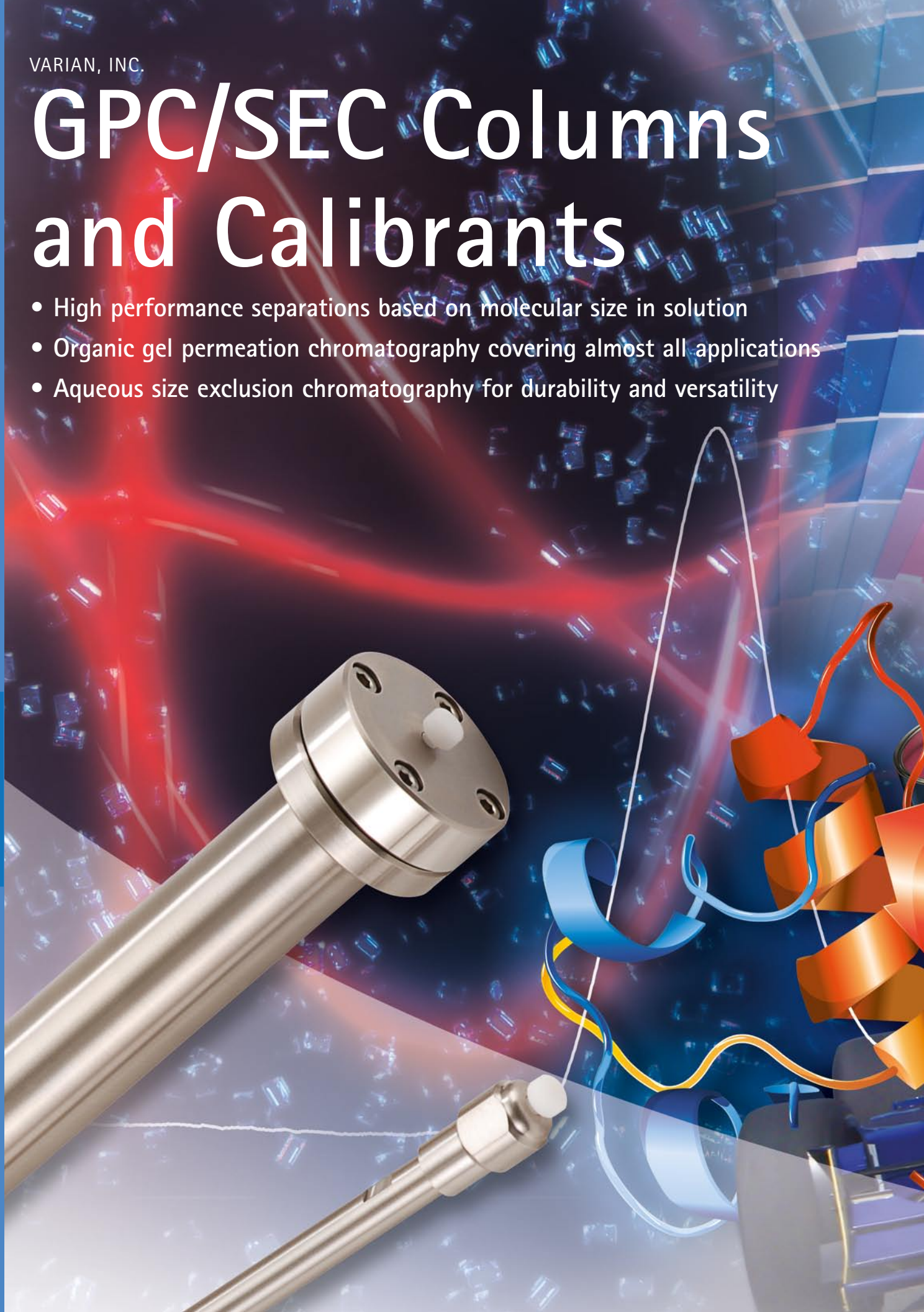
VARIAN, INC.

GPC/SEC Columns and Calibrants

- High performance separations based on molecular size in solution
- Organic gel permeation chromatography covering almost all applications
- Aqueous size exclusion chromatography for durability and versatility



Contents

Varian delivers leading solutions for characterizing and separating polymers by GPC/SEC. We manufacture all components for accurate polymer analysis, including columns and standards, advanced technology detection systems, fully integrated instrumentation and software.

GPC reveals the molecular weight distribution of a resin, key to understanding its performance.

PLgel™ GPC Columns

For Almost All Polymer Applications Using Organic Solvents

PLgel materials have high pore volume and high efficiency to maximize resolution. Their unequalled solvent compatibility makes for easy transfer between polar and non polar eluents, and outstanding physical rigidity provides extended lifetimes that minimize downtime.

The key to successful GPC separations is the correct choice of columns. The comprehensive range of PLgel products has been designed to cover virtually all organic solvent-based polymer analysis application areas, and to make selection of the correct column, solvent and calibration standard fast and reliable.

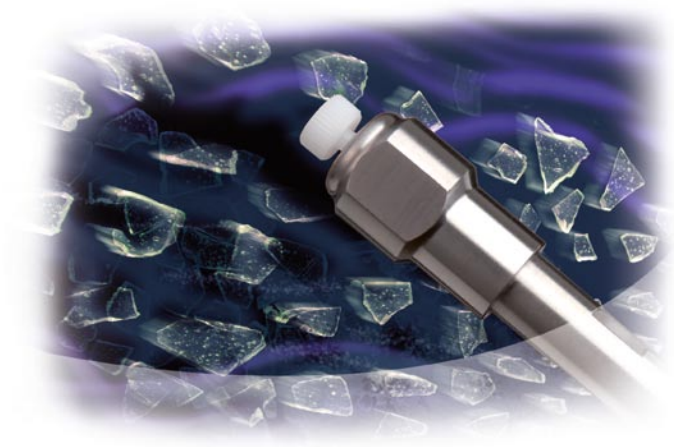
PLgel is a highly cross linked, porous polystyrene/divinylbenzene matrix, which is recognized as a market leader in GPC column technology. Manufactured and packed exclusively by Varian since 1976, PLgel is manufactured to ISO 9001:2000 and benefits from comprehensive QC/QA for total reproducibility, batch to batch and column to column.

The PLgel Range

- PLgel MIXED for polydisperse materials
- PLgel MIXED LS for light scattering and viscometry applications
- PLgel MiniMIX Narrow Bore saves solvent costs
- PLgel Individual Pore Size Columns for specific applications
- PLgel Preparative Columns for polymer fractionation
- EnviroPrep for sample clean-up
- PLgel Olexis for the analysis of polyolefins

Robust Performance Under the Most Exacting Conditions

Elevated temperature is used in GPC either to reduce eluent viscosity, for example in polar solvent applications, or to maintain sample solubility, as in polyolefin applications.



Temperature Stability to 220 °C

PLgel columns can be used at temperatures up to 220 °C and operating pressures up to 150 bar (2200 psi).

Tip

For good quality GPC make sure your solvent matches the polarity of your sample and packing material.

PLgel™ GPC Columns

Solvent Compatibility

PLgel columns are routinely supplied in ethyl benzene* but you can easily and rapidly transfer between solvents of varying polarity. In organic GPC, sample to column interaction may occur occasionally and eluent modification can be used to eliminate these effects. PLgel columns are the ideal choice for such analyses, as they easily tolerate eluents in the pH range 1-14, as well as up to 10% water in a miscible organic solvent.

PLgel is Compatible With All of These Solvents

Solvent Polarity	Solvent
6.0	Perfluoroalkane
7.3	Hexane
8.2	Cyclohexane
8.9	Toluene
9.1	Ethyl acetate
9.1	Tetrahydrofuran (THF)
9.3	Chloroform
9.3	Methyl ethyl ketone (MEK)
9.7	Dichloromethane
9.8	Dichloroethene
9.9	Acetone
10.0	0-Dichlorobenzene (o-DCB)
10.0	Trichlorobenzene (TCB)
10.2	m-Cresol
10.2	o-Chlorophenol (o-CP)
10.7	Pyridine
10.8	Dimethyl acetamide (DMAc)
11.3	n-Methyl pyrolidone (NMP)
12.0	Dimethyl sulfoxide (DMSO)
12.1	Dimethyl formamide (DMF)

* We also provide a custom packing service in which columns can be shipped in specific solvents to provide extra convenience to our customers.

PLgel Frit Porosity

Media type	Porosity (µm)
PLgel 3 µm	2
PLgel 5 µm	2
PLgel 10 µm	5
PLgel 20 µm	10

Ordering Information

PLgel Column accessories

Description	Quantity (pk)	Part No.
Frit Removal Tool for Threaded Columns only	1	PL1310-0001
Frit (2 µm) Kit for Threaded Columns, 7.5 mm ID	5	PL1310-0002
Frit (5 µm) Kit for Threaded Columns, 7.5 mm ID	5	PL1310-0012
Frit (10 µm) Kit for Threaded Columns, 7.5 mm ID	5	PL1310-0036
PLgel 10 µm Column Repair Gel	1	PL1410-0101
PLgel 5 µm Column Repair Gel	1	PL1410-0501
Column Connecting Nuts, 1/16 in. Tube	5	PL1310-0007
Tubing Ferrules, 1/16 in. Tube	5	PL1310-0008
Connecting Tubing, 10 cm Length, 0.01 in. ID	10	PL1310-0048

See Also

- Polymer Calibration Standards, with highly characterized molecular weights, page 316

GPC/SEC

PLgel™ MIXED

For Polydisperse Materials Covering a Very Broad Range of Molecular Weights

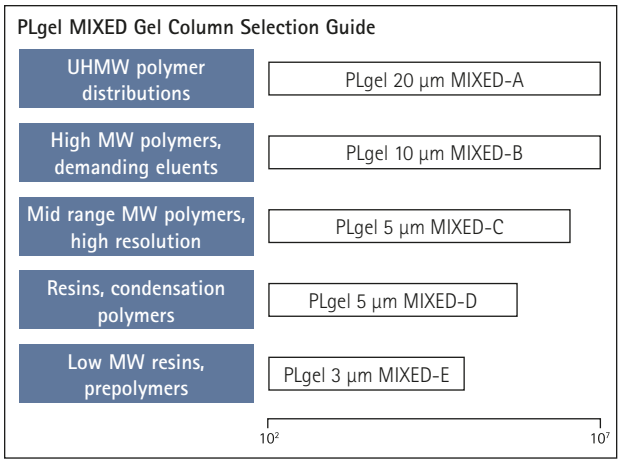
The PLgel MIXED range greatly simplifies column selection for easy decision making. Using these mixed columns you can eliminate mismatched column sets and spurious peaks for more reliable results. Simply add extra columns for even greater resolution.

Analysis of polydisperse materials was traditionally achieved by combining individual pore size columns in series to accommodate the molecular weight range of the polymer. However, this approach is often problematic because spurious peak shapes could be introduced and precision lost in the calculated averages due to "mismatched" calibration curves. MIXED gel columns overcome these drawbacks.

The modern approach to column selection for polydisperse materials is to choose MIXED gel columns from Varian. Every column contains a mixture of individual pore size materials, accurately blended to cover a specified broad range of molecular weight with a linear calibration to eliminate column mismatch.

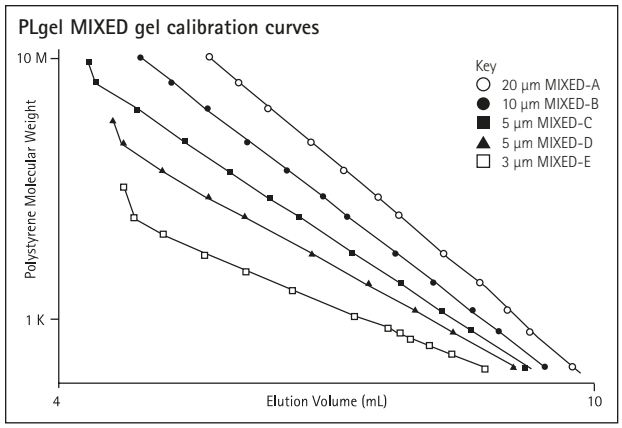
PLgel MIXED Column Selection Guide

As market leaders in this field, our comprehensive range of MIXED gel GPC columns are designed for specific application areas.



PLgel MIXED Gel Calibration Curves

MIXED gel calibration curves are designed to be linear over a specified molecular weight range, ensuring that the same degree of resolution is achieved across the full operating range of the column. The particle size of the packing and porosity of a particular MIXED gel column are carefully matched to the MW range and application, thus optimizing performance and eliminating the effects of shear degradation. Resolution in GPC is controlled by the slope of the calibration curve and the particle size of the packing material. Varian has scientifically determined the minimum number of MIXED gel columns required to perform accurate MWD determinations based on specific resolution (Rsp). Thus you can have complete confidence in the accuracy and precision of the calculated data.



Reference

Meehan, E. (1998) Size exclusion chromatography columns from Polymer Laboratories. In: Chi-San Wu (Ed.) Column Handbook for Size Exclusion Chromatography. Academic Press, New York, USA.

