Polydiene Standards

#### 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) Assembled Kits of Molecular Weight Standards of Poly(butadiene-1.4)

Description	MW 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

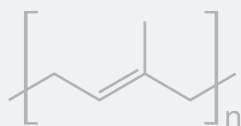
##### Poly(isoprene-1.4) narrow

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) Assembled Kits of Molecular Weight Standards of Poly(isoprene-1.4)

Description	MW Range [Da]	Number of standards	Part Number
PSS GPC/SEC Calibration Kit Poly(isoprene-1.4)	1 000 to 1 000 000	10 x 1000 mg	PSS-piokit





## 1.1| Organic standards



### Poly(olefins)

#### Poly(ethylene)

##### a) Individual Standards

Poly(ethylene)		Pack Size 250 mg
Part Number	Molar Mass [Da]	PDI
PSS-pe1.2k	1 200	<2.00
PSS-pe2k	2 000	<2.00
PSS-pe17k	17 000	<2.00
PSS-pe21k	21 000	<2.00
PSS-pe37k	37 000	<2.00
PSS-pe60k	60 000	<2.00
PSS-pe77k	77 000	<2.00
PSS-pe85k	85 000	<2.00
PSS-pe92k	92 000	<2.00
PSS-pe110k	110 000	<2.00
PSS-pe150k	150 000	<2.00
PSS-pe170k	170 000	<2.00
PSS-pe180k	180 000	<2.00

##### b) Assembled Kits of Molecular Weight Standards of Poly(ethylene)

Description	MW Range [Da]	Number of standards	Part Number
PSS GPC/SEC Calibration Kit Poly(ethylene)	340 to 180 000	10 x 250 mg	PSS-pekit

### Further Standards

#### Poly(2-vinylpyridine)

##### a) Individual Standards

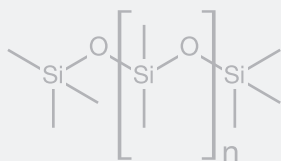
Poly(2-vinylpyridine) narrow		Pack Size 1000 mg
Part Number	Molar Mass [Da]	PDI
PSS-pvp1k	1 000	<1.50
PSS-pvp2.1k	2 100	<1.50
PSS-pvp4.7k	4 700	<1.50
PSS-pvp10k	10 000	<1.15
PSS-pvp21k	21 000	<1.15
PSS-pvp47k	47 000	<1.15
PSS-pvp110k	110 000	<1.15
PSS-pvp265k	265 000	<1.15
PSS-pvp1m	1 000 000	<1.50



##### b) Assembled Kits of Molecular Weight Standards of Poly(2-vinylpyridine)

Description	MW Range [Da]	Number of standards	Part Number
PSS GPC/SEC Calibration Kit Poly(2-vinylpyridine)	1 000 to 265 000	8 x 1000 mg	PSS-pvpkit

## Poly(dimethylsiloxane)



### Assembled Kits of Molecular Weight Standards of Poly(dimethylsiloxane)

Description	MW Range [Da]	Number of standards	Part Number
PSS GPC/SEC Calibration Kit Poly(dimethylsiloxane)	311 to 200 000	8 x 500 mg	PSS-pdmkit

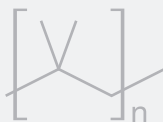
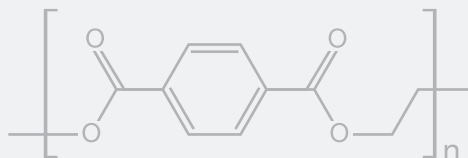
## Poly(ethylene terephthalate)

### 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)

### Assembled Kits of Molecular Weight Standards of Poly(isobutylene)

Description	MW Range [Da]	Number of standards	Part Number
PSS GPC/SEC Calibration Kit Poly(isobutylene)	350 to 700 000	10 x 250 mg	PSS-pibkit

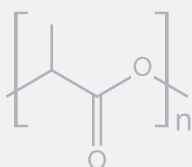
## Poly(lactide)

### a) Individual Standards

#### CRM-Poly(lactide)

Pack Size 1000 mg

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



### b) Assembled Kits of Molecular Weight Standards of Poly(L-lactide)

Description	MW Range [Da]	Number of standards	Part Number
PSS GPC/SEC Calibration Kit Poly(L-lactide)	150 to 40 000	8 x 200 mg	PSS-plakit
PSS GPC/SEC Calibration Kit Poly(L-lactide) high	150 to 200 000	8 x 200 mg + 1 (broad) 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-dxt12k	12 000	<1.50
PSS-dxt25k	25 000	<1.50
PSS-dxt50k	50 000	<1.50
PSS-dxt80k	80 000	<1.50
PSS-dxt150k	150 000	<1.50
PSS-dxt270k	270 000	<2.00
PSS-dxt410k	410 000	<2.00
PSS-dxt670k	670 000	<2.50

## Dextran broad/branched

Pack Size 1000 mg

Part Number	Molar Mass [Da]	PDI
PSS-dxtb4k	4 000	>1.50
PSS-dxtb10k	10 000	>1.50
PSS-dxtb40k	40 000	>1.50
PSS-dxtb70k	70 000	>1.50
PSS-dxtb500k	500 000	>1.70
PSS-dxtb1.5m	1 500 000	>1.70
PSS-dxtb3m	3 000 000	>1.70
PSS-dxtb17m	17 000 000	>1.70

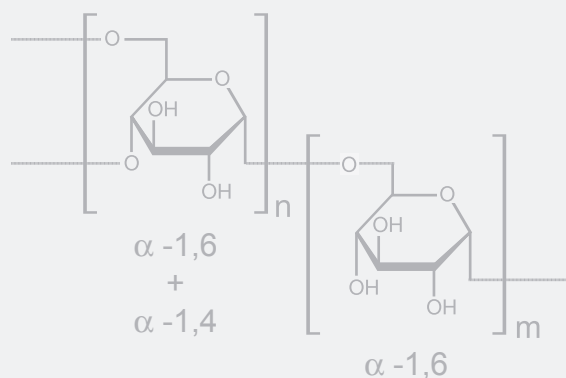
## DIN-Dextran

Pack Size 1000 mg

Part Number	Molar Mass [Da]	PDI
PSS-ddxt180	180	1.00
PSS-ddxt342	342	1.00
PSS-ddxt1.3k	1 300	<1.50
PSS-ddxt5k	5 000	<2.00
PSS-ddxt12k	12 000	<1.50
PSS-ddxt25k	25 000	<1.50
PSS-ddxt50k	50 000	<1.50
PSS-ddxt80k	80 000	<1.50
PSS-ddxt150k	150 000	<1.50
PSS-ddxt270k	270 000	<2.00
PSS-ddxt410k	410 000	<2.00
PSS-ddxt3m	3 000 000	>1.70

Dextran (Branched Poly(saccharide))  
Membrane Characterization StandardsPack Sizes  
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



## 1.2| Aqueous standards

### b) Assembled Kits of Molecular Weight Standards of Dextran

Description	MW Range [Da]	Number of standards	Part Number
PSS GPC/SEC Calibration Kit Dextran	180 to 410 000	10 x 500 mg	PSS-dxtkit
PSS DIN Kit Dextran	180 to 410 000	10 x 500 mg	PSS-dxtkitd
PSS LS-Visco Kit Dextran	12 000 to 410 000	4 x 500 mg	PSS-dxtkitv

### Pullulan

#### a) Individual Standards

##### DIN-Pullulan

Pack Size 100 mg

Part Number	Molar Mass [Da]	PDI
PSS-dpul342	342	1.00
PSS-dpul1.3k	1 300	<1.30
PSS-dpul6k	6 000	<1.20
PSS-dpul12k	12 000	<1.20
PSS-dpul22k	22 000	<1.20
PSS-dpul50k	50 000	<1.20
PSS-dpul110k	110 000	<1.20
PSS-dpul200k	200 000	<1.20
PSS-dpul400k	400 000	<1.20
PSS-dpul800k	800 000	<1.20
PSS-dpul1.3m	1 300 000	<1.50
PSS-dpul2.5m	2 500 000	<1.50

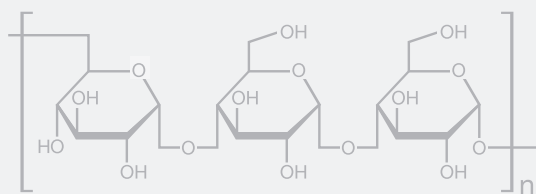
##### Pullulan (Linear Poly(saccharide)) Membrane Characterization Standard

Pack Sizes  
50 g, 100 g, 250 g, 500 g

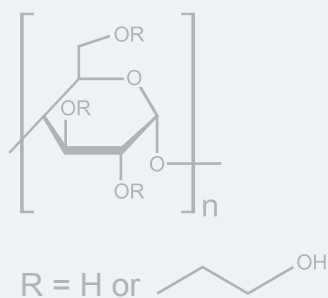
Part Number	Molar Mass [Da]	PDI
PSS-mepulb300k	300 000	>2.00

#### b) Assembled Kits of Molecular Weight Standards of Pullulan

Description	MW Range [Da]	Number of standards	Part Number
PSS GPC/SEC Calibration Kit Pullulan	342 to 800 000	10 x 100 mg	PSS-pulkit



## 1.2| Aqueous standards



### Hydroxyethyl starch

#### a) Individual Standards

##### Hydroxyethyl starch

Pack Size 250 mg

Part Number	Molar Mass [Da]	PDI
PSS-hes24k	24 000	<2.50
PSS-hes40k	40 000	<2.50
PSS-hes90k	90 000	<2.50
PSS-hes300k	300 000	<2.50
PSS-hes550k	550 000	<2.50
PSS-hes1.3m	1 300 000	<2.50
PSS-hes1.4m	1 400 000	<2.50
PSS-hes2m	2 000 000	<2.50

#### b) Assembled Kits of Molecular Weight Standards of Hydroxyethyl starch

Description	MW Range [Da]	Number of standards	Part Number
PSS GPC/SEC Calibration Kit Hydroxyethyl starch	24 000 to 2 000 000	7 x 250 mg	PSS-heskit

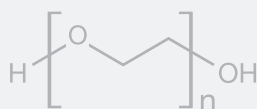
## Poly(ethylene glycol) and Poly(ethylene oxide)

### 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	<1.25
PSS-peg42k	42 000	<1.25

## 1.2| Aqueous standards



### DIN-Poly(ethylene glycol)

Pack Size 1000 mg

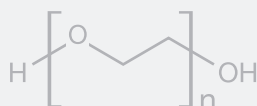
Part Number	Molar Mass [Da]	PDI
PSS-dpeg106	106	1.00
PSS-dpeg194	194	1.00
PSS-dpeg400	400	<1.25
PSS-dpeg1k	1 000	<1.25
PSS-dpeg2k	2 000	<1.25
PSS-dpeg3k	3 000	<1.25
PSS-dpeg6k	6 000	<1.25
PSS-dpeg12k	12 000	<1.25
PSS-dpeg26k	26 000	<1.25
PSS-dpeg42k	42 000	<1.25

### b) Assembled Kits of Molecular Weight Standards of Poly(ethylene glycol)

Description	MW Range [Da]	Number of standards	Part Number
PSS GPC/SEC Calibration Kit Poly(ethylene glycol)	106 to 42 000	10 x 500 mg	PSS-pegkit
PSS ReadyCal Kit Poly(ethylene glycol)	232 to 42 000	3 x 10 Vials-1.5mL	PSS-pegkitr1
PSS DIN Kit Poly(ethylene glycol)	106 to 42 000	10 x 500 mg	PSS-pegkitd
PSS MALDI Kit Poly(ethylene glycol)	400 to 26 000	6 x 500 mg	PSS-pegkitm

### 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

### ERM-Poly(ethylene oxide)

Pack Size 1000 mg

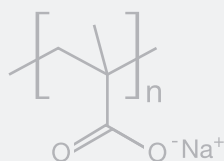
Part Number	Molar Mass [Da]	PDI
PSS-epeo6k	6 200	1.06
PSS-epeo11k	11 350	1.11

### b) Assembled Kits of Molecular Weight Standards of Poly(ethylene oxide)

Description	MW Range [Da]	Number of standards	Part Number
PSS GPC/SEC Calibration Kit Poly(ethylene oxide)	25 000 to 1 000 000	8 x 500 mg	PSS-peokit
PSS ReadyCal Kit Poly(ethylene oxide)/Poly(ethylene glycol)	232 to 1 000 000	3 x 10 Vials-4.0mL 3 x 10 Vials-1.5mL	PSS-peokit4 PSS-peokit1



## 1.2| Aqueous standards



### Poly((meth)acrylic 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) Assembled Kits of Molecular Weight Standards of Poly(methacrylic acid) sodium salt

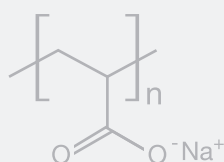
Description	MW Range [Da]	Number of standards	Part Number
PSS GPC/SEC Calibration Kit Poly(methacrylic acid) sodium salt	1 200 to 500 000	8 x 500 mg	PSS-pmakit

#### Poly(acrylic acid) sodium salt

##### a) Individual Standards

#### Poly(acrylic acid) sodium salt

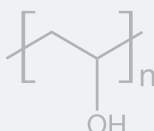
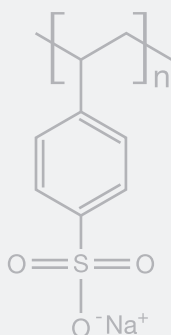
Pack Size 250 mg



##### b) Assembled Kits of Molecular Weight Standards of Poly(acrylic acid) sodium salt

Description	MW Range [Da]	Number of standards	Part Number
PSS GPC/SEC Calibration Kit Poly(acrylic acid) sodium salt	2 000 to 1 500 000	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-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) Assembled Kits of Molecular Weight Standards of Poly(styrene sulfonate) sodium salt

Description	MW Range [Da]	Number of standards	Part Number
PSS GPC/SEC Calibration Kit Poly(styrene sulfonate) sodium salt	1 000 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-pvo5k	5 000	<2.50
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	MW Range [Da]	Number of standards	Part Number
PSS GPC/SEC Calibration Kit Protein	243 to 670 000	10 x 100 mg	PSS-prokit



## 1.3| Validation Kits

### a) MALDI Validation Kits

Description	MW Range [Da]	Number of standards	Part Number
PSS MALDI Kit Poly(methyl methacrylate)	450 to 60 000	6 x 500 mg	PSS-mmkitm
PSS MALDI Kit Poly(styrene)	700 to 65 000	6 x 500 mg	PSS-pskitm
PSS MALDI Kit Poly(ethylene glycol)	400 to 26 000	6 x 500 mg	PSS-pegkitm
PSS MALDI mixed Kit (PS, PMMA, PDMS, PEG, PSS)	4 500 to 6 000	5 x 500 mg	PSS-mixkitm

### b) Light Scattering/Viscometry Validation Kits

Description	MW Range [Da]	Number of standards	Part Number
PSS LS-Visco Kit Poly(methyl methacrylate)	8 000 to 850 000	4 x 500 mg	PSS-mmkitv
PSS LS-Visco Kit Poly(styrene)	9 000 to 560 000	4 x 500 mg	PSS-pskitv
PSS LS-Visco Kit Dextran	12 000 to 410 000	4 x 500 mg	PSS-dxtkitv

### c) EasyValid Validation Kit

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



## 1.4| Custom Request Polymerizations, Specialty Polymers and Polymer Networks

This catalog shows some examples for specialty polymers, which have not been manufactured as “classical reference materials” with just a defined molar mass distribution. The term “Specialty Polymers” includes all different kinds of copolymers and functionalized or deuterated polymers.