See Also

- PLgel MiniMIX Columns, reduce the need for expensive solvents, page 297
- Polymer Calibration Standards, with highly characterized molecular weights, page 316

PLgel™ 20 µm MIXED-A

For Polymers Containing High MW Material

- **Extremely high exclusion limit tailored to the MW (molecular weight) of the application**
- **Large particle size matched to the MW range for optimum performance**
- **Low shear prevents sample degradation**

Characteristics

Linear MW Operating Range: 2000-40,00,000 g/mol (PS equiv)
Guaranteed Column Efficiency: >17,000 p/m

Typical Pressure:
1 mL/min (7.5 mm ID): ≈ 3 bar (44 psi) per 300 mm
0.3 mL/min (4.6 mm ID): ≈ 2.4 bar (35 psi) per 250 mm
(THF @ 20 °C, TCB @ 140 °C)

Maximum Flow Rate:
7.5 mm ID: 1.5 mL/min
4.6 mm ID: 0.5 mL/min

Maximum Pressure: 150 bar (2175 psi)

Maximum Temperature: 220 °C

Recommended no. of Columns/set:
4 x 250 mm, 4 x 300 mm or 2 x 600 mm

Recommended Calibrants:
EasiVial™ PS-H for convenient 12 point calibration in just three injections (page 317)

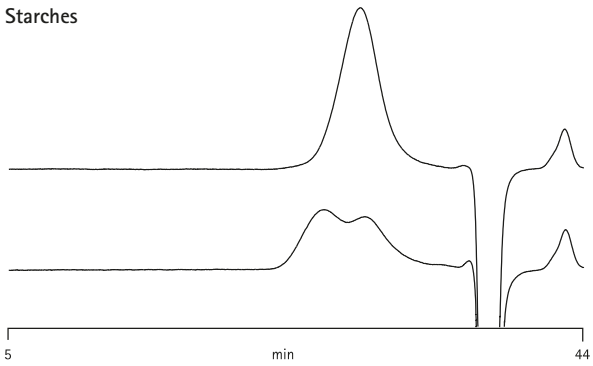
EasiCal™ PS-1 or S-H2-10 Kit provides rapid 10 point calibration (page 319)

S-H-10 plus S-M2-10 Kits for accurate 19 point calibration (page 320)

Typical Applications

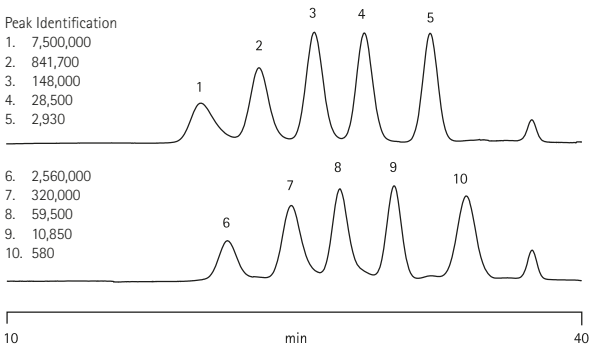
Polyolefins, polybutadienes, starches, polyisoprenes

Starches



Columns: 4 x PLgel 20 µm MIXED-A, 300 x 7.5 mm
Eluent: DMSO + 5mM $NaNO_3$
Flow Rate: 1.0 mL/min
Temp: 80 °C
Detector: PL-GPC 220 (RI)

Polystyrene standards separation



Columns: 4 x PLgel 20 µm MIXED-A, 300 x 7.5 mm
Sample: EasiCal PS-1
Eluent: THF
Flow Rate: 1.0 mL/min
Detector: UV, 254 nm

Ordering Information

PLgel 20 µm MIXED-A Columns

Description	Part No.
PLgel 20 µm MIXED-A, 300 x 7.5 mm	PL1110-6200
PLgel 20 µm MiniMIX-A, 250 x 4.6 mm	PL1510-5200
PLgel 20 µm MIXED-A, 600 x 7.5 mm	PL1110-8200
PLgel 20 µm Guard, 50 x 7.5 mm	PL1110-1220
PLgel 20 µm MiniMIX-A Guard, 50 x 4.6 mm	PL1510-1200

See Also

- PLgel MiniMIX-A Narrow Bore Columns, reduce the need for expensive solvents, page 297
- Polymer Calibration Standards, with highly characterized molecular weights, page 316

PLgel™ 10 µm MIXED-B

High Temperature Applications with Aggressive or Unusual Solvents

- **Wide MW operating range maximizes column usefulness**
- **Low operating pressure minimizes wear on the GPC system**
- **Wide range of applications simplifies column choice**

Characteristics

Linear MW Operating Range: 500-10,000,000 g/mol (PS equiv)
Guaranteed Column Efficiency: >35,000 p/m

Typical Pressure:
1 mL/min (7.5 mm ID): ≈ 10 bar (145 psi) per 300 mm
0.3 mL/min (4.6 mm ID): ≈ 8 bar (116 psi) per 250 mm
(THF @ 20 °C, TCB @ 140 °C)

Maximum Flow Rate:
7.5 mm ID: 1.5 mL/min
4.6 mm ID: 0.5 mL/min

Maximum Pressure: 150 bar (2175 psi)

Maximum Temperature: 220 °C

Recommended no. of Columns/set:
3 x 250 mm, 3 x 300 mm or 1-2 x 600 mm

Recommended Calibrants:
The EasiVial™ PS-H for convenient 12 point calibration in just three injections (page 317)

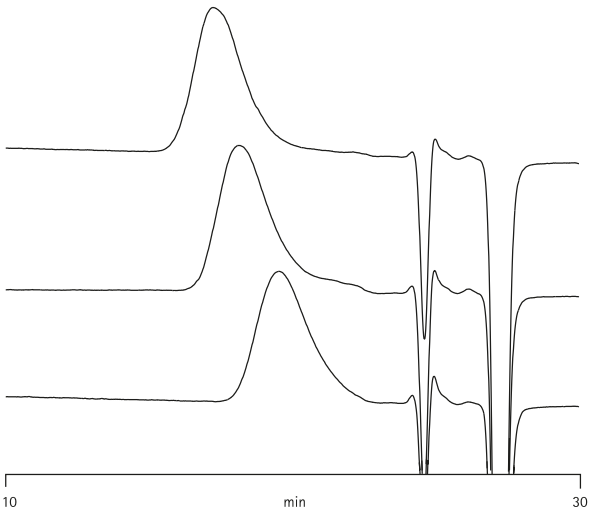
EasiCal™ PS-1 or S-H2-10 Kit provides rapid 10 point calibration (page 319)

Polystyrene S-H-10 plus S-M2-10 Kits for accurate 19 point calibration (page 320)

Typical Applications

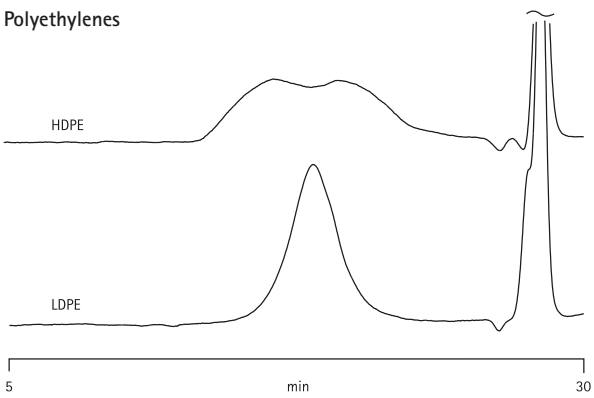
Polyolefins, fluoropolymers, acrylics/acrylates, cellulose derivatives

Polyphenylene sulfides



Columns: 3 x PLgel 10 µm MIXED-B, 300 x 7.5 mm
Eluent: o-Chloronaphthalene
Flow Rate: 1.0 mL/min
Temp: 210 °C
Detector: PL-GPC 220 (RI)

Polyethylenes



Columns: 3 x PLgel 10 µm MIXED-B, 300 x 7.5 mm
Eluent: TCB
Flow Rate: 1.0 mL/min
Temp: 160 °C
Detector: RI

Ordering Information

PLgel 10 µm MIXED-B Columns

Description	Part No.
PLgel 10 µm MIXED-B, 300 x 7.5 mm	PL1110-6100
PLgel 10 µm MiniMIX-B, 250 x 4.6 mm	PL1510-5100
PLgel 10 µm MIXED-B, 600 x 7.5 mm	PL1110-8100
PLgel 10 µm Guard, 50 x 7.5 mm	PL1110-1120
PLgel 10 µm MiniMIX-B Guard, 50 x 4.6 mm	PL1510-1100

See Also

- PLgel MiniMIX-B Narrow Bore Columns, reduce the need for expensive solvents, page 297
- Polymer Calibration Standards, with highly characterized molecular weights, page 316

For more information, please visit www.varianinc.com/plgel_mixed.html or visit www.varianinc.com/products.html to place an order.

PLgel™ 5 µm MIXED-C

For Analysis of Polymers up to 2 Million MW, Especially Those Containing Small Additives

- **Fast run times improve productivity**
- **Excellent solvent compatibility maximizes column utility**
- **Linear calibration curve ensures consistent resolution across the MW range**

Characteristics

Linear MW Operating Range: 200-2,000,000 g/mol (PS equiv)
Guaranteed Column Efficiency: >50,000 p/m

Typical Pressure:
1 mL/min (7.5 mm ID): ≈ 30 bar (435 psi) per 300 mm
0.3 mL/min (4.6 mm ID): ≈ 24 bar (348 psi) per 250 mm
(THF @ 20 °C, TCB @ 140 °C)

Maximum Flow Rate:
7.5 mm ID: 1.5 mL/min
4.6 mm ID: 0.5 mL/min

Maximum Pressure: 150 bar (2175 psi)

Maximum Temperature: 150 °C

Recommended no. of Columns/set:
2 x 250 mm, 2 x 300 mm or 1 x 600 mm

Recommended Calibrants:
The EasiVial™ PS-H for convenient 10 point calibration in just three injections (page 317)

EasiCal™ PS-1 provides rapid 10 point calibration (page 319)

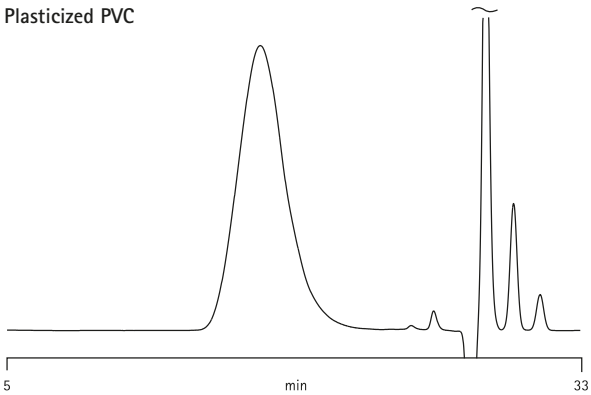
Polystyrene Kit S-M-10 for accurate 10 point calibration (page 320)

Polyethylene Oxide/Glycol PEO/PEG-10 Kits for DMF, chemically similar for a broad MW range (page 322)

Typical Applications

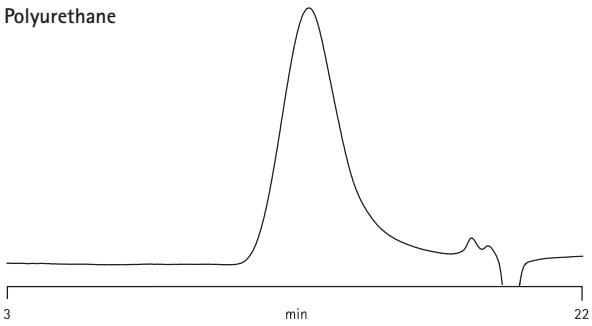
Polystyrenes, polyurethanes, polycarbonates, polysiloxanes

Plasticized PVC



Columns: 2 x PLgel 5 µm MIXED-C, 300 x 7.5 mm
Eluent: THF
Flow Rate: 1.0 mL/min
Detector: PL-GPC 220 (RI)

Polyurethane



Columns: 2 x PLgel 5 µm MIXED-C, 300 x 7.5 mm
Eluent: DMF + 0.1% LiBr
Flow Rate: 1.0 mL/min
Temp: 80 °C
Detector: PL-GPC 220 (RI)

GPC/SEC

Ordering Information

PLgel 5 µm MIXED-C Columns

Description	Part No.
PLgel 5 µm MIXED-C, 300 x 7.5 mm	PL1110-6500
PLgel 5 µm MiniMIX-C, 250 x 4.6 mm	PL1510-5500
PLgel 5 µm MIXED-C, 600 x 7.5 mm	PL1110-8500
PLgel 5 µm Guard, 50 x 7.5 mm	PL1110-1520
PLgel 5 µm MiniMIX-C Guard, 50 x 4.6 mm	PL1510-1500

See Also

- PLgel MiniMIX-C Narrow Bore Columns, reduce the need for expensive solvent, page 297
- Polymer Calibration Standards, with highly characterized molecular weights, page 316

PLgel™ 5 µm MIXED-D

For Condensation Polymers Containing Some Low MW Oligomers

- **High pore volume and high efficiency optimize performance**
- **Elevated temperature capability maintains sample solubility**
- **Optimized particle size and porosity eliminate shearing effects for reliable results**

Characteristics

Linear MW Operating Range: 200-400,000 g/mol (PS equiv)
Guaranteed Column Efficiency: >50,000 p/m

Typical Pressure:
1 mL/min (7.5 mm ID): ≈ 30 bar (435 psi) per 300 mm
0.3 mL/min (4.6 mm ID): ≈ 24 bar (348 psi) per 250 mm
(THF @ 20 °C, TCB @ 140 °C)

Maximum Flow Rate:
7.5 mm ID: 1.5 mL/min
4.6 mm ID: 0.5 mL/min

Maximum Pressure: 150 bar (2175 psi)

Maximum Temperature: 150 °C

Recommended no. of Columns/set:
2 x 250 mm, 2 x 300 mm or 1 x 600 mm

Recommended Calibrants:
The EasiVial™ PS-M for convenient 12 point calibration in just three injections (page 317)

EasiCal™ PS-2 provides rapid 10 point calibration (page 319)

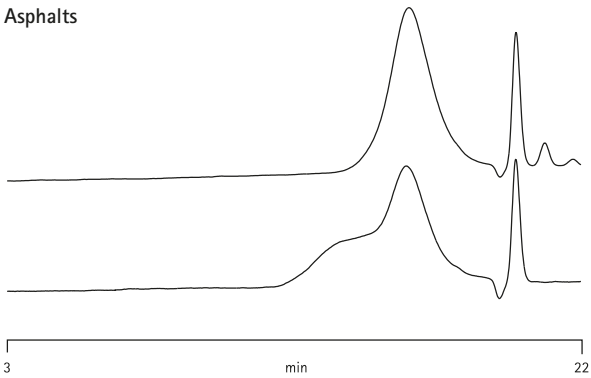
Polystyrene Kit S-M2-10 for accurate 10 point calibration (page 320)

Polyethylene Oxide/Glycol PEO/PEG-10 Kits for DMF, chemically similar for a broad MW range (page 322)

Typical Applications

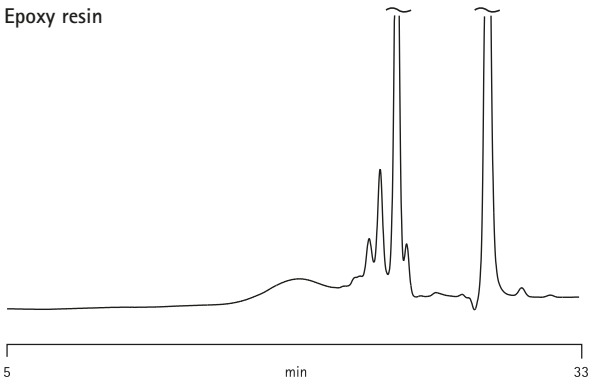
Epoxy resins, silicone fluids, polyester resins, polyolefins

Asphalts



Columns: 2 x PLgel 5 µm MIXED-D, 300 x 7.5 mm
Eluent: THF
Flow Rate: 1.0 mL/min
Detector: PL-GPC 220 (RI)

Epoxy resin



Columns: 3 x PLgel 5 µm MIXED-D, 300 x 7.5 mm
Eluent: THF
Flow Rate: 1.0 mL/min
Detector: PL-GPC 220 (RI)

Ordering Information

PLgel 5 µm MIXED-D Columns

Description	Part No.
PLgel 5 µm MIXED-D, 300 x 7.5 mm	PL1110-6504
PLgel 5 µm MiniMIX-D, 250 x 4.6 mm	PL1510-5504
PLgel 5 µm MIXED-D, 600 x 7.5 mm	PL1110-8504
PLgel 5 µm Guard, 50 x 7.5 mm	PL1110-1520
PLgel 5 µm MiniMIX-D Guard, 50 x 4.6 mm	PL1510-1504

See Also

- PLgel MiniMIX-D Narrow Bore Columns, reduce the need for expensive solvents, page 297
- Polymer Calibration Standards, with highly characterized molecular weights, page 316

For more information, please visit www.varianinc.com/plgel_mixed.html or visit www.varianinc.com/products.html to place an order.

PLgel™ 3 µm MIXED-E

Oligomers and Polymers up to 30,000 MW

- **Ultra high efficiency resolves narrow peaks**
- **Fast analysis improves productivity**
- **Optimized particle size for low MW applications**

Characteristics

Linear MW Operating Range: up to 30,000 g/mol (PS equiv)
Guaranteed Column Efficiency:
300 x 7.5 mm: >80,000 p/m
250 x 4.6 mm: >70,000 p/m
Highest efficiency/resolution achieved only on high performance, low dead volume equipment.

Typical Pressure:
1 mL/min (7.5 mm ID): ≈ 50 bar (725 psi) per 300 mm
0.3 mL/min (4.6 mm ID) : ≈ 42 bar (609 psi) per 250 mm
(THF @ 20 °C)

Maximum Flow Rate:
7.5 mm ID: 1.5 mL/min
4.6 mm ID: 0.5 mL/min

Maximum Pressure: 180 bar (2611 psi)

Maximum Temperature: 110 °C

Recommended no. of Columns/set:
1-3 x 250 mm or 1-3 x 300 mm

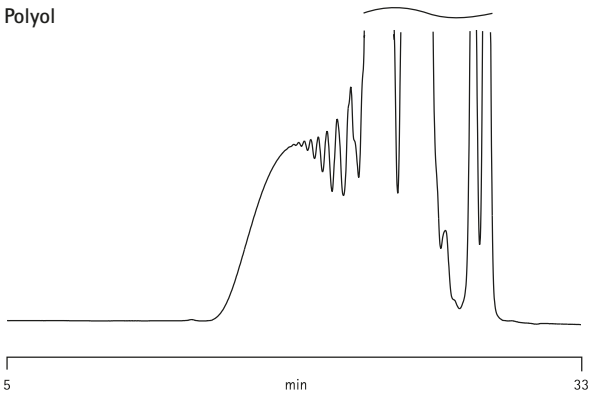
Recommended Calibrants:
Polystyrene Kit S-L-10 for accurate 10 point calibration (page 320)

Polyethylene Glycol Kit PEG-10 for DMF, for low molecular weights (page 322)

Typical Applications

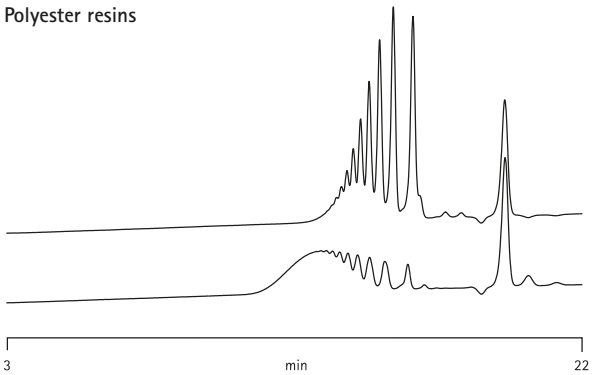
Prepolymers, polyols, resins, siloxanes

Polyol



Columns: 3 x PLgel 3 µm MIXED-E, 300 x 7.5 mm
Eluent: THF
Flow Rate: 1.0 mL/min
Detector: UV, 254 nm

Polyester resins



Columns: 2 x PLgel 3 µm MIXED-E, 300 x 7.5 mm
Eluent: THF
Flow Rate: 1.0 mL/min
Detector: PL-GPC 220 (RI)

GPC/SEC

Ordering Information

PLgel 3 µm MIXED-E Columns

Description	Part No.
PLgel 3 µm MIXED-E, 300 x 7.5 mm	PL1110-6300
PLgel 3 µm MiniMIX-E, 250 x 4.6 mm	PL1510-5300
PLgel 3 µm MIXED-E, 600 x 7.5 mm	PL1110-8504
PLgel 3 µm Guard, 50 x 7.5 mm	PL1110-1320
PLgel 3 µm MiniMIX-E Guard, 50 x 4.6 mm	PL1510-1300

See Also

- PLgel MiniMIX-E Narrow Bore Columns, reduce the need for expensive solvents, page 297
- Polymer Calibration Standards, with highly characterized molecular weights, page 316

PLgel™ MIXED-LS

Eliminates Particle Leakage to Improve Data Quality

- **Obtain an instant improvement in data quality**
- **No need for conditioning, saving time and solvent costs**
- **Maximize the potential of light scattering detectors**

PLgel MIXED-LS eliminates nano particle leakage to greatly improve the quality of light scattering data.

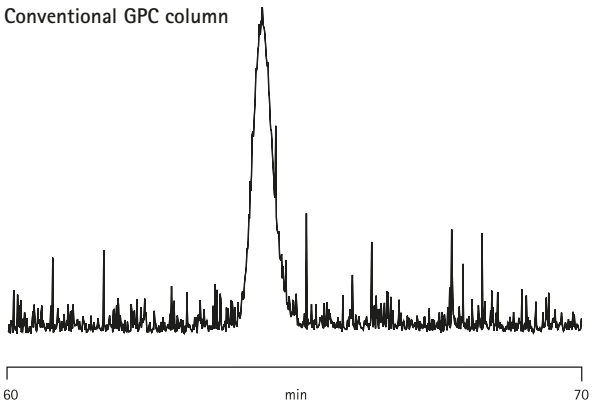
The PLgel MIXED-LS series is a PS/DVB packing using an innovative proprietary suspension polymerization technique to virtually eliminate nano-particle leakage. A startling improvement is achieved immediately in the quality of light scattering data obtained with PLgel MIXED-LS columns in place of conventional GPC columns. The light scattering chromatograms shown here were obtained after flushing the columns for one hour in THF at 1 mL/min. A polystyrene standard (Mp 210,000) was injected at 1 mg/mL in order to illustrate the dramatic improvement in signal to noise with the PLgel MIXED-LS column.

The performance of PLgel MIXED-LS columns has been matched to PLgel 20 µm MIXED-A and PLgel 10 µm MIXED-B columns in terms of calibration, column efficiency, wide solvent compatibility and operating temperature. MIXED-LS are also ideal for online viscosity detection, minimizing the risk of capillary blockage, and can be used with regular PLgel guard columns that are packed with rigid low pore size gels with no particle bleed.

Typical Applications

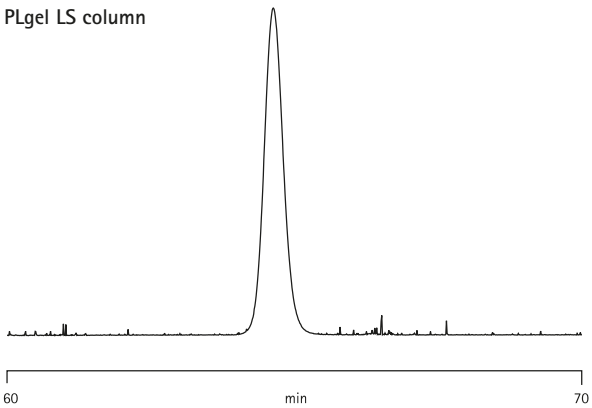
Polyethylenes, polyolefins

Conventional GPC column



Column: Conventional GPC column
Eluent: THF
Flow Rate: 1.0 mL/min
Detector: LS

PLgel LS column



Column: PLgel 10 µm MIXED-B LS, 300 x 7.5 mm
Eluent: THF
Flow Rate: 1.0 mL/min
Detector: LS

See Also

- Polymer Calibration Standards, with highly characterized molecular weights, page 316

Ordering Information

PLgel MIXED-LS Columns

Description	Linear MW Operating Range (g/mol) (PS)	Guaranteed Efficiency (p/m)	Part No.
PLgel 10 µm MIXED-B LS, 300 x 7.5 mm	500-10,000,000	>35,000	PL1110-6100LS
PLgel 20 µm MIXED-A LS, 300 x 7.5 mm	2,000-40,000,000	>17,000	PL1110-6200LS
PLgel 10 µm Guard, 50 x 7.5 mm			PL1110-1120
PLgel 20 µm Guard, 50 x 7.5 mm			PL1110-1220

For more information, please visit www.varianinc.com/plgel_mixed.html or visit www.varianinc.com/products.html to place an order.

PLgel MiniMIX™ Narrow Bore

Reduced Solvent Use

- **Use about 70% less solvent and save money**
- **Store less solvent and increase operator safety**
- **High performance comparable to Varian's conventional ID columns**

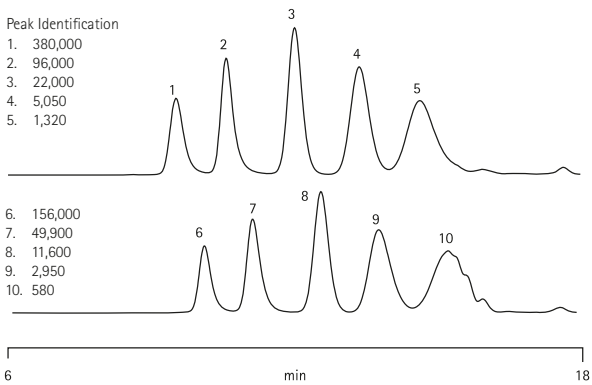
For reduced solvent cost and consumption, use industry standard PLgel MiniMIX mixed gel columns in 250 x 4.6 mm narrow bore dimensions. These narrow bore columns offer high performance, excellent solvent compatibility and mechanical stability. Both PlusPore Narrow Bore and PLgel MiniMIX columns can be used with conventional GPC equipment.

To maintain the same linear velocity through the column, the volumetric flow rate must be reduced to 0.3 mL/min in line with the column cross sectional area, resulting in significantly lower solvent consumption. Sample loading should also be scaled down in line with reduced column volume, and system dead volume should be minimized to avoid excessive band broadening.

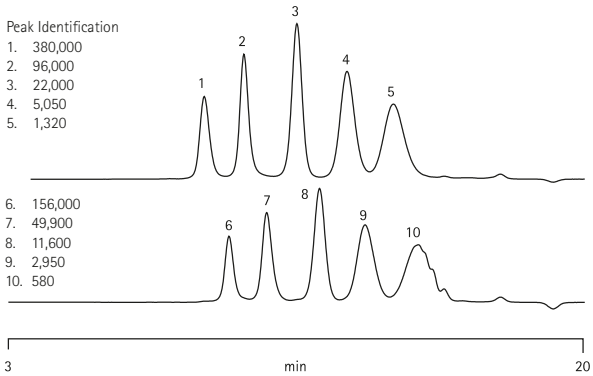
Typical Applications

As for PlusPore and MIXED ranges

Comparison of conventional and narrow bore columns



Columns: 2 x PLgel 5 µm MIXED-D, 300 x 7.5 mm
Sample: EasiCal™ PS-2
Eluent: THF
Flow Rate: 1.0 mL/min
Inj Vol: 100 µL
Detector: UV, 254 nm



Columns: 2 x PLgel MiniMIX-D, 300 x 7.5 mm
Sample: EasiCal PS-2
Eluent: THF
Flow Rate: 0.3 mL/min
Inj Vol: 20 µL
Detector: UV, 254 nm

See Also

- PlusPore Columns, very high resolution without artifacts, page 306
- PLgel MIXED Columns, simplify column selection, page 290
- Polymer Calibration Standards, with highly characterized molecular weights, page 316

Ordering Information

PLgel MiniMIX Columns, 250 x 4.6 mm

Description	Linear MW Operating Range (g/mol) (PS)	Guaranteed Efficiency (p/m)	Part No.
PLgel 20 µm MiniMIX-A	2,000-40,000,000	>17,000	PL1510-5200
PLgel 10 µm MiniMIX-B	500-10,000,000	>35,000	PL1510-5100
PLgel 5 µm MiniMIX-C	200-2,000,000	>50,000	PL1510-5500
PLgel 5 µm MiniMIX-D	200-400,000	>50,000	PL1510-5504
PLgel 3 µm MiniMIX-E	up to 30,000	>70,000	PL1510-5300

PLgel™ Individual Pore Size Columns

High Resolution Over a Specific Molecular Weight Range

- **Very high efficiency improves productivity**
- **Choose the optimum column for a perfect match of performance and application**
- **Fast analysis with fewer columns saves time and money**

Individual pore size GPC columns offer high resolution over a specific molecular weight range. The linear portion of the calibration curve, where the slope is at its shallowest, defines the MW region over which optimum resolution will be achieved.