**Please visit our website [www.pss-polymer.com](http://www.pss-polymer.com) for an extended list. Contact us to request tailor-made polymers.**

### Deuterated Polymers

Polymer	Molar Mass range [Da]	
	min.	max.
Poly(butadiene-1,4-d6)	23 000	
Poly(carbonate-d4) broad		50 000
Poly(methyl methacrylate-d8)	4 000	580 000
Poly(para-methylstyrene-d10)		100 000
Poly(styrene-d3)	160 000	
Poly(styrene-d8)	900	830 000
Poly(styrenesulfonate-d8) sodium salt	3 500	80 000

### Deuterated Block Copolymers

#### Excerpt of the available Copolymers

Poly(styrene-d8-b-methyl methacrylate-d8)
Poly(styrene-d8-b-n-butyl methacrylate)
Poly(styrene-d8-b-methyl methacrylate)
Poly(styrene-d8-b-isoprene-1.4)
Poly(styrene-d8-b-dimethyl siloxane)
Poly(styrene-d8-b-2-vinylpyridine)
Poly(alpha-methylstyrene-b-styrene-d8)

### Polymers with Functional End Groups

Polymer	Molar Mass range [Da]	
	min.	max.
Poly(butadiene-1.4) OH-endgroup		10 000
Poly(ethylene glycol) dimethylether	90	2 000
Poly(styrene) brominated	40 000	230 000
Poly(styrene) fluorescein labeled	700	680 000
Poly(styrene) sulfonated Li-labeled	5 000	18 000
Poly(styrene) with deuterium end group	2 000	70 000
Poly(styrene) without initiator end group	2 000	60 000

## Star Polymers

Polymer	Molar Mass range [Da]	
	min.	max.
Poly(isoprene-1.4) 3-star	67 000	120 000
Poly(styrene) 3-star	45 000	300 000

## Block Copolymers

### Excerpt of the available Copolymers

Poly(styrene-b-methyl methacrylate)
Poly(styrene-b-n-butyl methacrylate)
Poly(styrene-b-2-vinylpyridine)
Poly(styrene-b-butadiene-1.4)
Poly(styrene-b-isoprene-1.4)
Poly(styrene-b-dimethyl siloxane)
Poly(styrene-b-alpha-methylstyrene)
Poly(styrene-b-acrylic acid)
Poly(styrene-b-ethylene oxide)
Poly(methyl methacrylate-b-n-butyl methacrylate)
Poly(methyl methacrylate-b-t-butyl methacrylate)
Poly(butadiene-1.4-b-methacrylic acid)
Poly(isoprene-1.4-b-butadiene-1.2)
Poly(dodecyl methacrylate-b-n-butyl methacrylate)
Poly(2-vinylpyridine-b-methyl methacrylate)

## 1.5] Particle Standards\*



The 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 discrete 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

Nanosphere Particle Size Standards are used for the calibration of electron and atomic force microscopes, in laser light scattering studies and colloidal systems research. EZY-CAL Particle Size Standards are a series of ready-to-use standards for validating optical particle counters with an absolute minimum of diluting or handling. The products are suspensions of polymer microspheres in water with a concentration of 2 000 particles/ml. A magnetic stirrer bar is included in each bottle for clean, convenient, and direct sampling.

\* Only in selected countries.



## 2| Successful Separation with PSS Columns

Our high performance columns are the result of comprehensive research focusing on the development of more efficient and robust gel materials and on improved packing technology. Our experts work continuously on new, improved solutions and stationary phases to separate synthetic and natural macromolecules by their hydrodynamic volume.

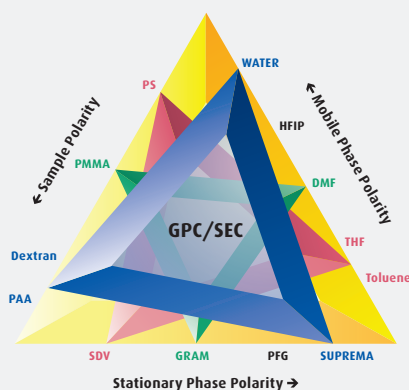
Although the application of isocratic conditions is sufficient for most tasks in macromolecular liquid chromatography, the selection of the best stationary phase and method development can be challenging.

Our concept for column selection and our recommendations are based on 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.

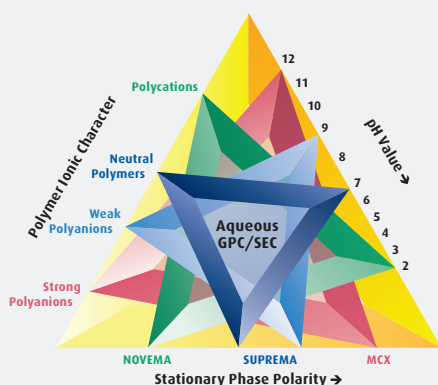
## GPC/SEC Column Selection

A GPC/SEC column can be selected by different criteria depending on your analytical goal (highest resolution, product screening, etc.). Our recommendations and applications are based on the following concepts.

PSS Magic Triangle for GPC/SEC applications



PSS Magic Triangle for aqueous GPC/SEC applications



### 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 determinant factor. The polarity of the sample defines the polarity of the solvent and therefore also that of the stationary phase.

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

#### Using the PSS Magic Triangle

Construct a new smaller equilateral 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 stationary phase into account.

### B Particle Sizes

PSS GPC/SEC column materials are available in several particle sizes from 3  $\mu\text{m}$  up to 20  $\mu\text{m}$  particles.

The optimum particle size depends on

- The solvent viscosity (higher viscosity requires larger particle size)
- The sample molar mass (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.
- The higher the molecular weight 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 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.

**PSS preconfigured column combinations and linear columns already use the optimum particle size for the molar mass range they are designed for.**

## 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	Protection
	4.6 x 30	
	20 x 50	
Analytical	8 x 300	Conventional analysis
Micro	4.6 x 250	Solvent saving, small sample amounts
Preparative	20 x 300	Preparative sample fractionation, sample collection
	40 x 250	
HighSpeed	20 x 50	Ultra-fast analysis

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

PEEK columns are available as 8 x 50 mm precolumns and 8 x 300 mm analytical columns.

**For additional column dimensions please call us or your local representative.**

## Advantages of PSS Column Technology



- Excellent separation efficiency obtained with narrow particle size distribution gels 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 alike.
- Column production under DIN EN ISO 9001 quality standards.
- Controlled Quality: each column is tested according to DIN 55672 and ISO/EN 13885.
- Delivered with detailed user documentation and a quality certificate.
- PSS engineered fittings and their 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 endfittings.
- Refill Service: PSS can refurbish old columns with new gel-material, providing a cost saving and environmental friendly option.
- 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 a GPC/SEC system. Although only isocratic conditions are normally used, 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 over many years.

### A Column Selection Service

In doubt or no PSS application available? Then use our column selection service, where we determine the optimum stationary and mobile phase combination. A service fee is only charged if we are able to find a column material – and is 100% credited if you purchase the recommended column.

### B 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.

### C Custom Synthesis

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

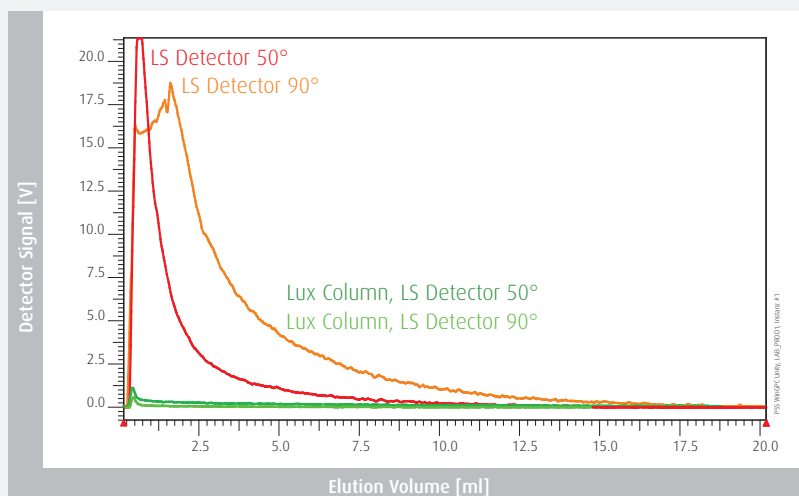
### D Batch Reservation

Long term reproducibility is important, not only for critical applications. PSS can reserve batches for dedicated applications and deliver columns to any location worldwide. This ensures highest inter-laboratory consistency and precise, accurate results.



## E Columns Pre-equilibrated for Light scattering (Lux)

PSS offers pre-equilibrated columns for the use with light scattering detectors that reach the steady state > 20 times faster than other columns. The overall noise reduction is more than 25 times better.



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

## F Solvent of Choice

PSS can deliver the columns in the solvent of choice, with the exception of solvents with a high freezing point (e.g. DMSO and TCB). Colour-coded end plugs indicate the solvent within the column.

## G Free Column Connectors

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

## H Test Mixture

Where applicable, PSS ships a polymer mixture for qualifying the column installation.

## I Refill Services

PSS offers a refill service at a considerable cost saving for all clients in the European Union. We deliver the new column, then, after installation, you send the old column back. PSS refurbishes the old column hardware – to protect the environment and to save precious resources.



## Overview of PSS Columns and Their Applications

### Organic GPC/SEC

	Calibration Standards	Applications	Solvents	Particle Size [ $\mu\text{m}$ ]	Porosities [ $\text{\AA}$ ]	Range MW [Da]
SDV	Poly(styrenes), all Poly(methacrylates) and Poly(acrylates), Polydienes, Poly(dimethylsiloxanes), Poly(2-vinylpyridine), Poly(isobutylene), Poly(vinyl acetate), Poly(vinylchloride)	Poly(styrene), Poly(vinylchloride), Poly(carbonate), Elastomers, Resins, etc.	THF, Toluene, TCM, DCM	3	50 – 10 <sup>5</sup> , Linear S, M	100 - 1 M
				5	50 – 10 <sup>6</sup> , Linear S, M, XL	100 - 30 M
				10	50 – 10 <sup>7</sup> , Linear M, XL	100 - 30 M
GRAM	Poly(styrene), Poly(methyl methacrylate), Poly(vinylpyrrolidone)	Polyurethanes, Polyimide, Starches, Cellulosics, certain Polyamides, other polar polymers	DMF, DMAC, NMP, DMSO	10	30 – 10 <sup>4</sup> , Linear	100 - 50 M
PolarSil	Poly(styrene), Poly(methyl methacrylate)	Resins, Lignins	DMF, DMAC, NMP, DMSO	5	100 – 1 000, Linear S	100 - 1 M
PFG	Poly(methyl methacrylate), Poly(lactides), Poly(ethylene terephthalate), Nylon 6 broad, Poly(amide)	Crystalline polymers, Polyesters, Nylons, Polylactides, POM, etc.	HFIP, TFE, other fluorinated solvents	5	100 - 1 000, Linear S, M	100 - 1 M
				7	100 - 4 000, Linear S, M, XL	100 - 3 M
POLEFIN	Poly(styrene), Poly(ethylene), Poly(isobutylene)	Poly(ethylene), Poly(propylene), other Polyolefins	TCB, oDCB, Decalin	10	1 000 - 10 <sup>7</sup> , Linear M, XL	100 - 10 M
				20	Linear XL	1 000 - 30 M

### Aqueous GPC/SEC

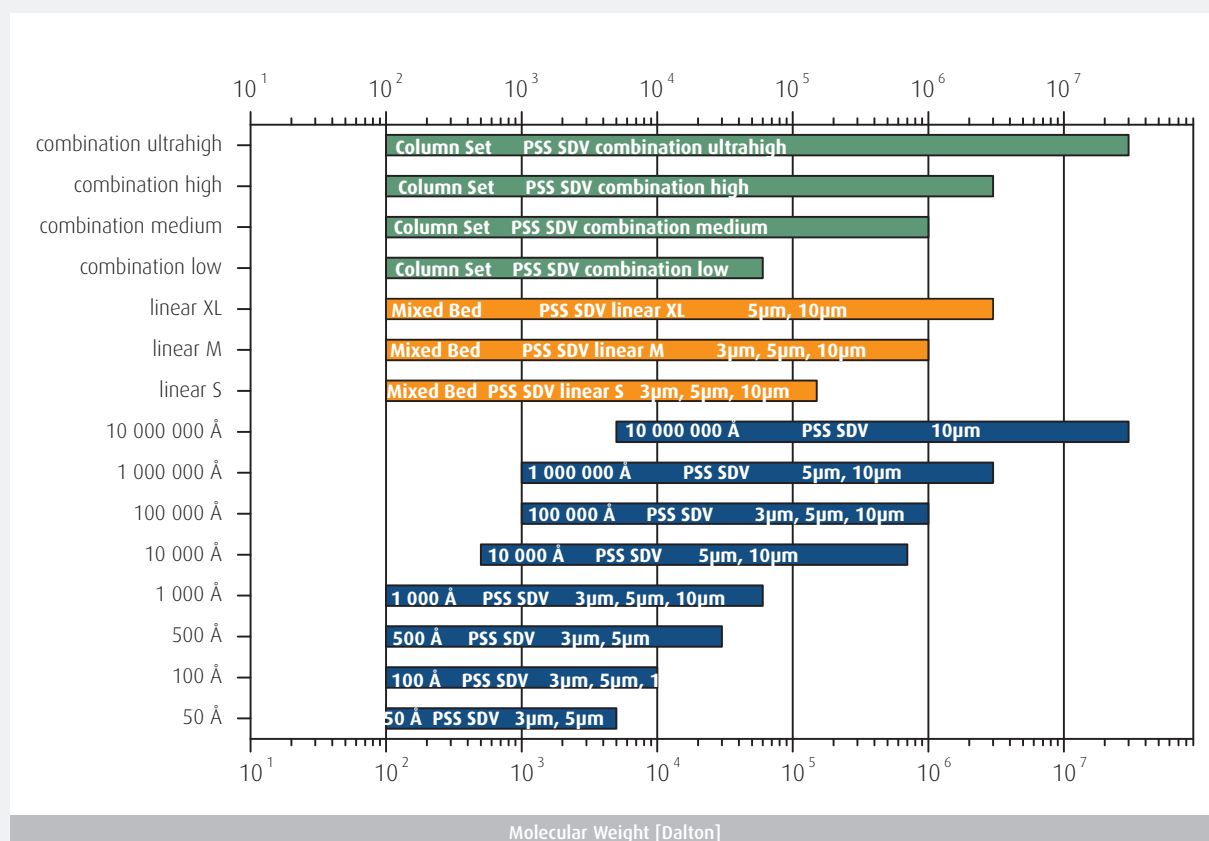
	Calibration Standards	Applications	Solvents	Particle Size [ $\mu\text{m}$ ]	Porosities [ $\text{\AA}$ ]	Range MW [Da]
SUPREMA	Pullulan, Dextran, Hydroxyethyl starch, Poly(ethylene glycol), Poly(ethylene oxide), Poly(vinylalcohol), Poly(acrylamide) broad, Poly((meth) acrylic acid) sodium salts	Neutral and anionic polymers, (PEO, PEG, Pullulan, Dextran, Poly(acrylamide), Hyaluronic acid, Poly(acryl acid), Carboxymethyl cellulose, etc.)	water (with salts/ buffers, MeOH, ACN) pH: 1.5 - 13	5	30 - 1 000, Linear S, M	100 - 1 M
				10	30 - 3 000, Linear S, M, XL, Ultrahigh	100 - 30 M
NOVEMA Max	Pullulan, Dextran, Poly(2-vinylpyridine), Poly(DADMAC)	Cationic polymers, (Polymeric Quaternary Ammonium Compounds, PolyDADMAC, Poly(vinyl pyridines), Chitosan, Poly(ethylene imine), etc.)	water (with salts/ buffers, MeOH, ACN, TFA) pH: 1.5 - 7	10	30 - 3 000, Linear S, M, XL, Ultrahigh	100 - 30 M
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: 7 - 13	5	100 - 1 000	100 - 70 K
				10	1 000 - 10 <sup>7</sup>	100 - 5 M
PROTEEMA	Pullulan, Dextran, Proteins	Natural and synthetic Proteins, Peptides, Enzymes, Gelatins/Collagens	water (with salts/ buffers) pH: 2 - 9	3	100 - 300	100 - 1.2 M
				5	100 - 1 000	100 - 7.5 M