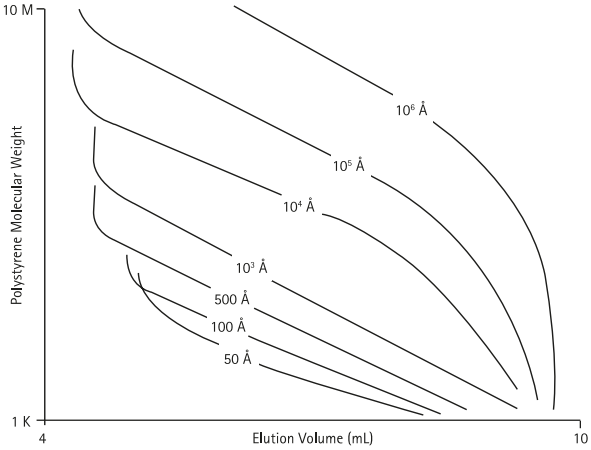
Typical Applications

PLgel 3 µm: Triglycerides, linear hydrocarbons

PLgel 5 µm: Phenolic resins

PLgel 10 µm: Formaldehyde resins

Calibration curves



Calibrant: Polystyrene
Eluent: THF
Flow Rate: 1.0 mL/min

Ordering Information

PLgel Guard Columns, 50 x 7.5 mm

Description	Part No.
PLgel 3 µm Guard	PL1110-1320
PLgel 5 µm Guard	PL1110-1520
PLgel 10 µm Guard	PL1110-1120
PLgel 20 µm Guard	PL1110-1220

See Also

- Polymer Calibration Standards, with highly characterized molecular weights, page 316

Ordering Information

PLgel Individual Pore Size Columns

Description	Pore Size (Å)	MW Range (g/mol) (PS)	Guaranteed Efficiency (p/m)	Part No.		
				300 x 7.5 mm	600 x 7.5 mm	250 x 4.6 mm
PLgel 3 µm	100	up to 4,000	>100,000	PL1110-6320		PL1510-5320
PLgel 5 µm	50	up to 2,000	>60,000	PL1110-6515	PL1110-8515	PL1510-5515
PLgel 5 µm	100	up to 4,000	>60,000	PL1110-6520	PL1110-8520	PL1510-5520
PLgel 5 µm	500	500-30,000	>60,000	PL1110-6525		
PLgel 5 µm	10^3	500-60,000	>50,000	PL1110-6530		
PLgel 5 µm	10^4	10,000-600,000	>50,000	PL1110-6540		
PLgel 5 µm	10^5	60,000-2,000,000	>50,000	PL1110-6550	PL1110-8550	
PLgel 10 µm	50	up to 2,000	>35,000	PL1110-6115	PL1110-8115	
PLgel 10 µm	100	up to 4,000	>35,000	PL1110-6120		
PLgel 10 µm	500	500-30,000	>35,000	PL1110-6125		
PLgel 10 µm	10^3	500-60,000	>35,000	PL1110-6130		
PLgel 10 µm	10^4	10,000-600,000	>35,000	PL1110-6140		
PLgel 10 µm	10^5	60,000-2,000,000	>35,000	PL1110-6150		
PLgel 10 µm	10^6	600,000-10,000,000	>35,000	PL1110-6160		

For more information, please visit www.varianinc.com/plgel_individual.html or visit www.varianinc.com/products.html to place an order.

PLgel™ Preparative Columns

Fractionation of Samples Based on Their Molecular Size in Solution

- **Excellent column efficiency provides optimum resolution**
- **High loading can isolate mg amounts for further study**
- **Over x10 scale up permits efficient quantification**

Preparative GPC is generally employed to fractionate polymers, isolate components in a polymer formulation or simplify mixtures of relatively small molecules in complex matrices. Mixtures of materials are easily separated on the basis of size, preferably in a low boiling organic solvent. They are then collected as a series of discrete fractions and isolated by simple evaporation of the solvent.

PLgel preparative columns are packed with the same rigid, high performance media as the analytical columns. The 10 µm particle provides high column efficiency (>25,000 p/m) for optimum resolution and loading characteristics. PLgel 25 mm ID preparative columns offer over x10 scale up compared to the 7.5 mm analytical columns. The increased ID and column volume permit even higher loading. With low molecular weight materials, sample concentration can also be significantly increased, enabling production of milligram quantities of very pure material. The actual loading is ultimately controlled by the sample and its molecular weight.

Select your PLgel Preparative Column

Column ID (mm)	Column Volume per 300 mm Length (mL)	Minimum Scale Up
PLgel 7.5 Analytical	13	x1
PLgel 25 Preparative	147	x11

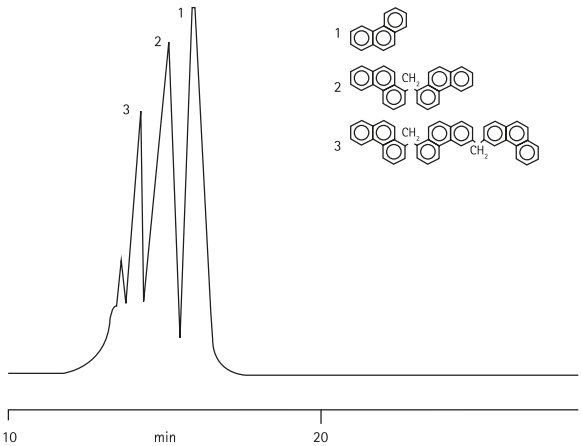
Tip

Not sure which prep column to use? Phone for free application advice.

Typical Applications

Polymer fractionation, component isolation, mixture simplification

Fractionation



Column: PLgel 10 µm 500Å, 600 x 25 mm
Sample Conc: 100 mg/mL, 2 mL
Eluent: Dichloromethane
Flow Rate: 9.0 mL/min
Loading: 200 mg on column
Detector: UV, 254 nm

Ordering Information

PLgel Preparative Columns

Description	MW Range (g/mol) (PS)	Part No.
PLgel 10 µm 50Å, 300 x 25 mm	up to 2,000	PL1210-6115
PLgel 10 µm 50Å, 600 x 25 mm	up to 2,000	PL1210-8115
PLgel 10 µm 100Å, 300 x 25 mm	up to 4,000	PL1210-6120
PLgel 10 µm 100Å, 600 x 25 mm	up to 4,000	PL1210-8120
PLgel 10 µm 500Å, 300 x 25 mm	500-30,000	PL1210-6125
PLgel 10 µm 500Å, 600 x 25 mm	500-30,000	PL1210-8125
PLgel 10 µm 10^3Å, 300 x 25 mm	500-60,000	PL1210-6130
PLgel 10 µm 10^4Å, 300 x 25 mm	10,000-600,000	PL1210-6140
PLgel 10 µm 10^5Å, 300 x 25 mm	60,000-2,000,000	PL1210-6150
PLgel 10 µm 10^6Å, 300 x 25 mm	600,000-10,000,000	PL1210-6160
PLgel 10 µm MIXED-B, 300 x 25 mm	500-10,000,000	PL1210-6100
PLgel 10 µm MIXED-B, 600 x 25 mm	500-10,000,000	PL1210-8100
PLgel 10 µm MIXED-D, 300 x 25 mm	200-400,000	PL1210-6104
PLgel 10 µm MIXED-D, 600 x 25 mm	200-400,000	PL1210-8104
PLgel Prep Guard, 25 x 25 mm		PL1210-1120

See Also

- Polymer Calibration Standards, with highly characterized molecular weights, page 316

EnviroPrep™

Environmental Clean up With EPA Methods

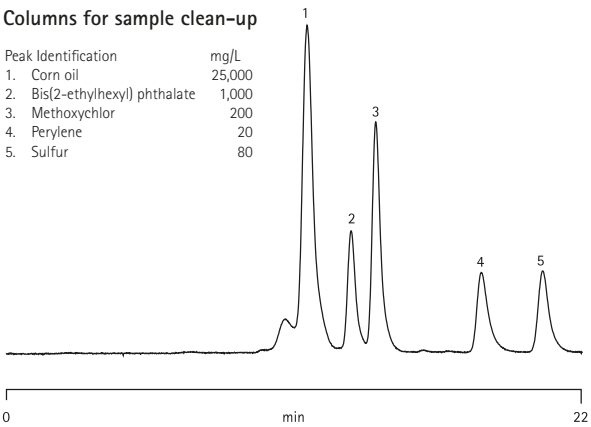
- **High sample loading ensures effective trace analysis**
- **Simple clean-up procedure saves sample preparation costs**
- **Optimized particle size distribution provides high resolution**

EnviroPrep columns permit a simple, one stage clean-up to determine pesticides in many organic matrices. The higher molecular weight fractions such as lipids, polymers, natural resins and dispersed high molecular weight components are easily eliminated in the GPC analysis.

Preparative GPC for soil extract clean-up is described in "EPA Method 3640A" Method 3640A using 300 x 25 mm and 150 x 25 mm columns to give higher sample loading and fraction yields, which is particularly useful for low levels of pollutants. Low pore size EnviroPrep columns are ideal for this method.
The columns have 10 µm particles with 100 Å pore sizes for high resolution, with an exclusion limit of 4000 MW. The preparative columns offer good resolution and high loading through optimization of the particle size distribution.

Columns for sample clean-up

Peak Identification	mg/L
1. Corn oil	25,000
2. Bis(2-ethylhexyl) phthalate	1,000
3. Methoxychlor	200
4. Perylene	20
5. Sulfur	80



Column: EnviroPrep, 300 x 25 mm
EnviroPrep, 150 x 25 mm
Eluent: DCM
Flow Rate: 10 mL/min
Detector: UV, 254 nm

Ordering Information

EnviroPrep Columns

Description	Part No.
EnviroPrep, 150 x 21.2 mm	PL1E10-3120EPA
EnviroPrep, 150 x 25 mm	PL1210-3120EPA
EnviroPrep, 300 x 21.2 mm	PL1E10-6120EPA
EnviroPrep, 300 x 25 mm	PL1210-6120EPA

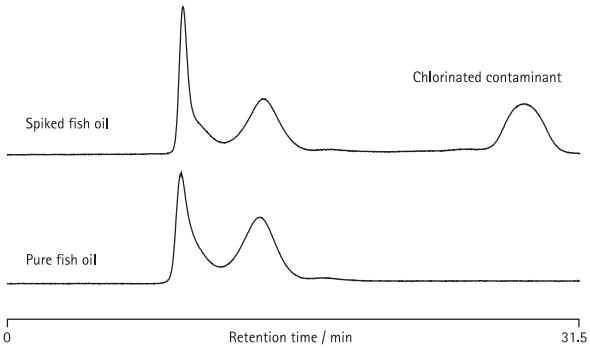
EcoSpheres™

Microporous Gel for Environmental Clean up

- **Self packing loose media for maximum flexibility**
- **Available with glass columns for a complete solution**
- **Use with any LC isocratic system for maximum utility**

EcoSpheres is a loose microporous media for packing into any suitable column hardware. It operates up to 300 psi and the 25 mm ID glass columns can handle eluent flows up to 10 mL/min. EcoSpheres can be used with any isocratic system, and with a wide range of organic solvents. The narrow particle size distribution gives excellent peak shape and well packed columns, and the low pore size excludes high molecular weight material, maximizing separation from low molecular weight additives.

Separation of trichlorobenzene from sardines



Column: Glass column packed with swollen EcoSpheres
Solvent: 50:50 mixture of cyclohexane and ethyl acetate
Flow Rate: 5 mL/min
Inj Vol: 5 mL
System: Modular system (dual piston pump with injection valve)
Detector: UV, 254 nm

See Also

- Polymer Calibration Standards, with highly characterized molecular weights, page 316

Ordering Information

EcoSpheres

Description	Part No.
EcoSpheres Loose Media (100 g)	PL1460-4M03
Complete Glass Column	PL1310-0054
Glass Column Only (no end fittings)	PL1310-0055
Adjustable End Piece	PL1310-0056
Fixed End Piece	PL1310-0057
Seals (Kalrez®)	PL1310-0058
Frits (glass, 10-13 µm)	PL1310-0059

Visit www.varianinc.com/enviroprep.html or www.varianinc.com/ecospheres.html or visit www.varianinc.com/products.html to place an order.

PLgel Olexis™

Analyzing Polymers of Very High Molecular Weight

- **Optimized design for polyolefin analysis**
- **High temperature capability**
- **High resolution with no damage from sample shear provides clean separations**

PLgel Olexis is designed for the analysis of very high molecular weight polymers, specifically polyolefins. The column resolves up to 100,000,000 g/mol (polystyrene in THF), and is packed with 13 µm particles to optimize efficiency and resolution without the risk of sample shear degradation during analysis. The packing of PLgel Olexis has the mechanical stability and robustness expected from a PLgel column, and so it is able to operate up to 220 °C for the analysis of highly crystalline materials.

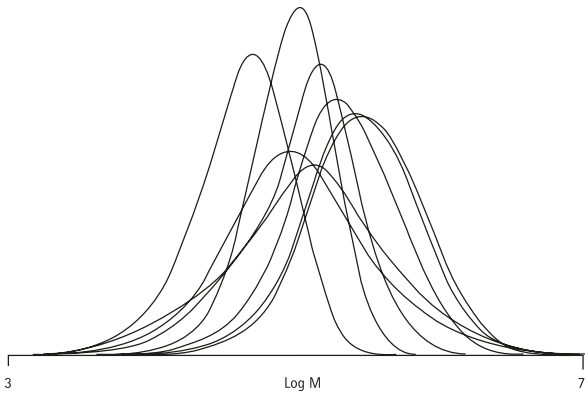
Tip

Remember to heat and cool columns for high temperature analysis slowly to avoid damage from thermal shock.

Typical Applications

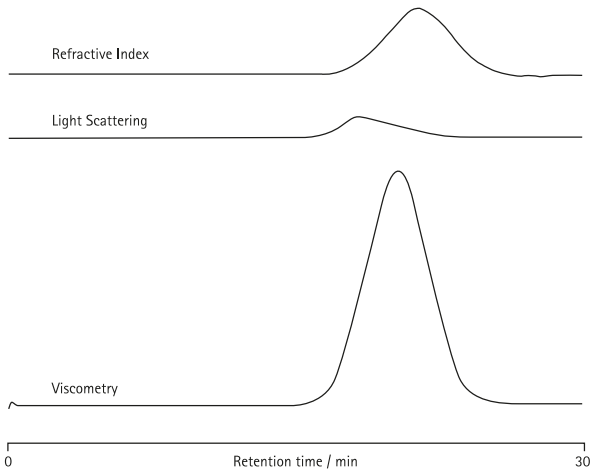
Polyolefins

PLgel Olexis reveals true modalities across the range of polyolefins



Columns:	3 x PLgel Olexis, 300 x 7.5 mm
Eluent:	Trichlorobenzene + 0.0125% BHT
Flow Rate:	1.0 mL/min
Inj Vol:	200 µL
Temp:	160 °C
Detector:	PL-GPC 220 (RI)

GPC of polyethylene by PLgel Olexis with different detectors



Columns:	3 x PLgel Olexis, 300 x 7.5 mm
Eluent:	Trichlorobenzene + 0.0125% BHT
Inj Vol:	200 µL
Temp:	160 °C
Detector:	PL-GPC 220 (RI) + dual angle LS + viscometry

Ordering Information

PLgel Olexis Columns

Description	Part No.
PLgel Olexis, 300 x 7.5 mm	PL1110-6400
PLgel Olexis Guard, 50 x 7.5 mm	PL1110-1400

See Also

- Polymer Calibration Standards, with highly characterized molecular weights, page 316

PL HFIPgel™

Improved Performance When Using HFIP

- **Optimized separation range delivers high performance with no artifacts**
- **Highly durable packing prolongs column lifetime**
- **Low operating pressure reduces system wear and unnecessary downtimes**

Hexafluoroisopropanol (HFIP) is used as a solvent in GPC for the analysis of important industrial polymers such as polyesters, polyamides and polylactide/glycolide copolymers. For greatly improved performance in extremely polar solvents such as HFIP and trifluoroethanol, we have developed novel "multipore" technology to produce PL HFIPgel, a PS/DVB packing featuring a monodisperse particle size, high pore volume and high resolution.