## 2.1| Columns for Organic Solvents

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

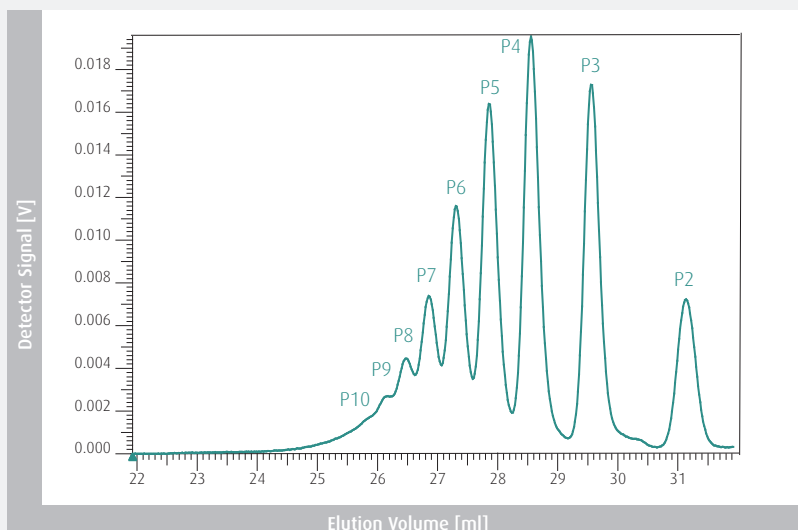
Field of Application	
Applicability	Poly(styrene), Poly(vinyl chloride), Poly(carbonate), Elastomers, Resins and other
Eluents	THF, Toluene, TCM, DCM
Specifications	
Material	Styrene-divinylbenzene-copolymer network
Maximum Pressure	45 - 150 bar (650 - 2180 psi), depending on porosity
Maximum Temperature	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

### Separation Ranges



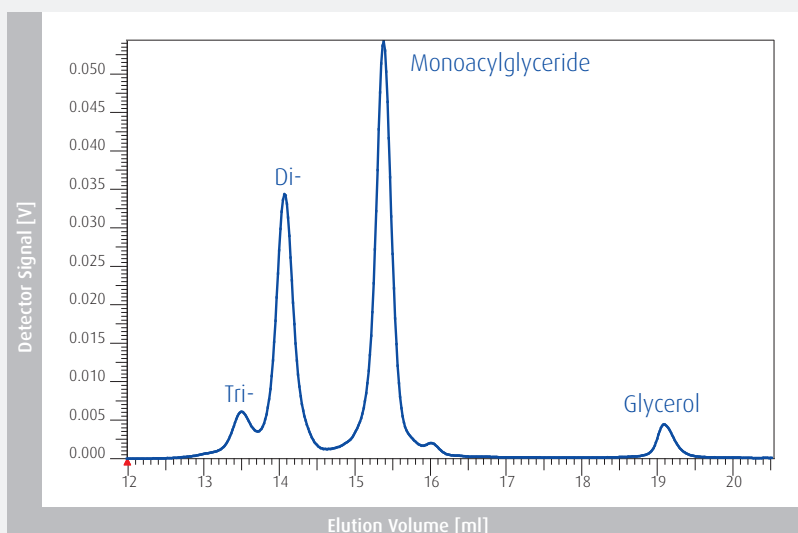
## Oligomeric Poly(styrene)

**Flow rate:** 0.5 ml/min  
**Loading:** 1 g/l, 20  $\mu$ l  
**Eluent:** THF  
**Temperature:** 25° C  
**Detector:** SECcurity RI  
**Columns:** SDV 5  $\mu$ m, 50 Å, 100 Å,  
 100 Å (8 x 300 mm)  
 + precolumn



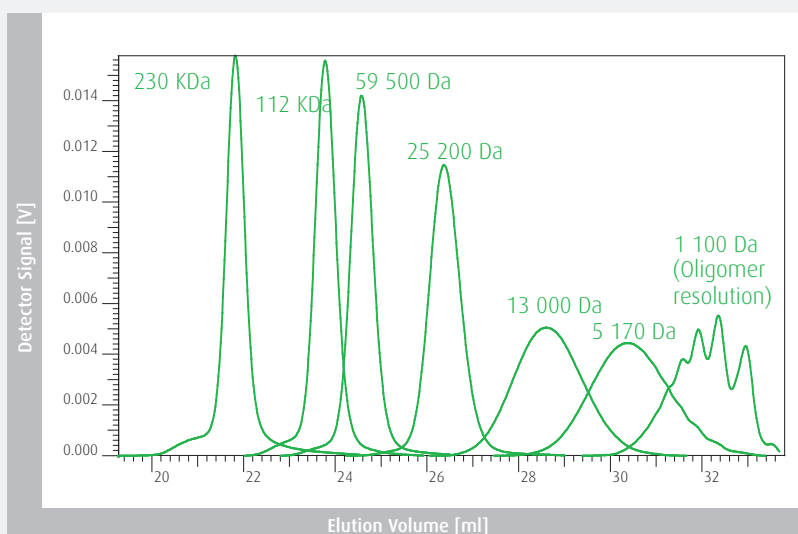
## Glyceride acc. EUP

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



## Poly(dimethyl siloxane)

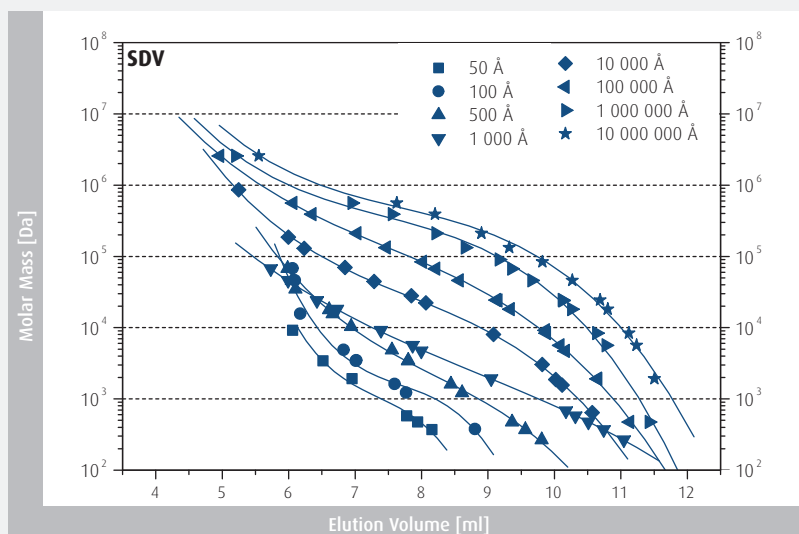
**Flow rate:** 1 ml/min  
**Loading:** 2 g/l, 20  $\mu$ l  
**Eluent:** Toluene  
**Temperature:** 25° C  
**Detector:** SECcurity RI  
**Columns:** PSS SDV Combination high  
 (P/N 201-0003)



## Calibration Curves

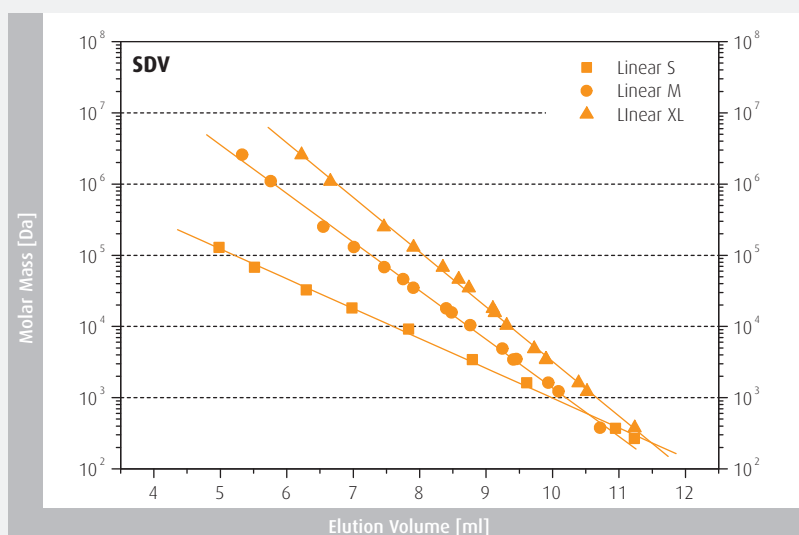
### Single Porosity Columns

Eluent: THF  
Calibrants: Poly(styrene)



### Linear Columns

Eluent: THF  
Calibrants: Poly(styrene)



## Part Numbers

### a) 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
1 000 - 1 000 000 Da	3	100 000	sda083003e5			sdm052503e5
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			
500 - 700 000 Da	10	10 000	sda0830101e4			
1 000 - 1 000 000 Da	10	100 000	sda0830101e5			
1 000 - 3 000 000 Da	10	1 000 000	sda0830101e6			
5 000 - 30 000 000 Da	10	10 000 000	sda0830101e7			
100 - 150 000 Da	10	Linear S	sda083010lis			
100 - 1 000 000 Da	10	Linear M	sda083010lim			
100 - 3 000 000 Da	10	Linear XL	sda083010lxl			

### b) Preconfigured Analytical Column Sets

Separation range [Da]	Column Set	Description	Part Number
100 - 60 000	PSS SDV combination low	1 x SDV precolumn 3µm 8x50mm (P/N sda080503) 3 x SDV columns 3µm 1000Å 8x300mm (P/N sda0830031e3)	201-0001
100 - 1 000 000	PSS SDV combination medium	1 x SDV precolumn 5µm 8x50mm (P/N sda080505) 1 x SDV column 5µm 1000Å 8x300mm (P/N sda0830051e3) 1 x SDV column 5µm 10e <sup>5</sup> Å 8x300mm (P/N sda0830051e5)	201-0002
100 - 3 000 000	PSS SDV combination high	1 x SDV precolumn 5µm 8x50mm (P/N sda080505) 1 x SDV column 5µm 1000Å 8x300mm (P/N sda0830051e3) 1 x SDV column 5µm 10e <sup>5</sup> Å 8x300mm (P/N sda0830051e5) 1 x SDV column 5µm 10e <sup>6</sup> Å 8x300mm (P/N sda0830051e6)	201-0003
100 - 30 000 000	PSS SDV combination ultrahigh	1 x SDV precolumn 10µm 8x50mm (P/N sda080510) 1 x SDV column 10µm 1000Å 8x300mm (P/N sda0830101e3) 1 x SDV column 10µm 10e <sup>5</sup> Å 8x300mm (P/N sda0830101e5) 1 x SDV column 10µm 10e <sup>7</sup> Å 8x300mm (P/N sda0830101e7)	202-0001

**General Information:** delivered in THF; inclusive column certificates, column connectors, test vials and column manual

**Options:** - Silver-titanium Frits for use with chloroform (P/N 299-2003)

- Solvent of choice (toluene, chloroform, dichlorormethan), please specify (P/N 299-2108 (precolum), P/N 299-2109 (8x300mm))

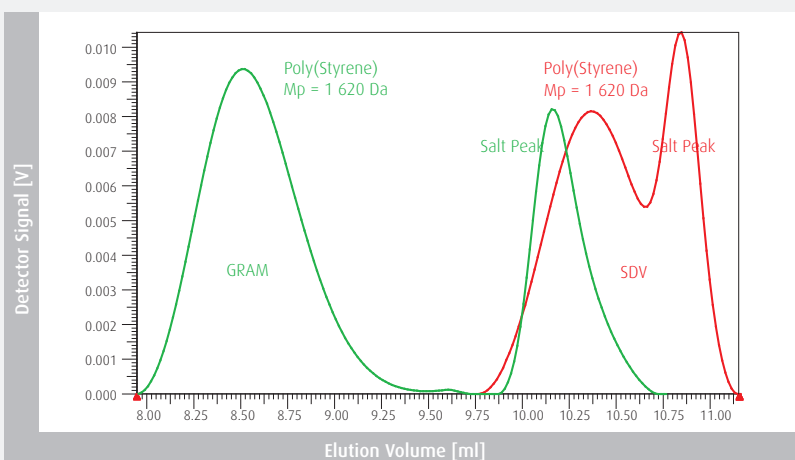
- Pre-equilibrated for light scattering measurements (P/N 299-2200 (precolum), P/N 299-2201 (8x300mm))

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

Field of Application	
Applicability	Polyurethane, Polyimide, Starches, Cellulose, certain Polyamide, 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