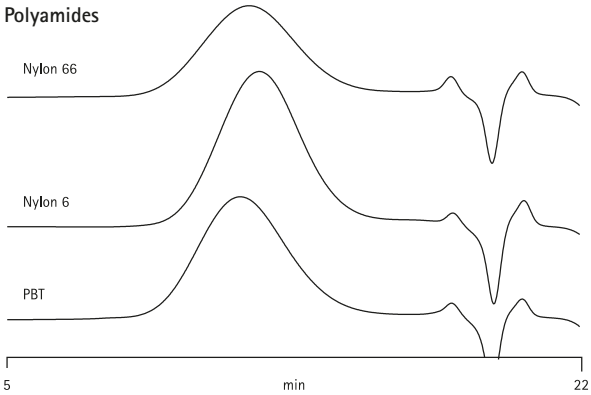
Using PL HFIPgel avoids issues associated with conventional packing and HFIP, such as excessive curvature of calibration curves, dislocations/shoulders on peaks for polydisperse samples and poor resolution in the low MW region.

Column efficiency is guaranteed >30,000 p/m and the columns are very durable, with a maximum operating pressure of 145 bar (2030 psi). They are packed and tested in methanol but shipped ready to use in HFIP.

PL HFIPgel columns with 7.5 mm ID normally operate at 1 mL/min. However, the 4.6 mm ID columns run at 0.3 mL/min, providing a 70% reduction in solvent consumption with consequent savings in the cost of buying and disposing of solvents.

Typical Applications

Polyesters, polyamides, polylactide/glycolide copolymers



Columns: 2 x PL HFIPgel, 300 x 7.5 mm
Eluent: HFIP + 20mM NaTFAc
Flow Rate: 1.0 mL/min
Temp: 40 °C
Detector: PL-GPC 50 Plus (RI)

Ordering Information

PL HFIPgel Columns

Description	Part No.
PL HFIPgel, 250 x 4.6 mm	PL1514-5900HFIP
PL HFIPgel, 300 x 7.5 mm	PL1114-6900HFIP
PL HFIPgel Guard, 50 x 7.5 mm	PL1114-1900HFIP
PL HFIPgel Guard, 50 x 4.6 mm	PL1514-1900HFIP

See Also

- Polymer Calibration Standards, with highly characterized molecular weights, page 316

For more information, please visit www.varianinc.com/pl_hfip_gel.html or visit www.varianinc.com/products.html to place an order.

PL Rapide™

Fast Separations for High Turnaround or When Analyzing Many Samples

- **Analysis in less than ten minutes saves time**
- **Significantly increased sample throughput improves efficiency**
- **Reduced solvent consumption and disposal costs saves money**

Two key parameters can be varied to reduce the analysis time of an experiment. Column length can be reduced or eluent flow rate increased. Using both methods, PL Rapide columns provides significantly increased sample throughput compared to a conventional GPC/SEC column set.

Rapid GPC is an excellent tool for screening polymer MWD for trend analysis. Short PL Rapide columns reduce analysis times while maintaining the excellent solvent compatibility and mechanical stability of all GPC columns from Varian.

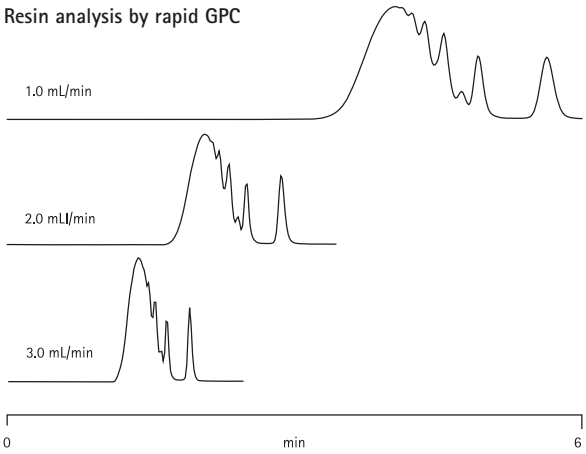
PL Rapide columns are ideal for high speed applications such as high throughput screening, process monitoring, or tracking changes in MW distributions, where time is the most critical factor in the analysis. Packed with high quality gels, these columns cover the complete spectrum of molecular weights and are available for the analysis of both organic and water soluble polymers. Key features include high pore volume and high resolution packing materials, no special system requirements, choice of molecular weight resolving range, wide solvent compatibility, and excellent mechanical stability.

PL Rapide is available in L, M and H versions for low, medium and high molecular weights. The F version is for flow injection analysis.

Typical Applications

Epoxy resins, process monitoring, flow injection analysis

Resin analysis by rapid GPC



Column: PL Rapide L, 100 x 10 mm
Sample: Epoxy resin
Eluent: THF
Flow Rate: 1.0 , 2.0 and 3.0 mL/min
Detector: UV, 254 nm

See Also

- Polymer Calibration Standards, with highly characterized molecular weights, page 316

GPC/SEC

Ordering Information

PL Rapide Columns

Description	MW Range (g/mol)	Guaranteed Efficiency (p/m)	Part No.
PL Rapide H, 150 x 7.5 mm	500-10,000,000	>35,000	PL1113-3100
PL Rapide H, 100 x 10mm	500-10,000,000	>35,000	PL1013-2100
PL Rapide M, 150 x 7.5 mm	200-2,000,000	>60,000	PL1113-3500
PL Rapide M, 100 x 10 mm	200-2,000,000	>60,000	PL1013-2500
PL Rapide L, 150 x 7.5 mm	200-400,000	>80,000	PL1113-3300
PL Rapide L, 100 x 10 mm	200-400,000	>80,000	PL1013-2300
PL Rapide F, 150 x 7.5 mm	up to 4,500	>55,000	PL1113-3120
PL Rapide F, 100 x 10 mm	up to 4,000	>40,000	PL1013-2120
PL Rapide Aqua H, 150 x 7.5 mm	100-10,000,000	>35,000	PL1149-3800
PL Rapide Aqua H, 100 x 10 mm	100-10,000,000	>35,000	PL1049-2800
PL Rapide Aqua L, 150 x 7.5 mm	100-30,000	>35,000	PL1120-3830
PL Rapide Aqua L, 100 x 10 mm	100-30,000	>35,000	PL1020-2830

PolarGel™ GPC Columns

For Intermediate Polarity Solvents and Polar Solvent Combinations

The PolarGel range is ideal for use with polar solvents, for example dimethyl formamide and dimethyl sulfoxide, and for solvent combinations such as tetrahydrofuran with water. These eluents are very useful in GPC/SEC to separate polar materials, such as polar resins, modified polysaccharides or complex polar polymers that are difficult to analyze in traditional SEC solvents, such as tetrahydrofuran alone. PolarGel-L is used for low molecular weight polar polymers and PolarGel-M for high MW polar polymers.

With polar polymers, highly polar groups can lead to non-specific interactions and secondary separation mechanisms when using polar solvents and traditional non-polar styrene/divinylbenzene columns. Additives and/or column conditioning are normally required to reduce these interactions. PolarGel has no need for these interventions, and also avoids the interactions and secondary effects that produce chromatogram distortions.

These PolarGel "mixed bed" columns have a medium polarity surface and high mechanical stability. They are capable of operating in a wide range of solvents and solvent combinations, greatly enhancing your ability to analyze polar polymers that are not necessarily water soluble. PolarGel is available in two resolving ranges to meet your precise requirements.

Charateristics

PolarGel-L

Particle Size: 8 µm

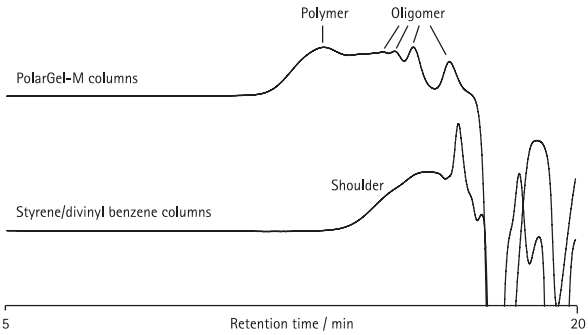
Resolving Range (PEG/PEO in water): Up to 30,000 g/mol

PolarGel-M

Particle Size: 8 µm

Resolving Range (PEG/PEO in water): Up to 700,000 g/mol

Superior polar performance from PolarGel columns



Columns:	2 x PolarGel-M, 300 x 7.5 mm
Sample:	Melamine resins
Eluent:	Dimethylformamide + 0.1% LiBr
Flow Rate:	1.0 mL/min
Temp:	50 °C
Detector:	PL-GPC 220 (RI)

For more information, please visit www.varianinc.com/polargel.html or visit www.varianinc.com/products.html to place an order.

PolarGel™-L

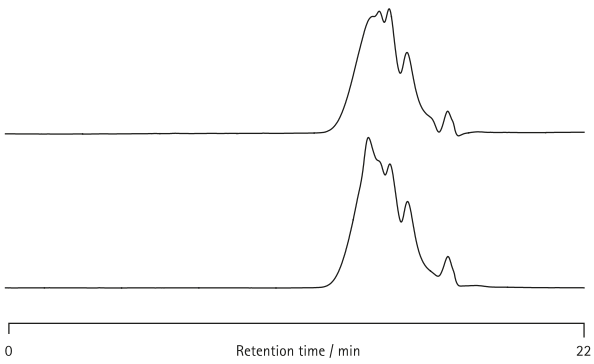
For Analysis of Low Molecular Weight Polymers in Polar Solvents

- **Specifically designed for polar samples**
- **Mixed bed technology delivers near linear calibrations for greater accuracy**
- **Mechanical stability for longer column lifetimes**

Typical Applications

Melamines, polar resins and polar pre-polymers

Two samples of melamine resin analyzed by PolarGel-L



Columns:	2 x PolarGel-L, 300 x 7.5 mm
Eluent:	Dimethylacetamide + 0.1% LiBr
Flow Rate:	1.0 mL/min
Inj Vol:	100 µL
Temp:	50 °C
Detector:	PL-GPC 220 (RI)

See Also

- EasiVial™ PEG/PEO and PMMA Standards, pre-weighed to save time, page 317

Ordering Information

PolarGel-L Columns

Description	Part No.
PolarGel-L, 300 x 7.5 mm	PL1117-6830
Frit Removal Tool for Threaded Columns only	PL1310-0001
End Fitting for Threaded Columns, 7.5 mm ID	PL1310-0004
Frit (5 µm) Kit for Threaded Columns, 7.5 mm ID (5/pk)	PL1310-0012
Column Connecting Nuts (Pk of 5), 1/16 in. (5/pk)	PL1310-0007
Tubing Ferrules (Pk of 5), 1/16 in. (5/pk)	PL1310-0008
Column End Plugs (Pk of 10), 1/16 in. (10/pk)	PL1310-0003
LDV Intercolumn SS Connector	PL1310-0005
PolarGel-L Repair Gel	PL1417-0830
PolarGel-L Guard Column, 50 x 7.5 mm	PL1117-1830

PolarGel™-M

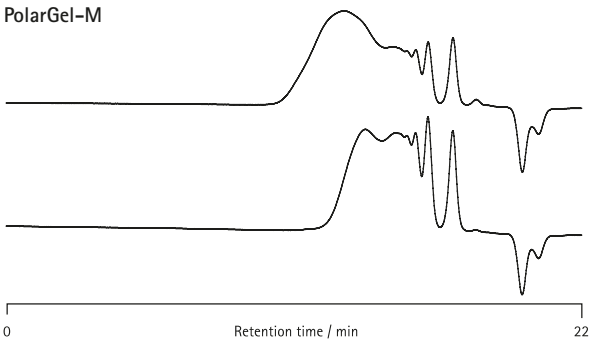
For Analyzing a Wide Range of Polymers in Polar Solvents

- **Optimized pore size distribution and particle size for superior resolution**
- **Mixed bed technology simplifies column selection**
- **No sample and stationary phase interaction for accurate MW measurement**

Typical Applications

Phenol formaldehyde resins and lignins

Excellent separation of two phenol formaldehyde resins with PolarGel-M



Columns:	2 x PolarGel-M, 300 x 7.5 mm
Eluent:	0.2% (w/v) DMF & 0.1% LiBr to reduce sample aggregation
Flow Rate:	1.0 mL/min
Inj Vol:	100 µL
Temp:	50 °C
Detector:	PL-GPC 50 Plus (RI)

See Also

- EasiVial PEG/PEO and PMMA Standards, pre-weighed to save time, page 317

Ordering Information

PolarGel-M Columns

Description	Part No.
PolarGel-M, 300 x 7.5 mm	PL1117-6800
Frit Removal Tool for Threaded Columns only	PL1310-0001
End Fitting for Threaded Columns, 7.5 mm ID	PL1310-0004
Frit (5 µm) Kit for Threaded Columns, 7.5 mm ID (5/pk)	PL1310-0012
Column Connecting Nuts, 1/16 in. Tube (5/pk)	PL1310-0007
Tubing Ferrules, 1/16 in. Tube (5/pk)	PL1310-0008
Column End Plugs, 1/16 in. (10/pk)	PL1310-0003
LDV Intercolumn SS Connector	PL1310-0005
PolarGel-M Repair Gel	PL1417-0800
PolarGel-M Guard Column, 50 x 7.5 mm	PL1117-1800

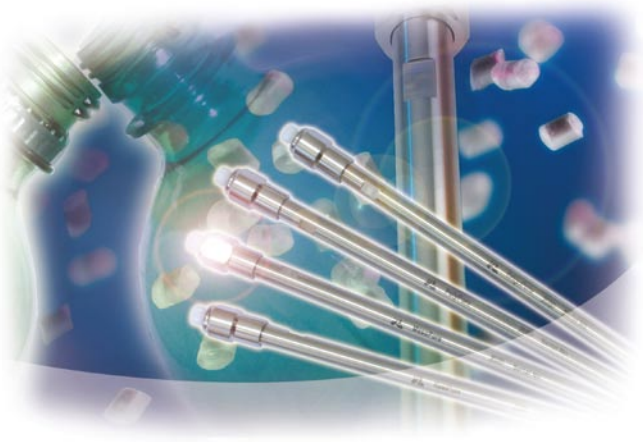
PlusPore™

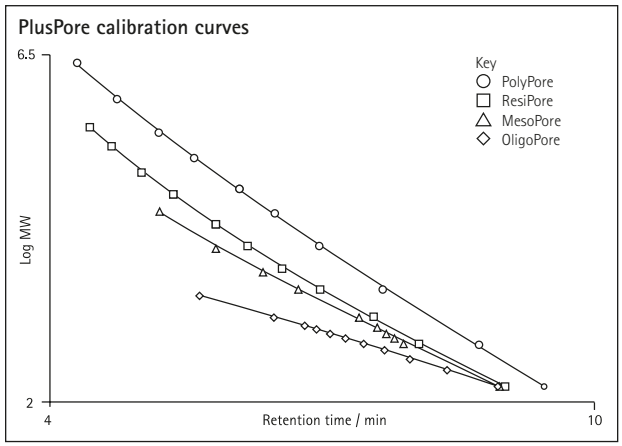
Very High Resolution Without Artifacts

The PlusPore range has an increased pore volume that provides high resolution for specific applications. The high stability media permits the use of a wide range of organic solvents with accuracy and precision so that there is no distortion of the MW distribution shape.

The PlusPore series of columns has been specifically designed for high resolution GPC, and represents the very latest in GPC column technology. These novel packing materials are based on the industry standard, highly cross linked polystyrene/divinylbenzene (PS/DVB), for the widest applicability and solvent compatibility. Each is made using a novel polymerization process to produce particles that exhibit a specific, controlled pore structure for optimum GPC performance. Typical applications include resins, condensation polymers, prepolymers, and oligomers.

For high resolution polymer analysis, the PolyPore, ResiPore, MesoPore and OligoPore columns of the PlusPore product series exhibit a wide pore size distribution with near linear calibration curves covering an extended molecular weight range. These so-called "multipore" structures have increased pore volume compared to regular PS/DVB packing materials. This results in very high resolution GPC columns designed for specific application areas. The highly cross linked porous particles provide excellent chemical and physical stability and permit easy transfer across the full range of organic solvents with little change in the shape of the calibration curve or the efficiency of the columns. As this multipore column technology does not require the combination of individual pore size packing materials, the result is high accuracy and precision without any artifacts in the shape of the molecular weight distribution.





The PlusPore Range

- PolyPore for the routine analysis of general polymers
- ResiPore for resins and condensation polymers
- MesoPore for prepolymers and low MW resins
- OligoPore for oligomeric samples

See Also

- Polymer Calibration Standards, with highly characterized molecular weights, page 316

PlusPore Selection Guide

Column	MW Range (g/mol) (PS)	Nominal Particle Size (µm)	Typical Efficiency (p/m)	Recommended Calibrants	Frit Porosity (µm)
PolyPore™	200-2,000,000	5	>60,000	EasiCal™ PS-1or EasiVial™ PS-H	2
ResiPore™	200-400,000	3	>80,000	EasiCal PS-2 or EasiVial PS-M	2
MesoPore™	up to 25,000	3	>80,000	Polystyrene S-L-10 Kit,	2
OligoPore™	up to 4,500	6	>55,000	Polystyrene S-L2-10 Kit	2

For more information, please visit www.varianinc.com/pluspore.html or visit www.varianinc.com/products.html to place an order.

PolyPore™

Unrivalled Resolution of General Polymers

- **Routine polymer analysis with very high resolution**
- **Wide operating range simplifies column choice**
- **Low particle size extracts maximum information from the analyte**

PolyPore columns have been specifically developed to give unrivalled resolution for the analysis of polymers with broad molecular weight distributions. With a wide operating range covering many decades of molecular weight, PolyPore columns combine a low 5 µm particle size with extremely high pore volume to give the highest possible resolution, ensuring the most detailed information possible from your analysis.

Characteristics

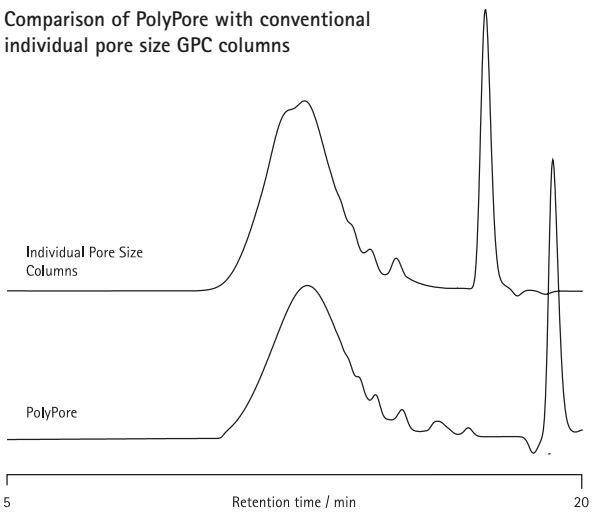
MW Range: 200-2,000,000 (g/mol)
Nominal Particle Size: 5 µm
Typical Efficiency: >60,000 p/m

Recommended Calibrants:
EasiCal™ PS-1 for rapid 10 point calibration or EasiVial™ for convenient 10 point calibration in just three injections
(page 317)

Typical Applications

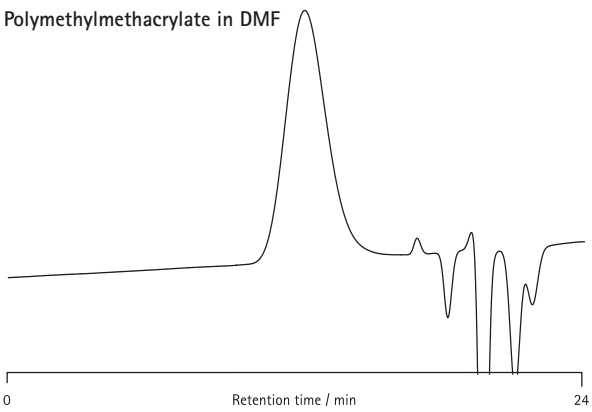
Polystyrenes, polycarbonates, polyurethanes, polysiloxanes

Comparison of PolyPore with conventional individual pore size GPC columns



Columns:	2 x PolyPore, 300 x 7.5 mm PLgel 5 µm 10^3Å, 300 x 7.5 mm PLgel 5 µm 10^5Å, 300 x 7.5 mm
Sample:	High MW Resin
Eluent:	THF
Flow Rate:	1.0 mL/min
Inj Vol:	100 µL
Detector:	PL-GPC 50 Plus (RI)

Polymethylmethacrylate in DMF



Columns:	2 x PolyPore, 300 x 7.5 mm
Sample:	Commercial PMMA
Eluent:	DMF + 0.1% LiBr
Flow Rate:	1.0 mL/min
Temp:	80 °C
Inj Vol:	100 µL
Detector:	PL-GPC 50 Plus (RI)

Ordering Information

PolyPore Columns

Description	Part No.
PolyPore, 250 x 4.6 mm	PL1513-5500
PolyPore, 300 x 7.5 mm	PL1113-6500
PolyPore Guard, 50 x 4.6 mm	PL1513-1500
PolyPore Guard, 50 x 7.5 mm	PL1113-1500

See Also

- Polymer Calibration Standards, with highly characterized molecular weights, page 316

ResiPore™

High Resolution of Resins and Condensation Polymers

- **Efficient separation of complex molecular weight distributions**
- **Reveals oligomer content to provide a true representation of the sample**
- **High pore volume extracts maximum information from the analyte**

ResiPore columns are the ideal choice for the analysis of resins, and condensation polymers with complex molecular weight distributions that include oligomer content. By combining a low 3 µm particle size and high pore volume, high efficiency ResiPore columns offer maximum resolution of these intermediate molecular weight polymers.

Characteristics

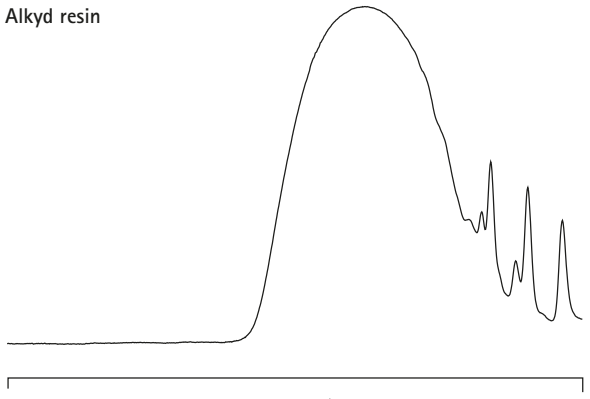
MW Range: 200-400,000 (g/mol)
Nominal Particle Size: 3 µm
Typical Efficiency: >80,000 p/m

Recommended Calibrants:
EasiCal™ PS-2 for rapid 10 point calibration (page 319), or
EasiVial™ PS-M for convenient 10 point calibration in just 3 injections (page 317)

Typical Applications

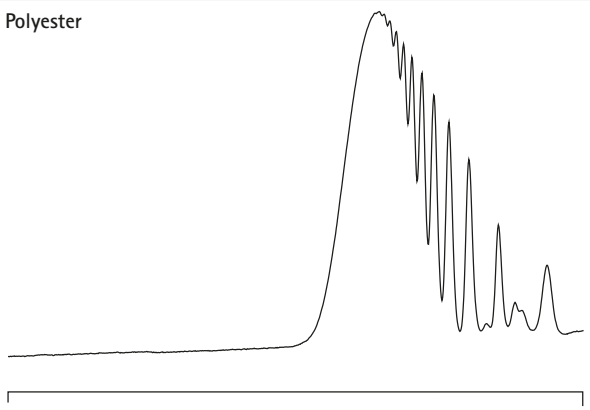
Epoxy resins, polyester resins, silicone fluids, polyolefin waxes

Alkyd resin



Columns: 2 x ResiPore, 300 x 7.5 mm
Eluent: THF
Flow Rate: 1.0 mL/min
Inj Vol: 20 µL
Detector: UV, 254 nm

Polyester



Columns: 2 x ResiPore, 300 x 7.5 mm
Eluent: THF
Flow Rate: 1.0 mL/min
Inj Vol: 20 µL
Detector: UV, 254 nm

Ordering Information

ResiPore Columns

Description	Part No.
ResiPore, 250 x 4.6 mm	PL1513-5300
ResiPore, 300 x 7.5 mm	PL1113-6300
ResiPore Guard, 50 x 4.6 mm	PL1513-1300
ResiPore Guard, 50 x 7.5 mm	PL1113-1300

See Also

- Polymer Calibration Standards, with highly characterized molecular weights, page 316

For more information, please visit www.varianinc.com/pluspore.html or visit www.varianinc.com/products.html to place an order.

MesoPore™

Unsurpassed Separation of Prepolymers and Low MW Resins

- **Full solvent compatibility with no detrimental effect on efficiency**
- **Low particle size extracts maximum information from the analyte**
- **No MWD dislocations so the distribution is a faithful representation of the sample**

MesoPore columns have been specifically designed to give optimum results in the analysis of prepolymers, i.e. polymeric materials with a large oligomeric component. By combining a 3 µm particle size with high pore volume, MesoPore columns give the highest resolution separations for the analysis of low molecular weight polymers, such as prepolymers, resins, polyols and siloxanes.

Characteristics

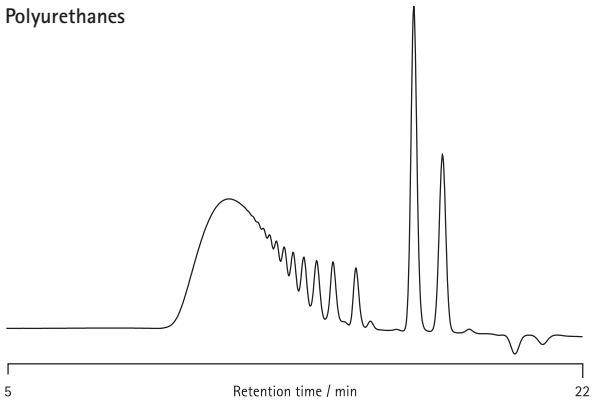
MW Range: up to 25,000 (g/mol)
Nominal Particle Size: 3 µm
Typical Efficiency: >80,000 p/m

Recommended Calibrants:
Polystyrene S-L-10 Kit for rapid 10 point calibration (page 320), or the Polyethylene Glycol PEG-10 Kit for DMF (page 322)

Typical Applications

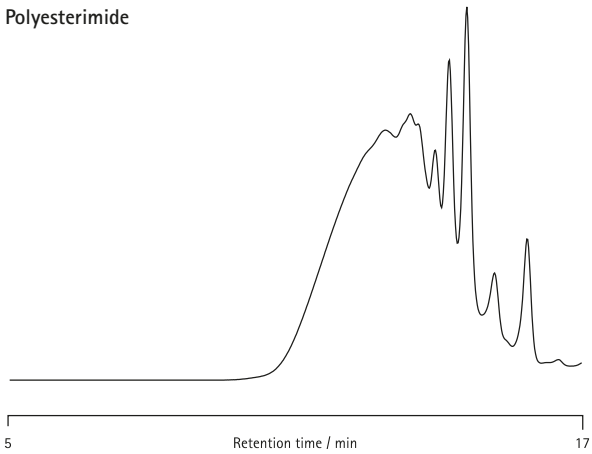
Prepolymers, resins, polyols, siloxanes

Polyurethanes



Columns:	2 x MesoPore, 300 x 7.5 mm
Eluent:	THF
Flow Rate:	1.0 mL/min
Inj Vol:	20 µL
Detector:	PL-GPC 50 Plus (RI)

Polyesterimide



Columns:	2 x MesoPore, 300 x 7.5 mm
Eluent:	THF
Flow Rate:	1.0 mL/min
Inj Vol:	20 µL
Detector:	PL-GPC 50 Plus (RI)

Ordering Information

MesoPore Columns

Description	Part No.
MesoPore, 250 x 4.6 mm	PL1513-5325
MesoPore, 300 x 7.5 mm	PL1113-6325
MesoPore Guard, 50 x 4.6 mm	PL1513-1325
MesoPore Guard, 50 x 7.5 mm	PL1113-1325

See Also

- Polymer Calibration Standards, with highly characterized molecular weights, page 316

OligoPore™

Excellent Resolution of Oligomeric Samples

- **Near linear calibration curve for best accuracy and precision**
- **Very stable media allows for a wide choice of solvents**
- **Isolation of individual fractions reveals more information from whole samples**

OligoPore columns have been developed from an innovative new media that exhibits significantly increased pore volumes compared to conventional low pore size GPC columns. The outcome is higher resolution in the oligomeric region. The 300 x 25 mm preparative column offers high resolution at greatly increased loading for effective isolation of individual components. Oligomer fractions collected from the OligoPore preparative column can then be re-injected on analytical columns to check for the purity of the fractions and for comparison with the whole sample.