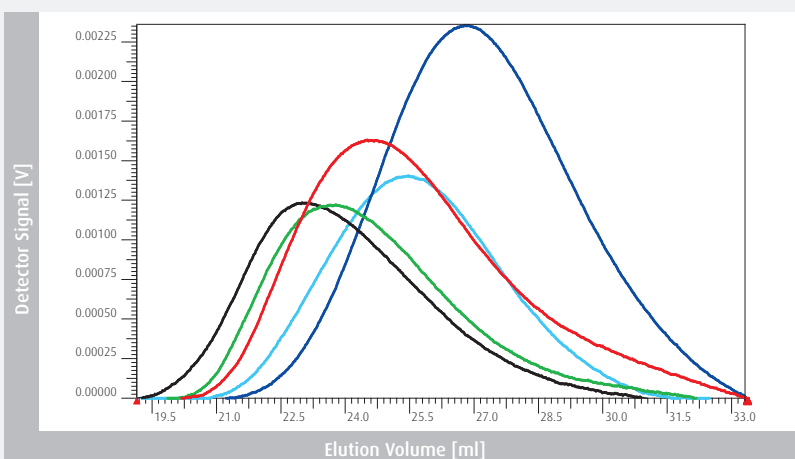
### Separation Oligomers from Salt Peak

**Flow rate:** 1.00 ml/min  
**Loading:** 1.0 g/l, 20 µl  
**Eluent:** DMAc  
**Temperature:** 60° C  
**Detector:** SECcurity RI  
**Columns:** SDV 10 µm 1 000 Å (red line);  
 GRAM 10 µm 100 Å (green line)  
 (8 x 300 mm)



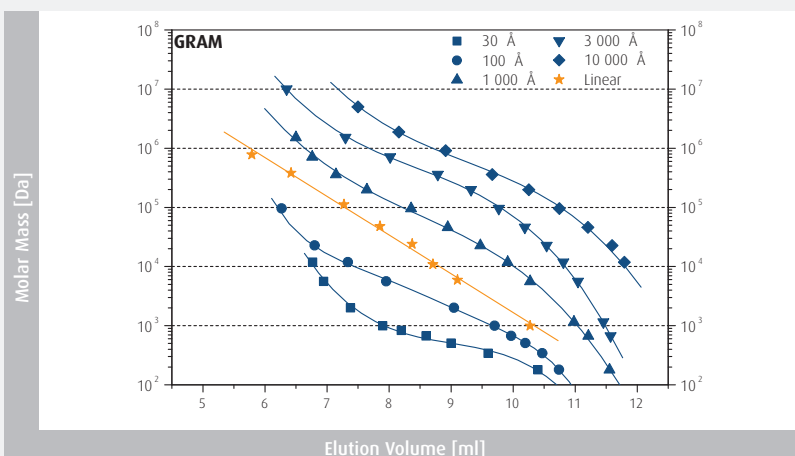
### Methyl Cellulose

**Flow rate:** 0.50 ml/min  
**Loading:** 1.0 g/l, 100 µl  
**Eluent:** DMSO, LiBr 5 g/l  
**Temperature:** 60° C  
**Detector:** SECcurity RI1260  
**Columns:** PSS GRAM  
 Combination ultrahigh

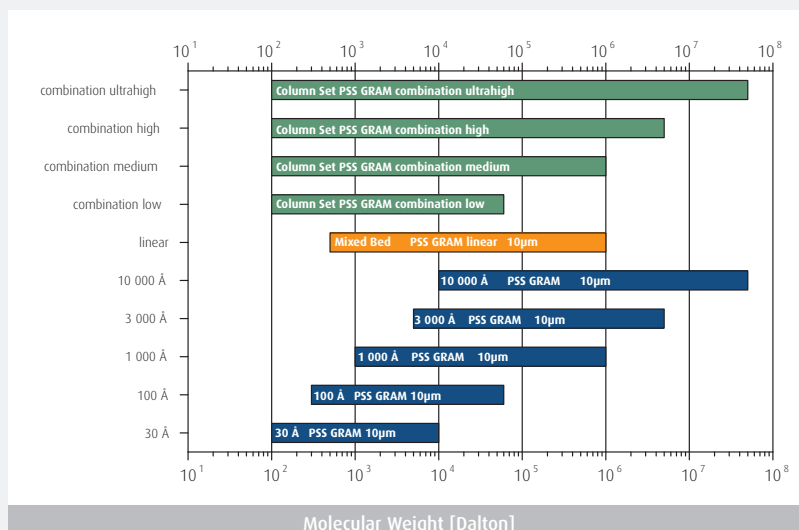


### Calibration Curves

**Eluent:** DMF  
**Calibrants:** Poly(methyl methacrylate)



## Separation Ranges



## Part Numbers

### a) 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	ams2005051e3
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

### b) Preconfigured Analytical Column Sets

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

**General Information:** delivered in DMF, inclusive column certificates, column connectors, test vials and column manual

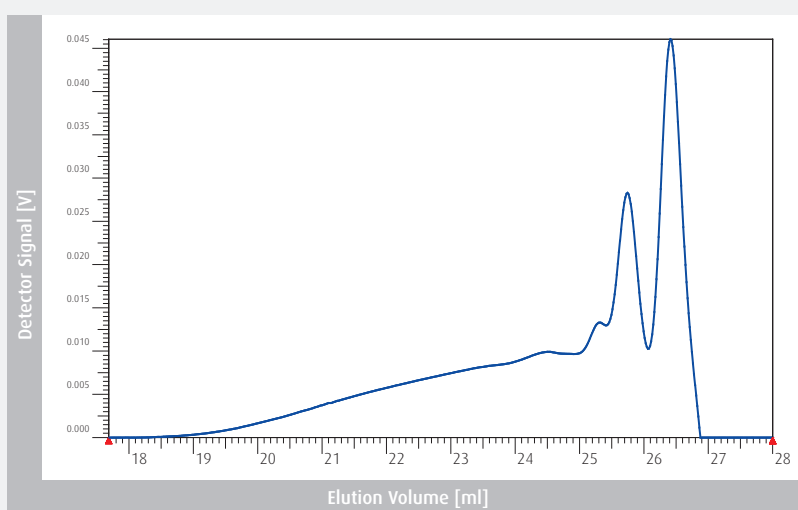
**Options:** - Solvent of choice (DMAc, NMP, THF), please specify (P/N 299-2108 (precolumn), P/N 299-2109 (8x300mm))  
- Pre-equilibrated for light scattering measurements (P/N 299-2200 (precolumn), P/N 299-2201 (8x300mm))

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

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

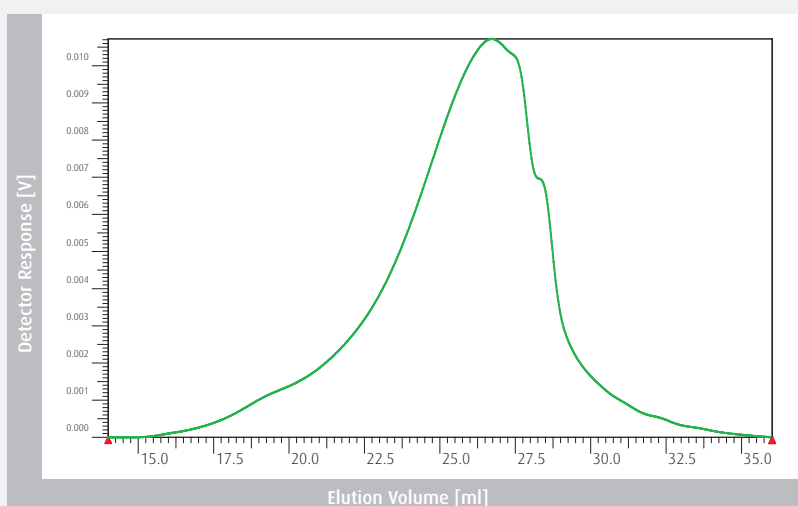
### Phenolic Resin

**Flow rate:** 1.00 ml/min  
**Loading:** 1.0 g/l, 50 µl  
**Eluent:** DMF, LiBr 5 g/l  
**Temperature:** 60° C  
**Detector:** SECcurity R11260  
**Columns:** PSS PolarSil 3 x Linear S 5µm  
 (P/N psa080505 and  
 3 x psa083005lis)



### Lignin

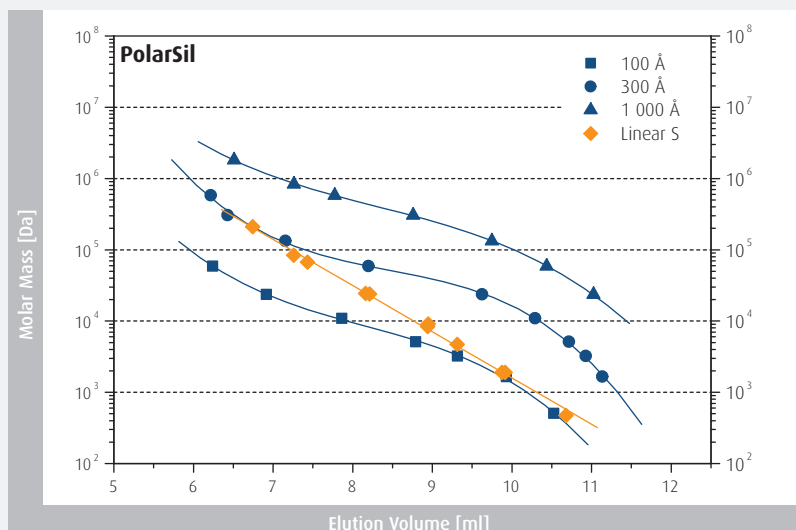
**Flow rate:** 1.00 ml/min  
**Loading:** 2.0 g/l, 20 µl  
**Eluent:** DMSO, LiBr 5 g/l  
**Temperature:** 60° C  
**Detector:** SECcurity R11260  
**Columns:** PSS PolarSil 2 x Linear S 5µm  
 (P/N psa080505 and  
 2 x psa083005lis)



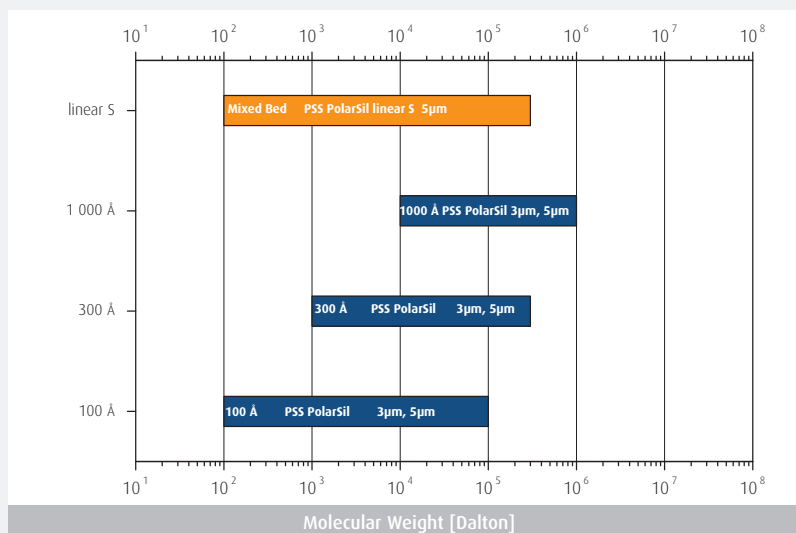


## Calibration Curves

Eluent: DMF  
Calibrants: PMMA



## Separation Ranges



## Part Numbers

### a) 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 – 100 000 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	
	3	Precolumn		psm050303
100 – 100 000 Da	3	100		psm0525031e2
1 000 – 300 000 Da	3	300		psm0525033e2
10 000 – 1 000 000 Da	3	1000		psm0525031e3

**General Information:** delivered in DMF, inclusive column certificates, column connectors, test vials and column manual

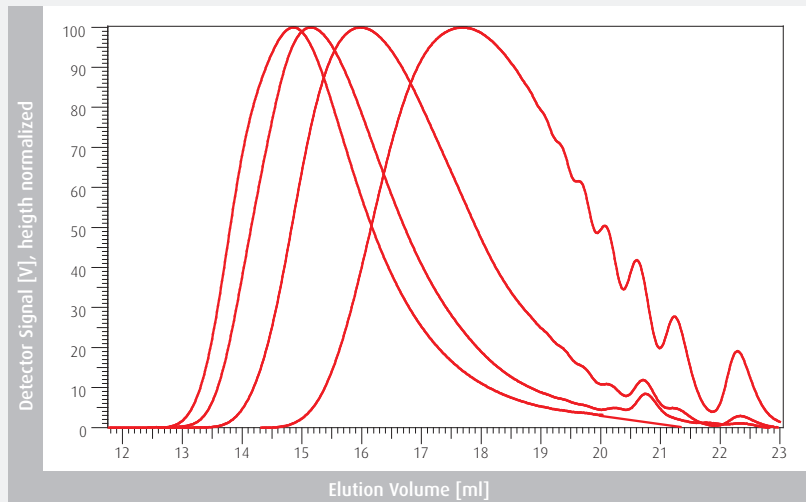
**Options:** - Solvent of choice (DMAc, NMP, THF), please specify (P/N 299-2108 (precolumn), P/N 299-2109 (8x300mm))  
- Pre-equilibrated for light scattering measurements (P/N 299-2200 (precolumn), P/N 299-2201 (8x300mm))

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

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

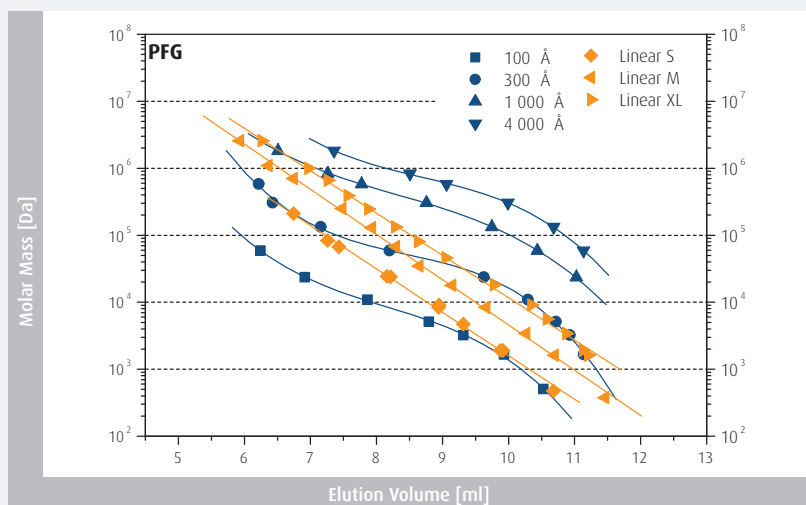
### Poly(ethylene terephthalate)

**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

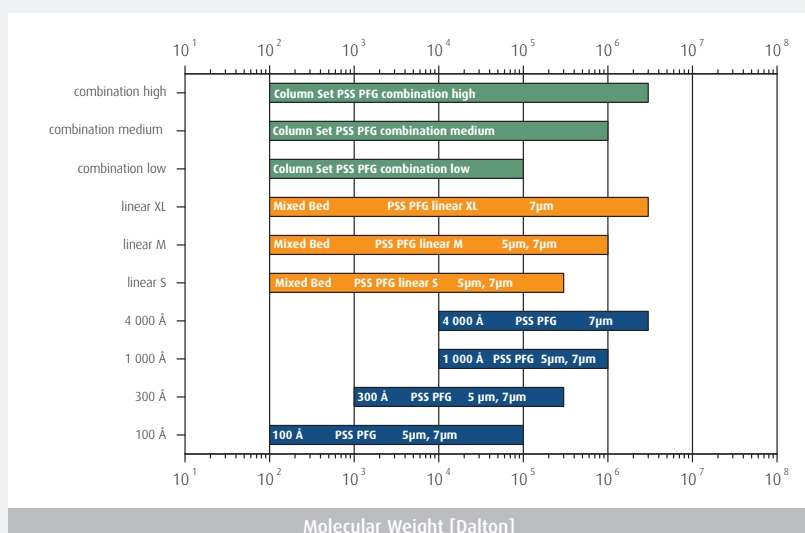


### Calibration Curves

**Eluent:** HFIP  
**Calibrants:** Poly(methyl methacrylate)



## Separation Ranges



## Part Numbers

### a) 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
	7	Precolumn	pfa080507	pfp2005		
100 - 100 000 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	
	5	Precolumn				pfm050305
100 - 100 000 Da	5	100				pfm0525051e2
1 000 - 300 000 Da	5	300				pfm0525053e2
10 000 - 1 000 000 Da	5	1 000				pfm0525051e3
100 - 300 000 Da	5	linear S				pfm052505lis
100 - 1 000 000 Da	5	linear M				pfm052505lim

### b) Preconfigured Analytical Column Sets

Separation range [Da]	Column Set	Description	Part Number
100 - 100 000	PSS PFG combination low	1 x PFG precolumn 7µm 8x50mm (P/N pfa080507) 2 x PFG column 7µm 100Å 8x300mm (P/N pfa0830071e2)	203-0001
100 - 1 000 000	PSS PFG combination medium	1 x PFG precolumn 7µm 8x50mm (P/N pfa080507) 1 x PFG column 7µm 100Å 8x300mm (P/N pfa0830071e2) 1 x PFG column 7µm 1000Å 8x300mm (P/N pfa0830071e3)	203-0002
100 - 3 000 000	PSS PFG combination high	1 x PFG precolumn 7µm 8x50mm (P/N pfa080507) 1 x PFG column 7µm 100Å 8x300mm (P/N pfa0830071e2) 1 x PFG column 7µm 1000Å 8x300mm (P/N pfa0830071e3) 1 x PFG column 7µm 4000Å 8x300mm (P/N pfa0830074e3)	203-0003

**General Information:** delivered in THF, inclusive column certificates, column connectors, test vials and column manual

**Options:** - Silver-titanium Frits for use with TFE, HFIP (P/N 299-2003)

- Solvent of choice (TFE, HFIP), please specify (P/N 299-2100 (precolumn), P/N 299-2101 (8x300mm))

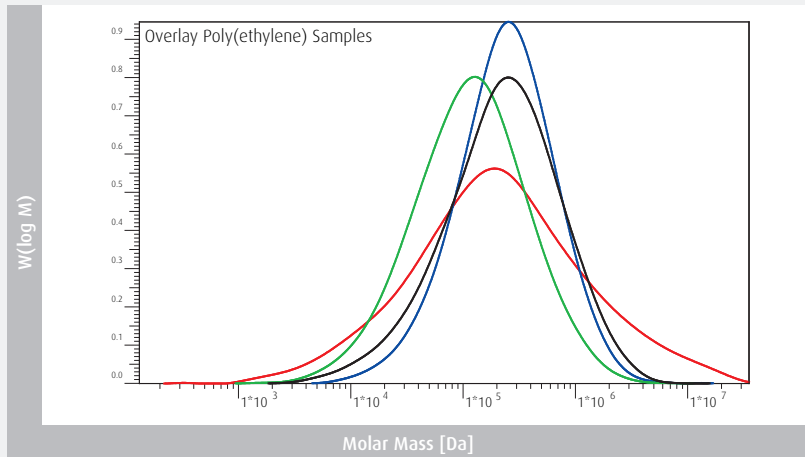
- Pre-equilibrated for light scattering measurements (P/N 299-2200 (precolumn), P/N 299-2201 (8x300mm))

## High Temperature GPC/SEC of Polyolefins - POLEFIN Columns

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

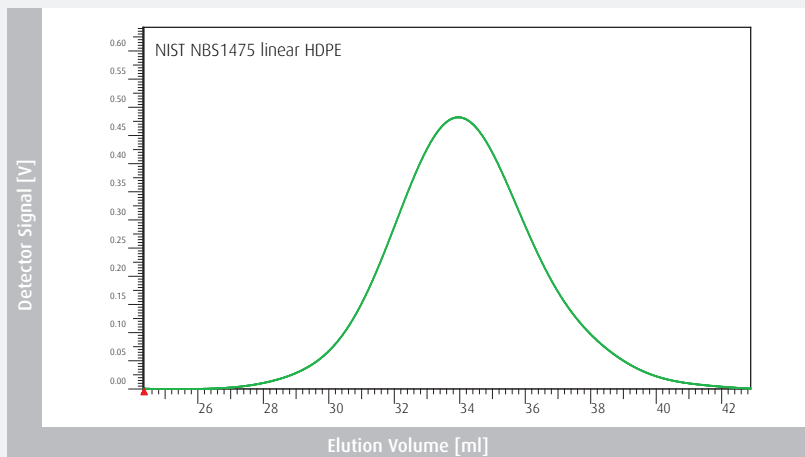
### Poly(olefins), broad distribution

**Flow rate:** 0.50 ml/min  
**Loading:** 3.0 g/l, 200 µl  
**Eluent:** TCB  
**Temperature:** 170° C  
**Detector:** GPC-IR4-CH<sub>2</sub>  
**Columns:** PSS POLEFIN 4 x Linear XL 20µm  
 (P/N poa080520 and  
 4 x poa083020lxl)



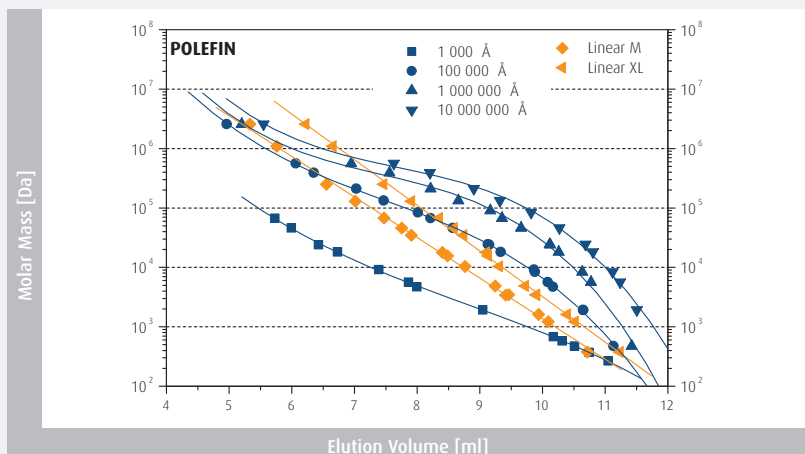
### NBS 1475, linear HDPE

**Flow rate:** 0.50 ml/min  
**Loading:** 3.0 g/l, 200 µl  
**Eluent:** TCB  
**Temperature:** 170° C  
**Detector:** GPC-IR4-CH<sub>2</sub>  
**Columns:** PSS POLEFIN 4 x Linear XL 20µm  
 (P/N poa080520 and  
 4 x poa083020lxl)

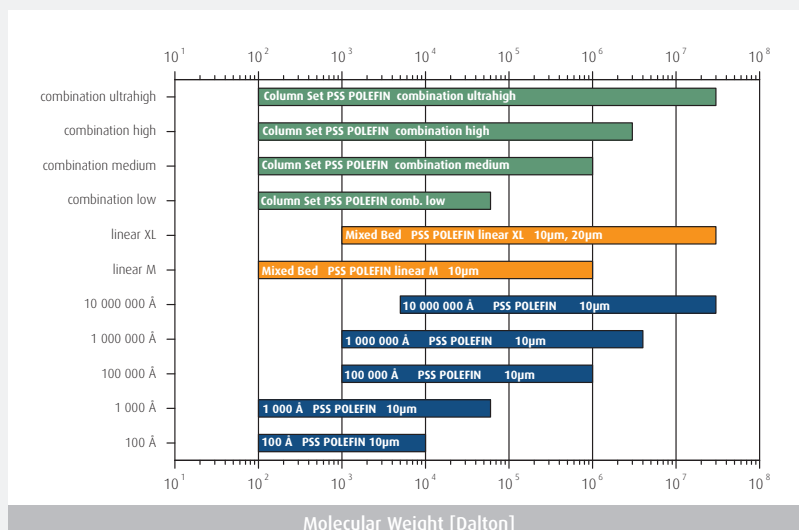


### Calibration Curves

**Eluent:** TCB  
**Calibrants:** Poly(styrene)



## Separation Ranges



## Part Numbers

### a) 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	poa083010xl	pos203010xl
	20	Precolumn	poa080520	
1 000 - 30 000 000 Da	20	linear XL	poa083020xl	

### b) Preconfigured Analytical Column Sets

Separation range [Da]	Column Set	Description	Part Number
100 - 60 000	PSS POLEFIN combination low	1 x POLEFIN precolumn 10µm 8x50mm (P/N poa080510) 3 x POLEFIN columns 10µm 1000Å 8x300mm (P/N poa0830101e3)	210-0001
100 - 1 000 000	PSS POLEFIN combination medium	1 x POLEFIN precolumn 10µm 8x50mm (P/N poa080510) 1 x POLEFIN column 10µm 1000Å 8x300mm (P/N poa0830101e3) 1 x POLEFIN column 10µm 10e <sup>5</sup> Å 8x300mm (P/N sda0830101e5)	210-0002
100 - 3 000 000	PSS POLEFIN combination high	1 x POLEFIN precolumn 10µm 8x50mm (P/N poa080510) 1 x POLEFIN column 10µm 1000Å 8x300mm (P/N poa0830101e3) 1 x POLEFIN column 10µm 10e <sup>5</sup> Å 8x300mm (P/N poa0830101e5) 1 x POLEFIN column 10µm 10e <sup>6</sup> Å 8x300mm (P/N poa0830101e6)	210-0003
100 - 30 000 000	PSS POLEFIN combination ultrahigh	1 x POLEFIN precolumn 10µm 8x50mm (P/N poa080510) 1 x POLEFIN column 10µm 1000Å 8x300mm (P/N poa0830101e3) 1 x POLEFIN column 10µm 10e <sup>5</sup> Å 8x300mm (P/N poa0830101e5) 1 x POLEFIN column 10µm 10e <sup>7</sup> Å 8x300mm (P/N poa0830101e7)	210-0004

**General Information:** delivered in xylene, inclusive column certificates, column connectors, test vials and column manual

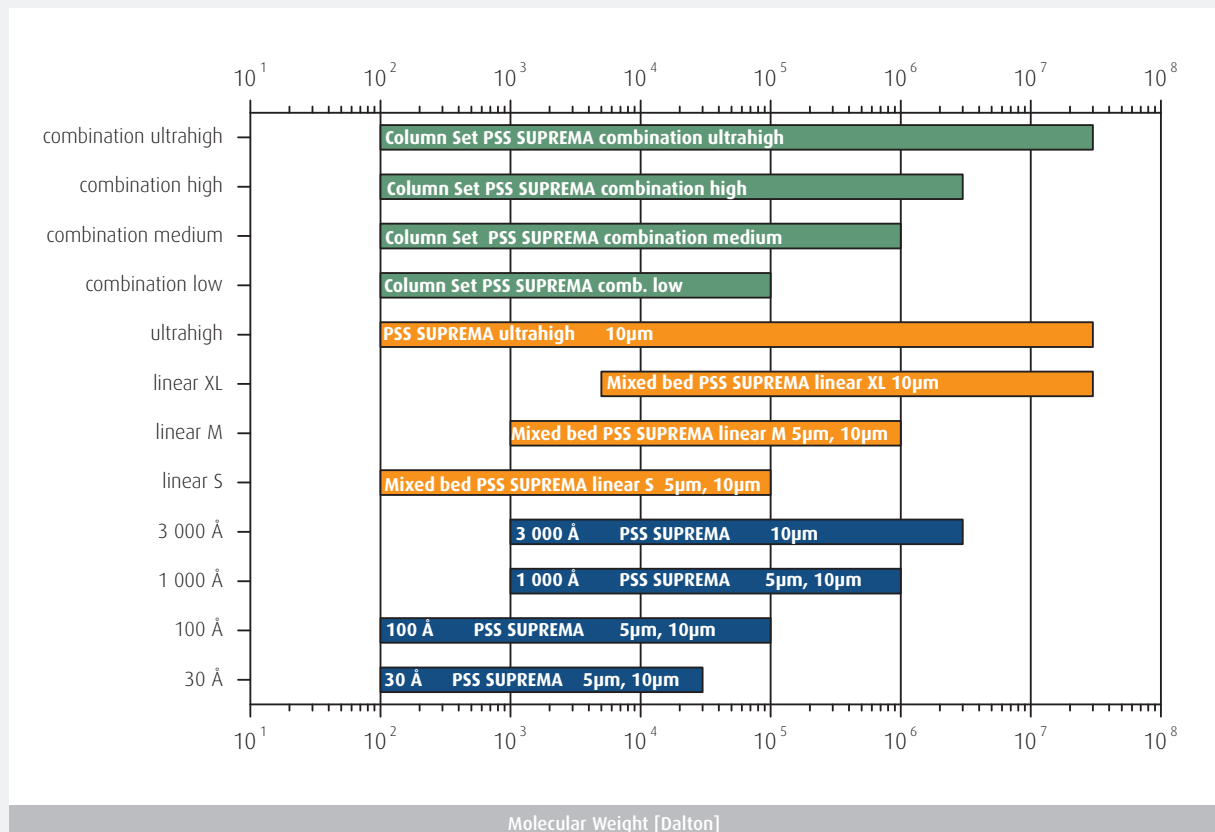
**Option:** Pre-equilibrated for light scattering measurements (P/N 299-2200 (precolumn), P/N 299-2201 (8x300mm))

## 2.2| Columns for Aqueous Solvents

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

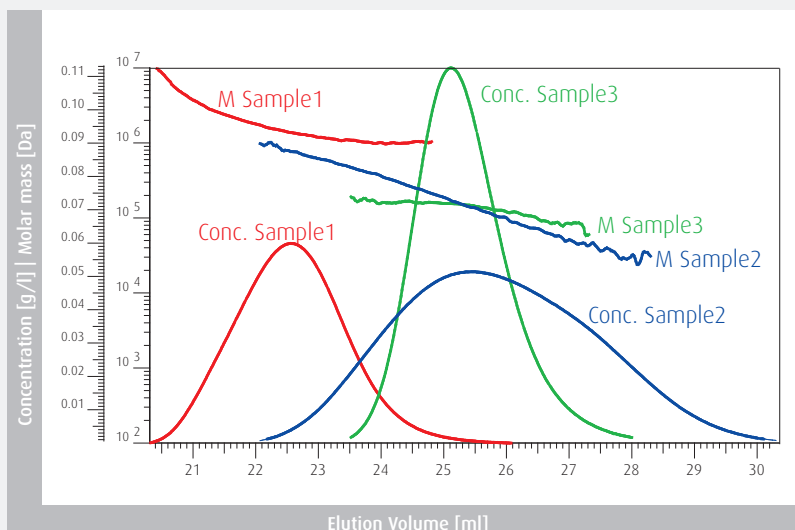
Field of Application	
Applicability	Neutral and anionic polymers (PEO, PEG, Pullulan, Dextran, Poly(acrylamide), Hyaluronic acid, Poly(acrylic acid), Carboxymethyl cellulose, etc.)
Eluents	water (with salts/buffers, MeOH, ACN) pH: 1.5 - 13
Specifications	
Material	Modified acrylate copolymer network
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