Characteristics

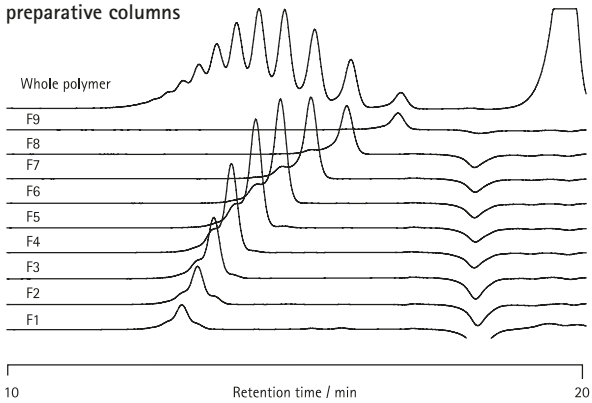
MW Range: up to 4,500 (g/mol)
Nominal Particle Size: 6 µm
Typical Efficiency: >55,000 p/m

Recommended Calibrants:
Individual MW polystyrenes – the first choice for many organic solvents (page 320)

Typical Applications

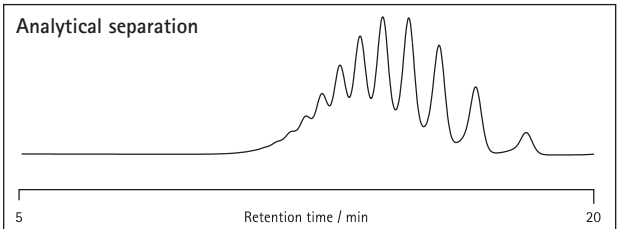
Polyurethanes, epoxy resins, polystyrenes

Analysis of whole polymer and fractions collected from OligoPore preparative columns



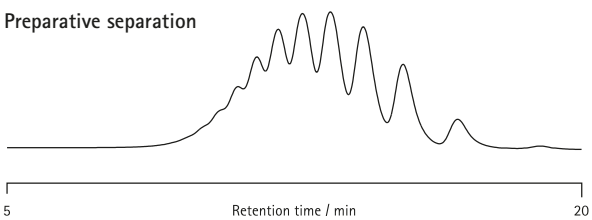
Columns: 2 x OligoPore, 300 x 7.5 mm
Eluent: THF
Flow Rate: 1.0 mL/min
Detector: UV

Analytical separation



Columns: 2 x OligoPore, 300 x 7.5 mm
Eluent: THF
Flow Rate: 1.0 mL/min
Loading: 0.2%, 100 mL
Detector: UV

Preparative separation



Columns: 2 x OligoPore, 300 x 25 mm
Eluent: THF
Flow Rate: 10.0 mL/min
Loading: 2.0%, 2 mL
Detector: UV

Ordering Information

OligoPore Columns

Description	Part No.
OligoPore, 250 x 4.6 mm	PL1513-5520
OligoPore, 300 x 7.5 mm	PL1113-6520
OligoPore, 300 x 25 mm	PL1213-6520
OligoPore Guard, 50 x 4.6 mm	PL1513-1320
OligoPore Guard, 50 x 7.5 mm	PL1113-1320

See Also

- Polymer Calibration Standards, with highly characterized molecular weights, page 316

For more information, please visit www.varianinc.com/pluspore.html or visit www.varianinc.com/products.html to place an order.

ProSEC™ 300S Protein Solutions

Protein Size Exclusion Chromatography

- **High pore volume material delivers excellent resolution across the application range**
- **Surface modified silica for high performance protein SEC with minimal interaction**
- **Single packing material for small to medium sized globular proteins**

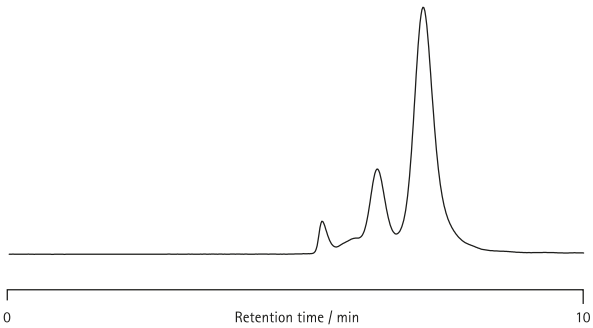
The ProSEC 300S column contains a silica based packing with a surface modified for compatibility with proteins, ensuring that true size exclusion is obtained with minimal unwanted interaction affects. The nominally 300Å pore size and 5 µm particle size have been specifically selected to allow the analysis of a wide range of small to medium sized proteins.

ProSEC 300S offers excellent chromatographic performance with a wide resolving range from a single packing material.

Typical Applications

Protein mix, globular proteins

Globulin multimodal peak indicates a complex protein mixture



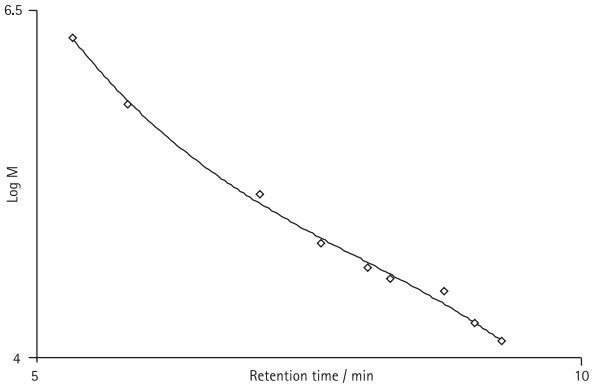
Column: ProSEC 300S, 300 x 7.5 mm
Eluent: 0.3M KH_2PO_4/50mM K_2HPO_4, pH 6.8, containing 0.3M NaCl
Flow Rate: 1.0 mL/min
Inj Vol: 20 µL
Sample Conc.: 4 mg/mL
Temp: 25 °C
Detector: UV, 280 nm

PR-10 Protein Calibration Kit: Determine the Relationship Between Protein Size and Retention Time

- **Specially chosen components deliver a linear calibration for improved elution behaviour**
- **Contains a wide range of globular proteins of differing shapes to assess column performance**
- **Components show dimers, trimers and higher oligomers to assess column resolution**

The PR-10 kit contains eight protein standards with a range of molecular weights, blue dextran and glycine. These standards are used with Varian's ProSEC 300S columns to determine the relationship between protein size and retention time.

Typical calibration curve for the standards in the PR-10 Kit on a single ProSEC 300S Column



Column: ProSEC 300S, 300 x 7.5 mm
Sample: Proteins
Sample Conc.: 4 mg/mL
Eluent: 0.3 M KH_2PO_4, 50 mM K_2HPO_4, pH 6.8, containing 0.3 M NaCl
Flow Rate: 1.0 mL/min
Inj Vol: 20 µL
Temp: 25 °C
Detector: UV at 280 nm

See Also

- GPC/SEC Columns, page 286

Ordering Information

ProSEC 300S Columns

Description	Part No.
ProSEC 300S, 250 x 4.6 mm	PL1547-5501
ProSEC 300S, 300 x 7.5 mm	PL1147-6501
ProSEC 300S Guard, 50 x 4.6 mm	PL1547-1501
ProSEC 300S Guard, 50 x 7.5 mm	PL1147-1501

Ordering Information

Description	Part No.
PR1 Protein Kit (10 x 0.1 g)	PL2150-0100

PL aquagel-OH™ SEC Columns

SEC with Durability and Versatility

Aqueous size exclusion chromatography (SEC) is widely used for the determination of molecular weight distributions of a variety of synthetic and naturally occurring water soluble polymers, and separations of oligomers and small molecules. The requirement to eliminate ionic and hydrophobic effects makes aqueous SEC very demanding.

The PL aquagel-OH series provides a chemically and physically stable matrix for reliable aqueous SEC separations. The columns are packed with macroporous copolymer beads with an extremely hydrophilic polyhydroxyl functionality. The "neutral" surface and the capability to operate across a wide range of eluent conditions provide for high performance analyses of compounds with neutral, ionic and hydrophobic moieties, alone or in combination. PL aquagel-OH is available for analytical and preparative applications.

Optimizing Conditions for Aqueous SEC with PL aquagel-OH Columns

Due to the complex nature of water soluble polymers, it is often necessary to modify the eluent in order to avoid sample-to-sample and sample-to-column interactions which can result in poor aqueous SEC separations. The excellent stability of the PL aquagel-OH packing material allows the eluent to be tailored to suit the polymer, while retaining the high column efficiency. For ionic interactions, the eluent can be modified by the addition of salt and/or the adjustment of pH. For water soluble polymers with a hydrophobic character, only the addition of a weak organic solvent (methanol) is required to inhibit hydrophobic interactions.

PL aquagel-OH Analytical Columns

Available with mixed and individual pore sizes, and 5, 8 and 15 µm particle sizes, to cover a very wide range of molecular weights.

PL aquagel-OH Preparative Columns

For rapid and convenient scale-up from analytical separations. The columns are packed with the same robust macroporous particles as the analytical column range

Guide to eluent selection for PL aquagel-OH applications

	Water soluble polymer		
Polymer Chemistry	Neutral	Anionic	Cationic
Suggested Eluent	Pure water	0.1-0.3M $NaNO_3$ pH 7 - 9 0.01M NaH_2PO_4	0.2-0.8M $NaNO_3$ pH 2-7 0.01M NaH_2PO_4
Hydrophobic Polymers	Addition of up to 50% methanol		

PL aquagel-OH Column Selection Guide

Sample Type	Typical Applications	Recommended Column Sets
Low MW polymers and oligomers	Surfactants, oligosaccharides, PEGs, lignosulfonates, polyacrylates	2 or 3 30, 20, 10 PL aquagel-OH 8 µm, or PL aquagel-OH 20 5 µm, or PL aquagel-OH MIXED-M 8 µm
Polydisperse synthetic or naturally occurring polymers	Polysaccharides, PVA, cellulose derivatives, PEO, polyacrylic acid	2 or 3 PL aquagel-OH MIXED-H 8 µm, or PL aquagel-OH 60/50/40 8 µm
Very high MW polymers	Polyacrylamides, hyaluronic acids, CMC, starches, gums	PL aquagel-OH 60/50/40 15 µm in series

For more information, please visit www.varianinc.com/pl_aquagel.html or visit www.varianinc.com/products.html to place an order.

PL aquagel-OH™ SEC Columns

High Performance Aqueous Size Exclusion Chromatography

- **Highly stable matrix ensures reliable separations, even with modified eluents**
- **MIXED columns cover a wide spread of molecular weights, simplifying column selection**
- **Highly versatile for neutral, polar, anionic and cationic samples**

The PL aquagel-OH analytical series has a pH range 2 – 10, compatibility with organic solvent (up to 50% methanol), mechanical stability up to 140 bar (2030 psi) and low column operating pressures.

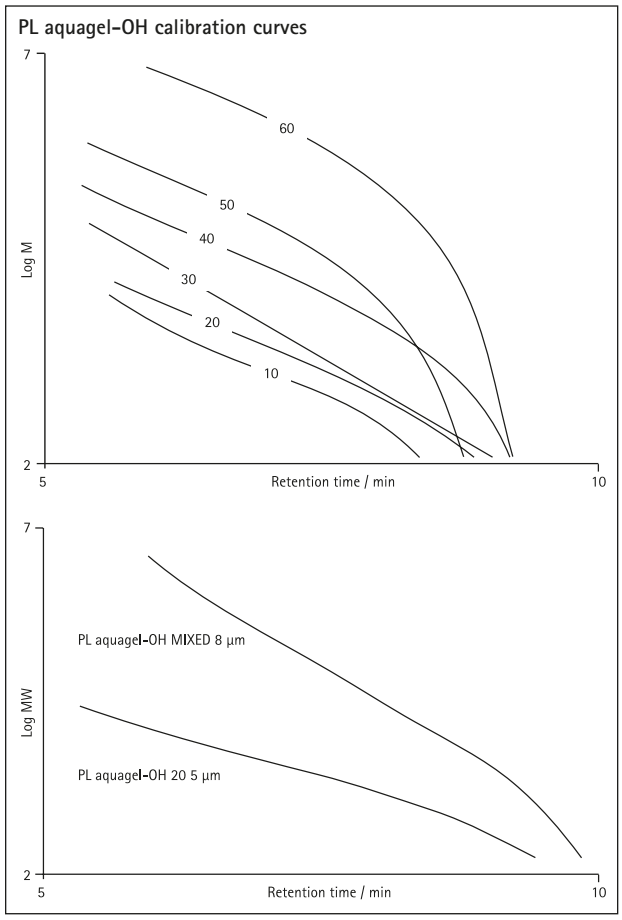
PL aquagel-OH MIXED 8 µm columns offer high resolution over a very wide range of molecular weight, simplifying column selection and providing a versatile analytical system.

PL aquagel-OH 20 5 µm columns are ideal for analysis of low MW polymers. The '20' column ensures maximum resolution for the analysis of low viscosity samples.

PL aquagel-OH 30 8 µm columns separate relatively low MW polymers, combining low exclusion limit, high pore volume and high column efficiency for maximum resolution.

PL aquagel-OH Individual Pore Size 8 µm columns are designed for high performance separations from 10,000 to >10,000,000. (g/mol PEG/PEO equiv.).

PL aquagel-OH 15 µm columns analyze very high MW polymers. Where molecular shear degradation is a consideration, the larger particle size and larger frit porosity permit the analysis of high viscosity polymers from 1M to 100M.



Tip

Buffers in a stored column may crystallize out and cause damage, so flush out the column with water containing a small amount of sodium azide, to prevent biological growth.