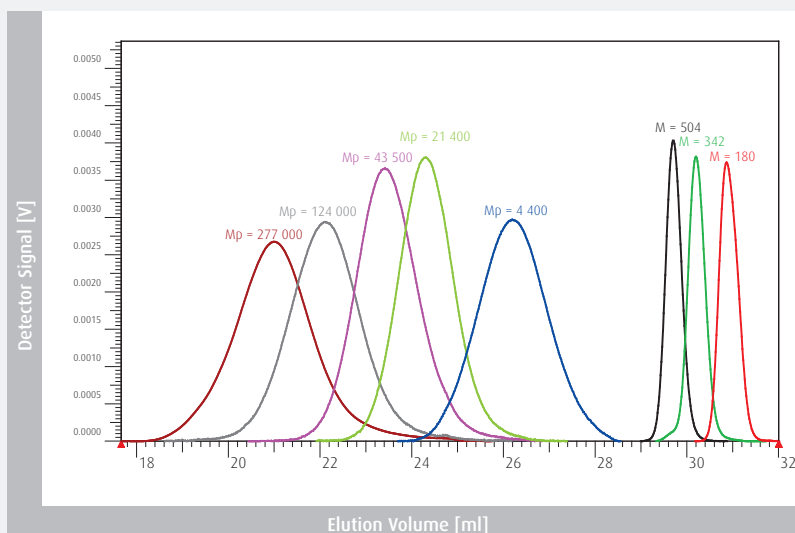
## Hydroxyethyl starch GPC/SEC-MALLS acc. EUP

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



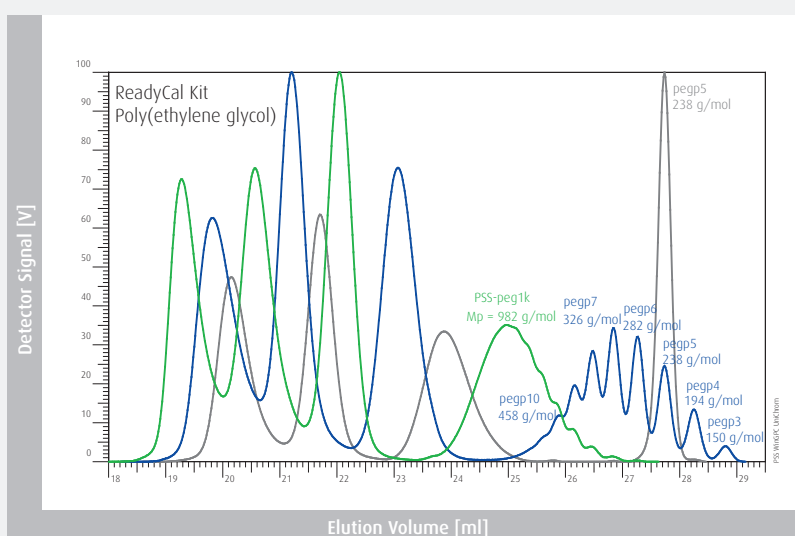
## Dextran

**Flow rate:** 1 ml/min  
**Loading:** 1.0 g/l, 20 µl  
**Eluent:** water, NaN<sub>3</sub> 0.2 g/l  
**Temperature:** 30° C  
**Detector:** SECcurity RI1260  
**Columns:** PSS SUPREMA  
 Combination high  
 (P/N 206-0003)



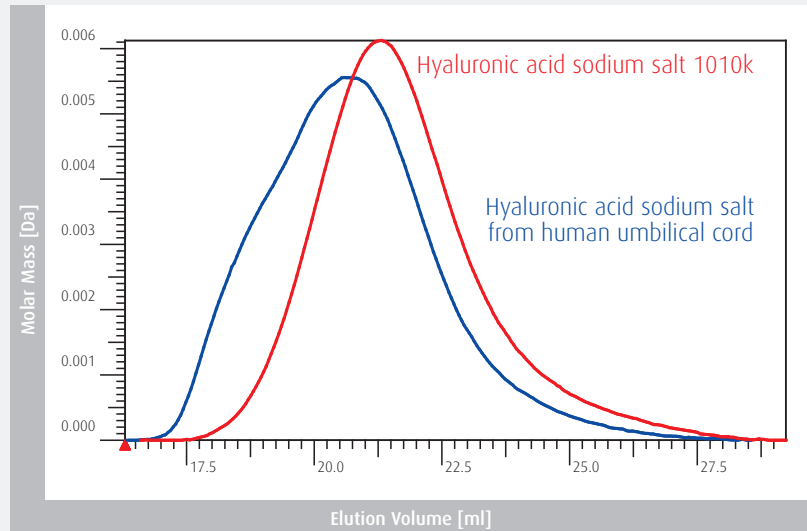
## Poly(ethylene glycol) (PEG)

**Flow rate:** 1 ml/min  
**Loading:** 1.5 g/l, 20 µl  
**Eluent:** water, NaN<sub>3</sub> 0.2 g/l  
**Temperature:** 30° C  
**Detector:** SECcurity RI1260  
**Columns:** PSS SUPREMA  
 Combination low  
 (P/N 206-0001)



## Hyaluronic acid sodium salt (HA)

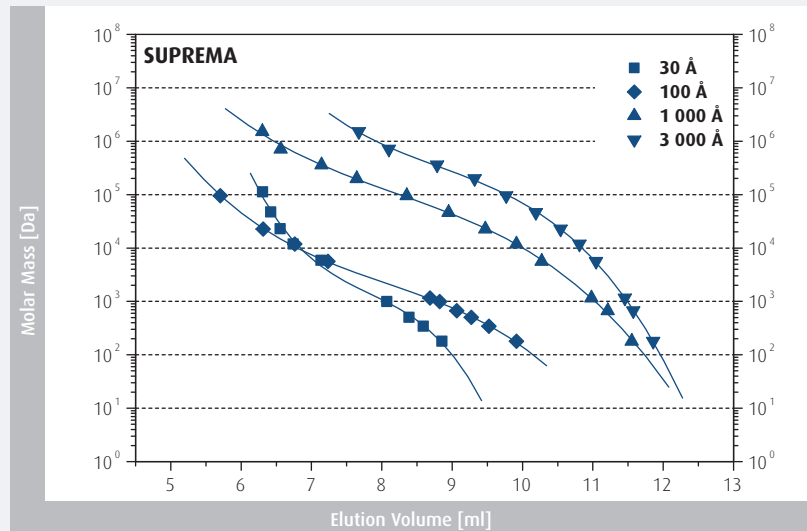
**Flow rate:** 0.25 ml/min  
**Loading:** 0.25 g/l, 100  $\mu$ l  
**Eluent:** water, PBS pH 7.4  
**Temperature:** 30° C  
**Detector:** SECcurity R11260  
**Columns:** PSS SUPREMA combination ultrahigh (P/N 206-0004)



## Calibration Curves

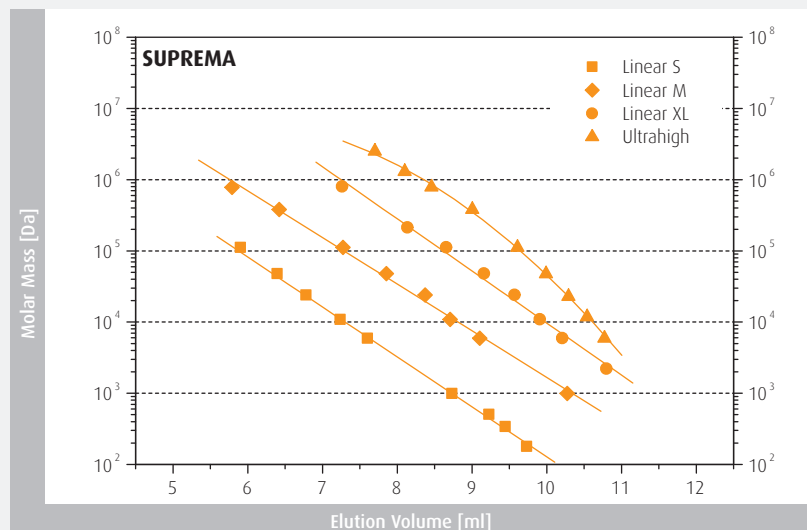
### Single Porosity Columns

**Eluent:** aqueous buffer  
**Calibrants:** Pullulan



### Mixed Bed/Linear Columns

**Eluent:** aqueous buffer  
**Calibrants:** Pullulan





## Part Numbers

### a) 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	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 – 10 000 000 Da	10	10 000	sua0830101e4	sup20301e4		
5 000 – >30 000 000 Da	10	30 000	sua0830103e4			
100 – 100 000 Da	10	Linear S	sua083010lis			
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			

### b) Preconfigured Analytical Column Sets

Separation range [Da]	Column Set	Description	Part Number
100 - 100 000	PSS SUPREMA combination low	1 x SUPREMA precolumn 5µm 8x50mm (P/N sua080505) 3 x SUPREMA column 5µm 1000Å 8x300mm (P/N sua0830051e2)	206-0001
100 - 1 000 000	PSS SUPREMA combination medium	1 x SUPREMA precolumn 5µm 8x50mm (P/N sua080505) 1 x SUPREMA column 5µm 30Å 8x300mm (P/N sua0830053e1) 2 x SUPREMA column 5µm 1000Å 8x300mm (P/N sua0830051e3)	206-0002
100 - 3 000 000	PSS SUPREMA combination high	1 x SUPREMA precolumn 10µm 8x50mm (P/N sua080510) 1 x SUPREMA column 10µm 100Å 8x300mm (P/N sua0830101e2) 2 x SUPREMA column 10µm 3000Å 8x300mm (P/N sua0830103e3)	206-0003
100 - 30 000 000	PSS SUPREMA combination ultrahigh	1 x SUPREMA precolumn 10µm 8x50mm (P/N sua080510) 3 x SUPREMA column 10µm ultrahigh 8x300mm (P/N sua083010luh)	206-0004

**General Information:** delivered in water, inclusive column certificates, column connectors and column manual

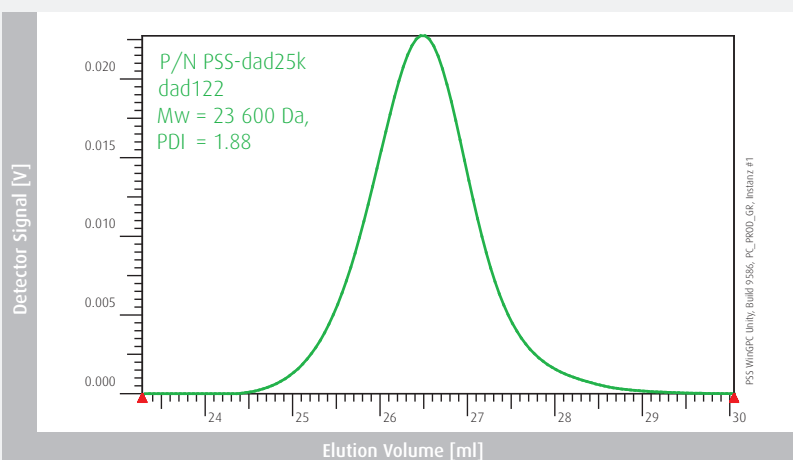
**Option:** Pre-equilibrated for light scattering measurements (P/N 299-2200 (precolumn), P/N 299-2201 (8x300mm))

## Aqueous GPC/SEC of Polycations - NOVEMA Max Columns

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: 1.5 – 7.0
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

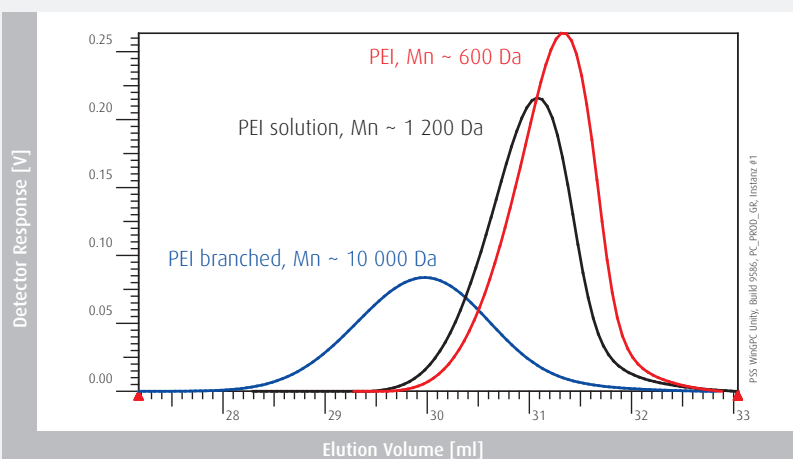
### Poly(DADMAC)

**Flow rate:** 1.00 ml/min  
**Loading:** 2.0 g/l, 50 µl  
**Eluent:** water, NaCl 0.1 M/TFA 0.1%  
**Temperature:** 30° C  
**Detector:** SECcurity RI1260  
**Columns:** PSS NOVEMA Max  
 Combination medium  
 (P/N 212-0002)



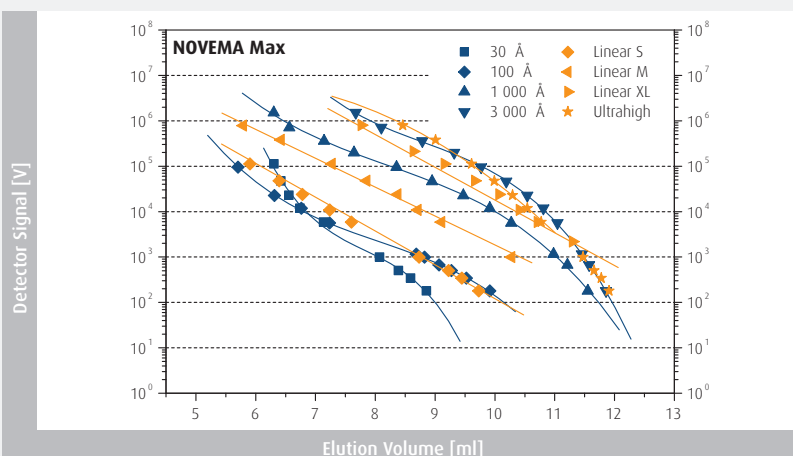
### Poly(ethyleneimine) (PEI)

**Flow rate:** 1.00 ml/min  
**Loading:** 4.0 g/l, 50 µl  
**Eluent:** water, Formic Acid 0.3 M  
**Temperature:** 30° C  
**Detector:** SECcurity RI1260  
**Columns:** PSS NOVEMA Max  
 Combination medium  
 (P/N 212-0002)

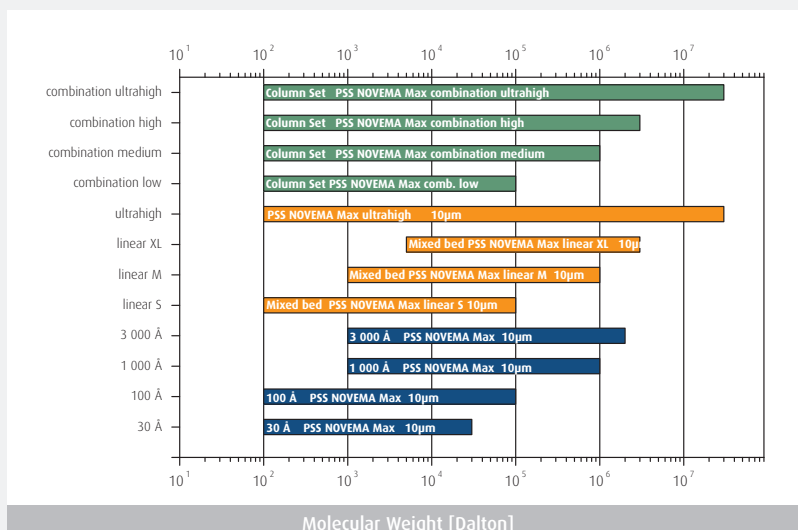


### Calibration Curves

**Eluent:** aqueous buffer  
**Calibrants:** Pullulan



## Separation Ranges



## Part Numbers

### a) 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	nma080510	nmp2005	
100 - 30 000 Da	10	30	nma0830103e1	nmp20303e1	
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		

### b) Preconfigured Analytical Column Sets

Separation range [Da]	Column Set	Description	Part Number
100 - 100 000	PSS NOVEMA Max combination low	1 x NOVEMA Max precolumn 10µm 8x50mm (P/N nma080510) 3 x NOVEMA Max column 10µm 100Å 8x300mm (P/N nma0830101e2)	212-0001
100 - 1 000 000	PSS NOVEMA Max combination medium	1 x NOVEMA Max precolumn 10µm 8x50mm (P/N nma080510) 1 x NOVEMA Max column 10µm 30Å 8x300mm (P/N nma0830103e1) 2 x NOVEMA Max column 10µm 1000Å 8x300mm (P/N nma0830101e3)	212-0002
100 - 3 000 000	PSS NOVEMA Max combination high	1 x NOVEMA Max precolumn 10µm 8x50mm (P/N nma080510) 1 x NOVEMA Max column 10µm 100Å 8x300mm (P/N nma0830101e2) 2 x NOVEMA Max column 10µm 3000Å 8x300mm (P/N nma0830103e3)	212-0003
100 - 30 000 000	PSS NOVEMA Max combination ultrahigh	1 x NOVEMA Max precolumn 10µm 8x50mm (P/N nma080510) 3 x NOVEMA Max column 10µm ultrahigh 8x300mm (P/N nma083010luh)	212-0004

**General Information:** delivered in water, inclusive column certificates, column connectors and column manual

**Option:** Pre-equilibrated for light scattering measurements (P/N 299-2200 (precolumn), P/N 299-2201 (8x300mm))

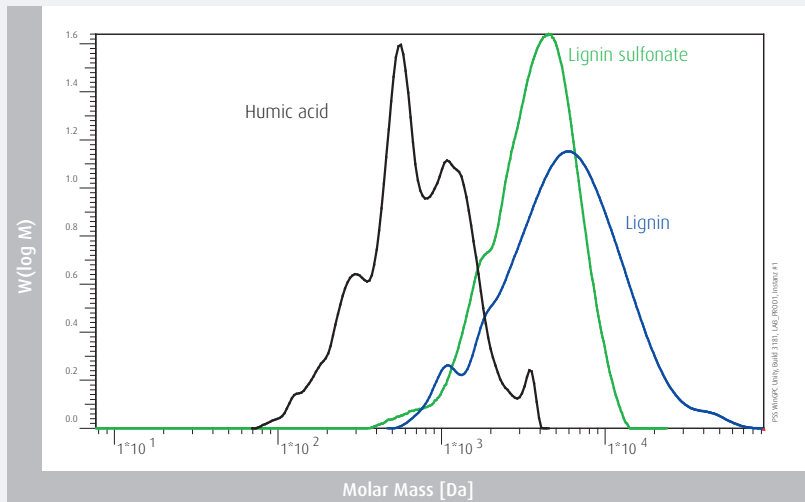
All applications which run on NOVEMA columns will run on NOVEMA Max columns, too. NOVEMA columns are available for existing applications. If in doubt, please contact us directly.

## Aqueous GPC/SEC of Sulfonated Polymers - MCX Columns

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: 7 - 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

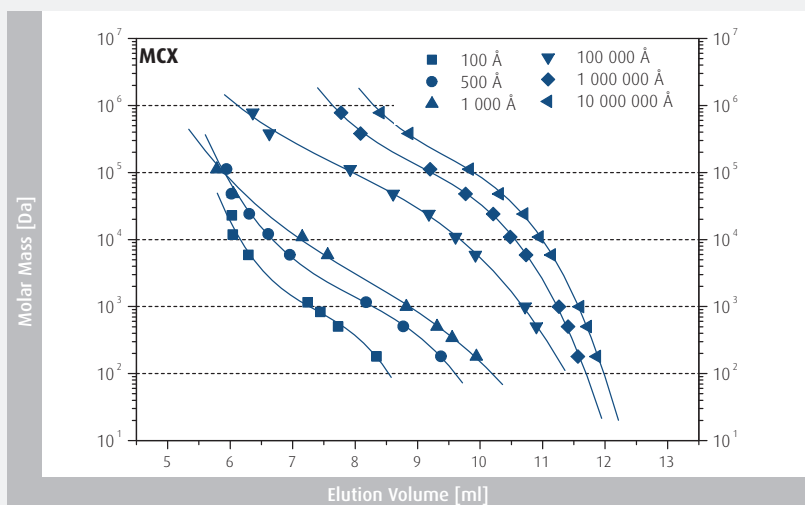
### Lignin, Lignin Sulfonate, Humic Acid

**Flow rate:** 1.00 ml/min  
**Loading:** 4 g/l, 20 µl  
**Eluent:** water, NaOH 0.1 M  
**Temperature:** 25° C  
**Detector:** SECcurity RI;  
**Columns:** MCX 10 µm 1 000 Å, 100 000 Å (8 x 300 mm) + precolumn

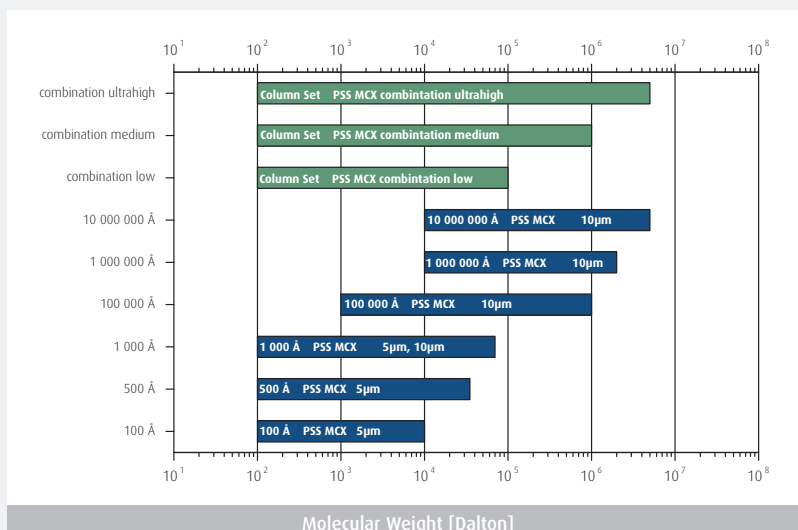


### Calibration Curves

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



## Separation Ranges



## Part Numbers

### a) 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
	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	

### b) 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	1 x MCX precolumn 10µm 8x50mm (P/N mca080510) 1 x MCX column 10µm 1000Å 8x300mm (P/N mca0830101e3) 1 x MCX column 10µm 10e5Å 8x300mm (P/N mca0830101e5)	211-0002
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 10e5Å 8x300mm (P/N mca0830101e5) 1 x MCX column 10µm 10e7Å 8x300mm (P/N mca0830101e7)	211-0004

**General Information:** delivered in water, inclusive column certificates, column connectors and column manual

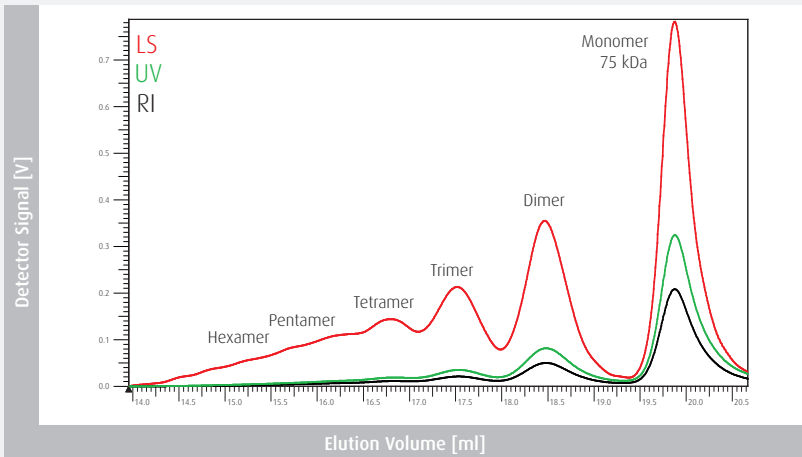
**Option:** Pre-equilibrated for light scattering measurements (P/N 299-2200 (precolumn), P/N 299-2201 (8x300mm))

## Aqueous GPC/SEC of Proteins - PROTEEMA Columns

Field of Application	
Applicability	Natural and synthetic Proteins, Peptides, Enzymes, Gelatins/Collagens
Eluents	Water, water with salt/buffer, MeOH, ACN; pH: <7
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*

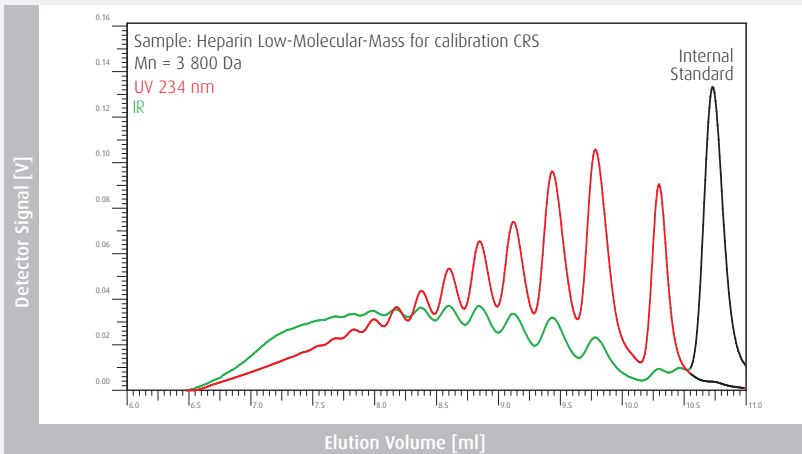
### BSA GPC/SEC-MALLS

**Flow rate:** 0.5 ml/min  
**Loading:** 1.0 g/l, 20 µl  
**Eluent:** Phosphate buffer pH = 6.6,  
 NaCl 0.3 M  
**Temperature:** 25° C  
**Detectors:** SECcurity RI + UV, SLD7000 MALLS  
**Columns:** PROTEEMA 5 µm 300 Å, 300 Å  
 (8 x 300 mm) + precolumn



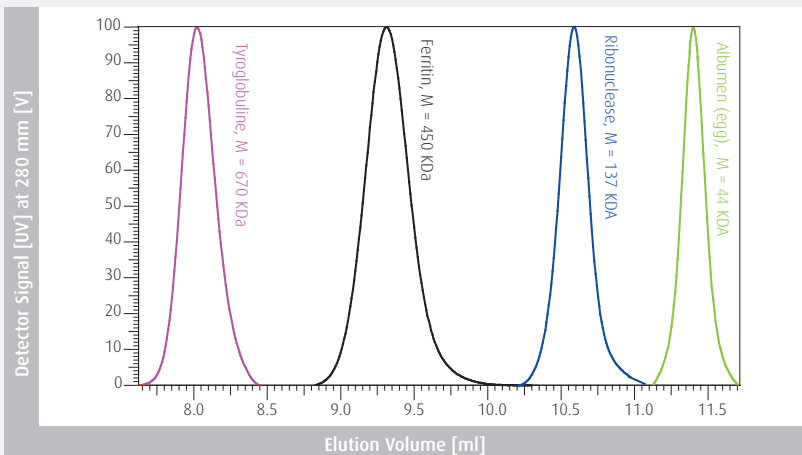
### Heparin Low-Molecular-Mass

**Flow rate:** 0.50 ml/min  
**Loading:** 10.0 g/l, 25 µl  
**Eluent:** Water Disodium phosphate  
 28.4 g/l pH 5  
**Temperature:** 30° C  
**Detectors:** SECcurity RI, SECcurity VWD  
**Columns:** PSS PROTEEMA 5µm 100 Å  
 (P/N pra080505 and pra0830051e2)  
 Used in monograph 0828



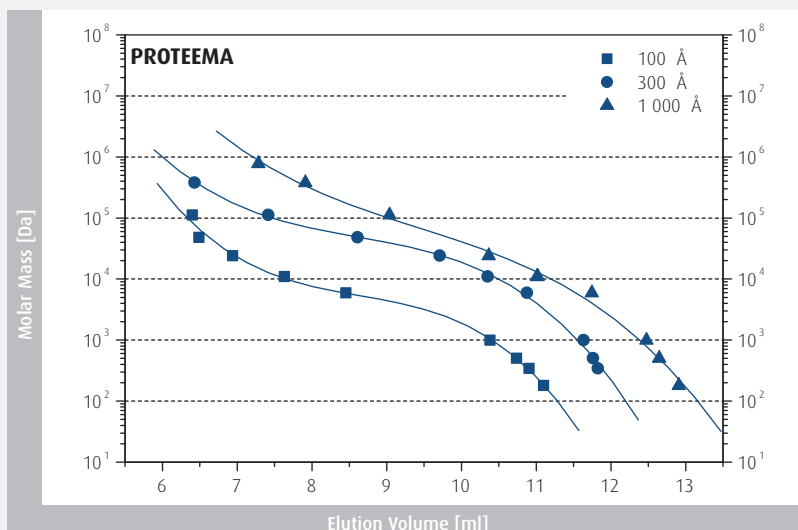
### Protein Mixture

**Flow rate:** 0.5 ml/min  
**Loading:** 1.0 g/l, 20 µl  
**Eluent:** water, NaCl 0.3 M  
**Temperature:** 25° C  
**Detector:** SECcurity UV  
**Columns:** PROTEEMA 5 µm 300 Å  
 (8 x 300 mm) + precolumn

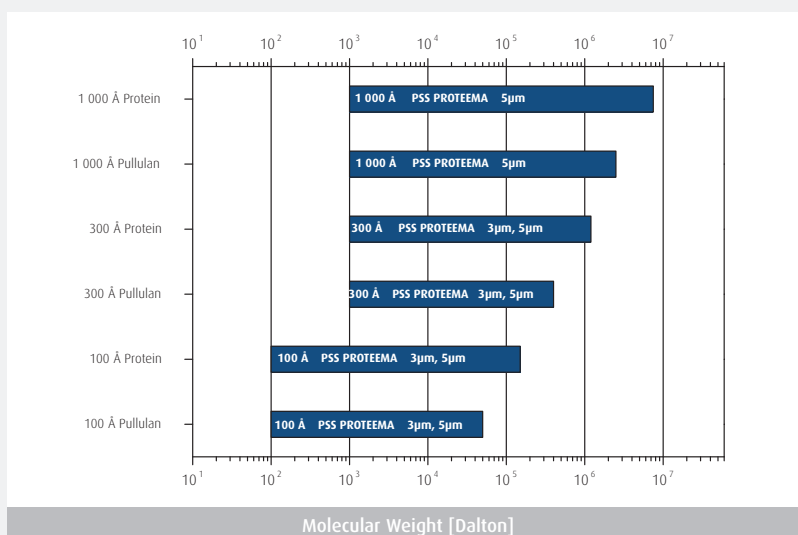


## Calibration Curves

Eluent: aqueous buffer  
Calibrants: Pullulan



## Separation Ranges



## Part Numbers

### a) 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		prm050303
100 – 150 000 Da	3	100		prm0525031e2
1 000 – 1 200 000 Da	3	300		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

**General Information:** delivered in water; inclusive column certificates, column connectors and column manual

**Option:** Pre-equilibrated for light scattering measurements (P/N 299-2201)



### 3| 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.

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 according the size of the molecules is ensured. Ideally, only entropic effects should influence this type of separation.

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

#### **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.  $\text{NaN}_3$ , 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 recapped. This keeps excessive moisture away and increases the standard shelf life.
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 condition is critical to 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. Precise concentration values are essential when using light scattering, viscometry or triple detection systems. In this case the moisture content should be known and/or the sample should be dried.
3. 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.
4. Select an appropriate clean dissolution container (autosampler vial, bottle, flask, etc.).
5. Select your working concentration based on detection type and number of columns in use.

### Recommended sample concentration

Molecular Weight Range [Da]	Concentration [g/l] or [mg/ml]
narrow standards/samples 100 - 10 000	2
narrow standards/samples 10 000 - 1 000 000	1 to 2
narrow standards/samples 1 000 000 and above	0.5 or less
broad standards/samples	typically 4.0 - 5.0

6. When using light scattering, viscometry or triple detection systems weigh in the appropriate amount of sample and solvent. For conventional GPC/SEC weighing the sample and adding the solvent using a syringe is sufficient.

7. 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.

**WARNING:** 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.

### Recommended Injection Volume

Number of columns (length 30 cm)	Guideline injection volume [ $\mu\text{l}$ ]
4 - 5 and more	200 to 250
3	100
2	50
1	20

#### Tips:

##### Standard Mixes:

It is possible to dissolve several standards of the same type in a given dissolution container. If you make your mixture, the individual standards 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 of large particle ( $10\mu\text{m}$ ,  $20\mu\text{m}$ ) 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  $100\ \mu\text{l}$  of a solution of  $0.1$  g/l in preference to  $20\ \mu\text{l}$  of a solution of  $0.5$  g/l.

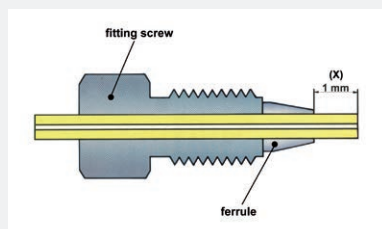
## D

### Column Installation Tips

1. Purge the system with mobile phase first. Pump solvent through the system to remove air and to prevent air 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.



More GPC/SEC tips and tricks or troubleshooting hints can be found at:

<http://www.polymer.de/infocenter.html>

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.

#### 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

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.
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.

#### 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.

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

## 4| 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 <sub>2</sub> HPO <sub>4</sub> 0.07 M	25	Pullulan
Amino resin	PolarSil	DMAC LiCl 0.1 M	70	Poly(methyl methacrylate)
Amylodextrine	MCX	Na <sub>2</sub> HPO <sub>4</sub> 0.07 M	25	Poly(styrene sulfonate) sodium salt
Anti-Human IgG	PROTEEMA	Phosphate buffer pH = 6.8	25	Pullulan
Apple juice	MCX	NaNO <sub>3</sub> 0.1 M	25	Pullulan
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 <sub>2</sub> HPO <sub>4</sub> 0.07 M	25	Pullulan
Carboxymethyl starch	SUPREMA	NaNO <sub>3</sub> 0,1 M	25	Pullulan
Carragenan	SUPREMA	LiNO <sub>3</sub> 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)
Chitin	NOVEMA Max	NaCl 0.1 M + TFAC 0.1 %	25	Pullulan
Chitosan	NOVEMA Max	NaCl 0.1 M + TFAC 0.1 %	25	Pullulan
Collagen	PROTEEMA	Phosphate buffer pH = 6.6 + NaCl 0.3 M	25	Pullulan
Dextran	SUPREMA	NaNO <sub>3</sub> 0.1 M	25	Dextran
Dextran sulfate	SUPREMA	NaNO <sub>3</sub> 0.1 M	35	Pullulan
Dextran, oligomer	MCX	NaN <sub>3</sub> 0.05 %	25	Dextran
Dextrine	SUPREMA	NaNO <sub>3</sub> 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

Polymer	Column Type	Solvent	Temp [° C]	Calibration Standards
Guar gum	SUPREMA	NaNO <sub>3</sub> 0.1 M	25	Pullulan
Gum arabic	SUPREMA	NaNO <sub>3</sub> 0.1 M	25	Pullulan
Heparin	SUPREMA	NaNO <sub>3</sub> 0.1 M	25	Pullulan
Heparin (Pharmaeuropa, low molar mass)	PROTEEMA	Na <sub>2</sub> SO <sub>4</sub> 28.4 g/L pH = 5	25	Heparin CRS 2
Heparin sulfate	SUPREMA	NaNO <sub>3</sub> 0.1 M	25	Pullulan
Humic acid	MCX	Na <sub>2</sub> HPO <sub>4</sub> 0.07 M	25	Poly(styrene sulfonate) sodium salt
Hyaluronic acid	SUPREMA	Na <sub>2</sub> HPO <sub>4</sub> 0.07 M	25	Pullulan
Hydraulic oil	SDV	THF	25	Poly(styrene)
Hydroxyethyl starch	SUPREMA	NaNO <sub>3</sub> 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)
Insulin	PROTEEMA	L-Arginin, Water, Acetic acid and ACN	25	Protein Mixture
Iron Dextran	SUPREMA	NaNO <sub>3</sub> 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 <sub>2</sub> HPO <sub>4</sub> 0.07 M	25	Pullulan
Maltodextrin	MCX	NaN <sub>3</sub> 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)
Naphthalin sulfonate	MCX	Na <sub>2</sub> HPO <sub>4</sub> 0.07 M	25	Pullulan
Norbenyl-cyclodextrine copolymer	GRAM	DMF 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 <sub>3</sub> 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	THF, DEAEA 0.1 %	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 <sub>3</sub> 0.1 M	25	Pullulan/ Poly(acrylamide) broad
Poly(acrylic acid)	SUPREMA	Na <sub>2</sub> HPO <sub>4</sub> 0.07 M	25	Poly(acrylic acid) sodium salt
Poly(acrylonitrile)	GRAM	DMF, LiBr 5 g/l	70	Poly(methyl methacrylate)
Poly(allylamine hydrochloride)	NOVEMA Max	NaCl 0.1 M + TFAc 0.1 %	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 + TFAc 0.1 %	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 <sub>3</sub> 0.05 %	25	Poly(ethylene glycol)
Poly(ethylene imide)	NOVEMA Max	NaCl 0.1 M + TFAc 0.1 %	25	Poly(2-vinylpyridine)
Poly(ethylene imine)	GRAM	DMAC LiBr 2 g/l + TRIS 2 g/l	70	Poly(styrene)
Poly(ethylene imine)	PFG	HFIP, K-TFAc 0.1 M	25	Poly(methyl methacrylate)
Poly(ethylene oxide)	SUPREMA	NaN <sub>3</sub> 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 <sub>2</sub> HPO <sub>4</sub> 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 <sub>2</sub> HPO <sub>4</sub> 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 alcohol)	SUPREMA	NaNO <sub>3</sub> 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 + TFAc 0.1 %	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	DMF 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)
Poly lactide	PFG	TFE, K-TFAc 0.1M	25	Poly(L-lactide)
Polyol	SDV	THF	25	Poly(styrene)
Polyolefin	POLEFIN	TCB	150	Poly(styrene)
Polysuccinamide	SDV	NMP, LiCl 0.1 M	70	Poly(methyl methacrylate)
Polysulfone	SDV	DMAC, LiBr 5 g/l	70	Poly(methyl methacrylate)
Polyurethane	SDV	THF	25	Poly(styrene)
Protein	PROTEEMA	Phosphate buffer pH = 6.6 + NaCl 0.3 M	25	Protein-Mixture
Pullulan	SUPREMA	NaN <sub>3</sub> 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 <sub>2</sub> HPO <sub>4</sub> 0.07 M	25	Pullulan

In doubt?

Use our column selection service!

For more applications register at

[www.pss-polymer.com](http://www.pss-polymer.com)



## 5| Frequently Asked Questions

### **What do I do if I need to replace a PSS column that is not in the catalog or on the website?**

The catalog and the website show the actual products that should be used for the development of new methods. For existing applications we do have many materials in stock (e.g. HEMA, HEMA Bio or others), that can be delivered on request. Please contact us directly for further details.

### **Can I replace my NOVEMA columns by NOVEMA Max columns?**

All applications which run on NOVEMA columns will also run on NOVEMA Max columns. For existing critical applications NOVEMA columns are still available. Please contact us directly.

### **How can I make sure that an application is robust with 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, of course we provide this service. 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 PSS columns replace columns of other vendors. 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 additional 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, smaller for lower molecular weights. The separation range depends on the porosity of the columns (see pages 29). If you want to use column combinations, please use the recommended combinations as we have thoroughly tested them to guarantee highest resolution while avoiding chromatographic artifacts.

**What is the difference between linear/mixed-bed and single porosity columns? For which application is which column most suitable?**

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, they are suitable for a rapid product screening. For a precise analysis with a higher resolution are combinations of single porosity columns suitable.

**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 and asymmetry are indicated and also with which substance they were determined.

## Glossar and Abbreviations

GPC	Gel permeation chromatography	TCB	Trichlorobenzene
SEC	Size exclusion chromatography	DMF	Dimethylformamide
GFC	Gel filtration chromatography	DMAc	Dimethylacetamide
HDPE	High density Polyethylene	DMSO	Dimethylsulfoxide
mL	Milliliter / Millilitre	HFIP	Hexafluoroisopropanol
min	Minute(s)	TFE	Trifluoro acetic acid (TFA) / Trifluoroethanol
M	Molar mass	PET	Polyethylene terephthalate
$M_n$	Number average molar mass	Poly(DADMAC)	Polydiallyldimethylammonium chloride
$M_w$	Weight average molar mass	H <sub>2</sub> O	water
$M_p$	molar mass at the peak maximum	RI	Refractive index (detector)
THF	Tetrahydrofuran	UV	Ultraviolet (detector)
$PDI / D = M_w / M_n$	Polydispersity index	cm	Centimeter / centimetre
Å	angstrom (units)	PEO	Polyethylene oxide
$\eta$	viscosity	LS	Light scattering
$[\eta]$	Intrinsic viscosity	PI	Polyisoprene
c	concentration	MMA	Methyl methacrylate
nm	nanometer / nanometre	tBMA	tert-Butyl methacrylate
$V_e$	Elution volume	<sup>1</sup> H-NMR	Proton nuclear magnetic resonance
LC	Liquid chromatography	3D	three-dimensional / tridimensional
MALDI-TOF	Matrix-assisted laser desorption/ionization - Time of Flight	MALLS	Multi-angle Laser Light Scattering
PVC	Polyvinyl chloride	$R_h$	hydrodynamic radius
MWD	Molecular weight distribution	K	Mark-Houwink parameter
2D	Two-dimensional	$\alpha$	Mark-Houwink parameter
$\mu$ L	Micro liter / litre	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
PMMA	Poly(methyl methacrylate)	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
BHT	Butylhydroxytoluene	GPC/SEC Calibration Kit	A kit consists of 8 to 12 well-characterized (single) standards of one polymer type
$V_p$	Elution volume at the peak maximum	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
L	Length (length of the column)	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
N	Plate count		
dn/dc	refractive index increment		
DMF	Dimethylformamide		
LiBr	Lithium bromide		
$V_h$	hydrodynamic volume		
NaN <sub>3</sub>	Sodium azide		
PS	Polystyrene		
PAA	Polyacrylic acid		
Da	Dalton		
DCB	Dichlorobenzene		

# Supplies and Services for Comprehensive Characterization of Natural and Synthetic Macromolecules

## Reference Polymer Standards

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

## Software

### WinGPC UniChrom MACROMOLECULAR CHROMATOGRAPHY DATA SYSTEM

- Light Scattering Module for LALLS, RALLS, TALLS, MALLS
- Viscosity Module
- Copolymer Module
- End-group Analysis Module
- 2-dimensional Chromatography Module
- Heparin Module
- LAN/Server Solutions
- Compliance Pack
- Mass Spectrometry Module
- 3D-spectra Module

### PoroCheck SOFTWARE FOR PORESIZE ANALYSIS AND INVERSE GPC/SEC

## Analytical Services

- Molar Mass Determination
- Branching/Structure Information
- Method Development and Transfer
- Complete Product Deformulation
- Consulting

## 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 up to Preparative Scale
- HighSpeed Columns for fast Analysis

## GPC/SEC Instruments

- Complete Systems and Components
- Light Scattering Detectors
- Viscosity Detectors
- dn/dc Instrumentation

## GPC/SEC Schools and Support

- Full Services from Installation to Validation, Operation, and Repair
- GPC/SEC and Software Training Schools
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