Ordering Information

PL aquagel-OH Columns, 300 x 7.5 mm

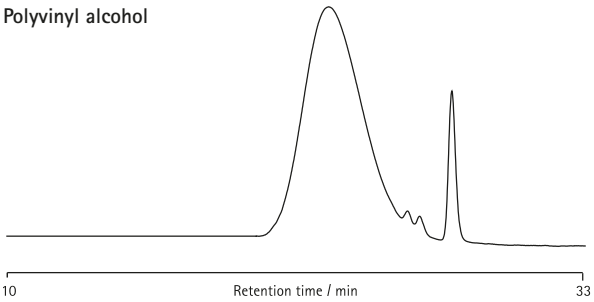
Description	Particle size (µm)	MW Range (g/mol) (PEG/PEO)	Guaranteed Efficiency (p/m)	Part No.
PL aquagel-OH 10	5	100-10,000	>55,000	PL1120-6510
PL aquagel-OH 10	8	100-10,000	>35,000	PL1120-6810
PL aquagel-OH 20	5	100-10,000	>55,000	PL1120-6520
PL aquagel-OH 30	8	100-30,000	>35,000	PL1120-6830
PL aquagel-OH 40	8	10,000-200,000	>35,000	PL1149-6840
PL aquagel-OH 40	15	10,000-200,000	>15,000	PL1149-6240
PL aquagel-OH 50	8	50,000-1,000,000	>35,000	PL1149-6850
PL aquagel-OH 50	15	50,000-1,000,000	>15,000	PL1149-6250
PL aquagel-OH 60	8	200,000->10,000,000	>35,000	PL1149-6860
PL aquagel-OH 60	15	200,000->10,000,000	>15,000	PL1149-6260
PL aquagel-OH MIXED-H	8	100-10,000,000	>35,000	PL1149-6800
PL aquagel-OH MIXED-M	8	100-10,000,000	>35,000	PL1149-6801

PL aquagel-OH™ SEC Columns

Typical Applications

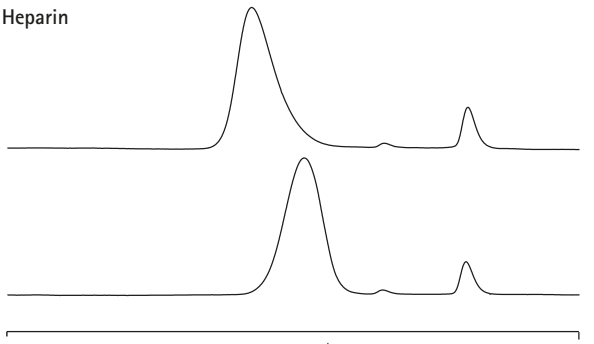
Heparin, gum, polyacrylic acid, polyacrylamide, pectin, dextran

Polyvinyl alcohol



Columns: 3 x PL aquagel-OH MIXED 8 µm, 300 x 7.5 mm
Eluent: 0.2 M $NaNO_3$, 0.01 M NaH_2PO_4, pH 7
Flow Rate: 1.0 mL/min
Detector: PL-GPC 50 Plus (RI)

Heparin



Columns: 2 x PL aquagel-OH 30 8 µm, 300 x 7.5 mm
Eluent: 0.2 M $NaNO_3$, 0.01M NaH_2PO_4, pH 7
Flow Rate: 1.0 mL/min
Detector: PL-GPC 50 Plus (RI)

See Also

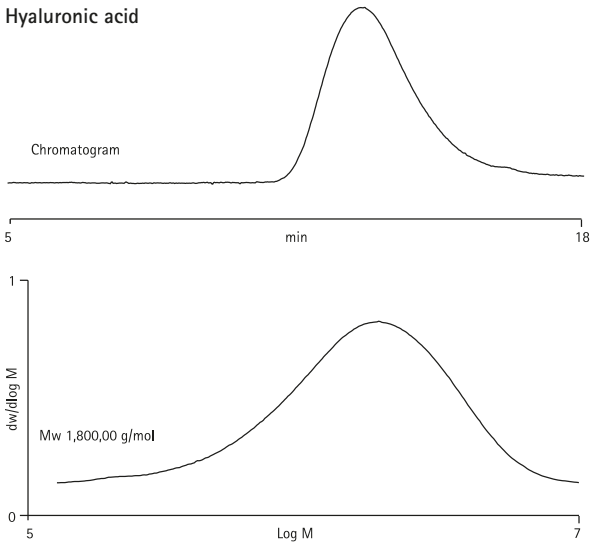
- Polymer Calibration Standards, with highly characterized molecular weights, page 316

Ordering Information

PL aquagel-OH Analytical Column accessories

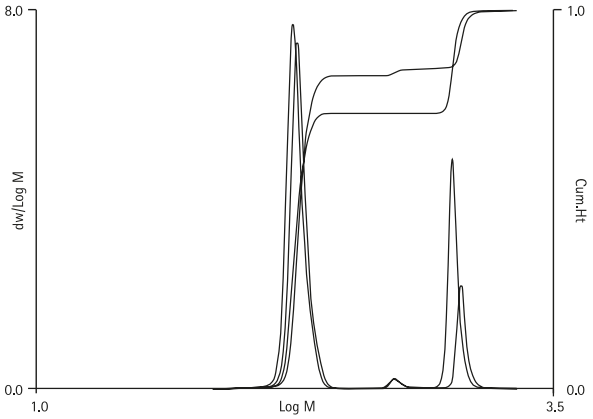
Description	Quantity (pk)	Part No.
Frit Removal Tool for Threaded Columns only	1	PL1310-0001
Frit (2 µm) Kit for Threaded Columns, 7.5 mm ID	5	PL1310-0002
Frit (5 µm) Kit for Threaded Columns, 7.5 mm ID	5	PL1310-0012
Column Connecting Nuts, 1/16 in. Tube	5	PL1310-0007
Tubing Ferrules, 1/16 in. Tube	5	PL1310-0008
LDV Intercolumn SS Connector	1	PL1310-0005
Connecting Tubing, 10 cm length, 0.01 in. ID	10	PL1310-0048

Hyaluronic acid



Columns: PL aquagel-OH 60 15 µm, 300 x 7.5 mm
PL aquagel-OH 40 15 µm, 300 x 7.5 mm
Eluent: 0.2 M $NaNO_3$, 0.01 M NaH_2PO_4, pH 7
Flow Rate: 1.0 mL/min
Detector: PL-GPC 50 Plus (RI)

Differences in composition of two alkyl naphthalene sulfonates



Columns: 2 x PL aquagel-OH 20 5 µm, 300 x 7.5 mm
Eluent: 0.25 M ammonium formate in water
Flow Rate: 1.0 mL/min
Inj. Vol: 20 µL
Software: Cirrus™ GPC module for Galaxie™ CDS
Detector: Varian ELS (neb=30 °C, evap=30 °C, gas=1.4 SLM)

Ordering Information

PL aquagel-OH Guard Columns

Description	Particle size (µm)	ID (mm)	Length (mm)	Part No.
PL aquagel-OH Guard	10	25.0	25	PL1249-1120
PL aquagel-OH Guard	5	7.5	50	PL1149-1530
PL aquagel-OH Guard	8	7.5	50	PL1149-1840

For more information, please visit www.varianinc.com/pl_aquagel.html or visit www.varianinc.com/products.html to place an order.

PL aquagel-OH™ Preparative SEC Columns

Rapid and Convenient Scale-up

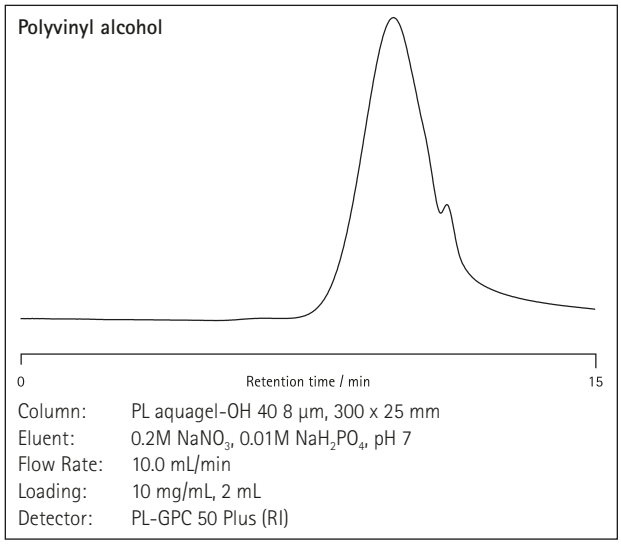
- **Up to 10 x scale-up maximizes yield**
- **High loading maximizes sample throughput**
- **Carefully chosen particle size provides optimum resolution**

Preparative SEC is used for the fractionation of a wide variety of water soluble samples based on their size in solution. The technique is applied to the fractionation of disperse polymers or to isolate components in a polymer formulation.

Preparative PL aquagel-OH columns and associated guard columns enable rapid and convenient scale-up from analytical separations. The 25 mm ID prep column offers at least a x10 scale-up in loading from the 7.5 mm ID analytical columns. Typically, a 10 mL/min flow rate results in a separation time of ten minutes with a 300 mm column. The columns are packed with the same robust macroporous particles as the analytical column range. The 8 µm particle size provides optimum resolution and loading characteristics with column efficiency >20,000 plates/m.

Typical Applications

Fractionation of disperse polymers, component isolation



Column:	PL aquagel-OH 40 8 µm, 300 x 25 mm
Eluent:	0.2M $NaNO_3$, 0.01M NaH_2PO_4, pH 7
Flow Rate:	10.0 mL/min
Loading:	10 mg/mL, 2 mL
Detector:	PL-GPC 50 Plus (RI)

GPC/SEC

Ordering Information

PL aquagel-OH Preparative Columns 8 µm, 300 x 25 mm

Description	MW Range (g/mol) (PEG/PEO)	Part No.
PL aquagel-OH 30	100-30,000	PL1220-6130
PL aquagel-OH 40	10,000-200,000	PL1249-6140
PL aquagel-OH 50	50,000-1,000,000	PL1249-6150
PL aquagel-OH MIXED	100-10,000,000	PL1249-6100
PL aquagel-OH Guard, 25 x 25 mm		PL1249-1120

See Also

- Polymer Calibration Standards, with highly characterized molecular weights, page 316

Polymer Standards for GPC/SEC

Standards and Specialty Polymers

Polymer standards from Varian, Inc. are the ideal reference materials for generating accurate, reliable GPC/SEC column calibrations, with the assurance of the ISO 9001:2000 quality standard. Additional applications for our highly characterized homopolymers and copolymers exhibiting unique characteristics are as model polymers for research and analytical method development.

With over 30 years' experience, Varian manufactures the highest quality polymer standards with extremely narrow polydispersity and the widest molecular weight range commercially available. These quality polymer standards are supplied with extensive characterization data utilizing a variety of independent techniques (e.g. light scattering and viscometry) and high performance GPC to verify polydispersity and assign that all important peak molecular weight (Mp).

Our comprehensive range of EasiVial™, EasiCal™ and traditional calibration kits has been specifically designed to cover all molecular weight ranges for organic and aqueous GPC/SEC applications. Varian provides you with the widest choice to maximize your specific characterization needs. In addition, we supply other polymers as individual molecular weights, and broad distribution polymers for system validation or broad standard calibration procedures.

Individual Polymer Molecular Weights: For the Ultimate in Calibration Flexibility

We design our individual standards to have the narrowest molecular weight distribution commercially available. Additionally, they also cover the widest molecular weight range, from 162 – 15 million MW. The current polystyrene nominal molecular weight of 15 million MW has a polydispersity ≤1.10. These standards are generally available in 1, 5 and 10 g quantities and each comes with its own Certificate of Analysis detailing analysis conditions and relevant data. To request other quantities please contact your local Varian office.

Calibration Kits: For Column and Detector Calibration

Varian offers a wide range of polymer standards kits for conventional GPC/SEC column calibration or for calibrating light scattering and viscometry detectors. The kits are in boxed sets of ten different polymer standards covering a particular molecular weight range, to be used with organic and aqueous, medium polarity and polar solvents. Every individual polymer has its own "Certificate of Analysis" of the analytical conditions and values, such as Mp needed for constructing a calibration plot. The polymers are chosen to give equidistant calibration points on a logarithmic MW scale, providing a more uniform calibration curve.

See Also

• GPC/SEC Columns, page 286

Standards Selection Guide

Polymer Type	Individual MW	Calibration Kits	EasiCal	EasiVial	Type of GPC/SEC
Polystyrene	Yes	Yes	Yes	Yes	Organic
Polymethylmethacrylate	Yes	Yes		Yes	Organic
Polyethylene	Yes	Yes			Organic
Polyethylene glycol (PEG)	Yes	Yes		Yes	Organic/Aqueous
Polyethylene oxide (PEO)	Yes	Yes		Yes	Organic/Aqueous
Pullulan polysaccharide	Yes	Yes			Organic/Aqueous
Polyacrylic acid Na salt	Yes	Yes			Aqueous

For more information, please visit www.varianinc.com/standards.html or visit www.varianinc.com/products.html to place an order.

EasiVial™

Easy-to-use Format Saves Time

- **Eliminates tedious weighing procedures to improve calibration accuracy**
- **Reduces solvent dispensing to limit risks associated with handling solvents**
- **For conventional and multi detector GPC to maximize applicability**

For organic and aqueous GPC/SEC column calibration, this premier product is the quickest and most convenient method to deliver an accurate 12 point column calibration.

The key to achieving baseline separation from polymer mixtures, and therefore eliminating doubt and errors, is in selecting only the narrowest polydispersity polymers. This is where Varian polymer standards excel and deliver, as shown in the chromatograms.

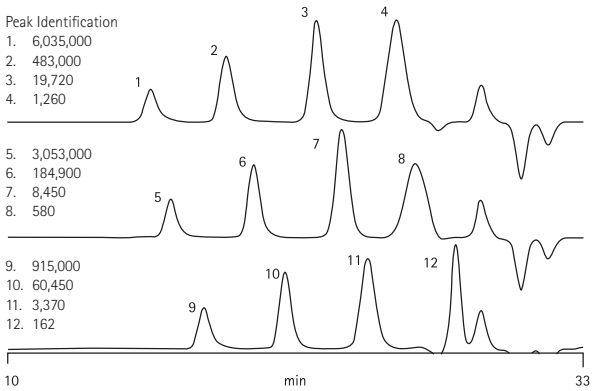
The EasiVial standards kit is a pre-prepared, time saving product for rapid and reliable GPC column calibration. EasiVial kits contain three vials, each with a mixture of four accurately pre-weighed polymer standards, providing a 12-point GPC calibration in just three injections. The mass of each polymer in the vial is accurately known, so that upon addition of a fixed volume of eluent, the solution is prepared at a precise concentration. EasiVial is ideal for both conventional and multi detector GPC calibration. Simply prepare and manually inject, or transfer to autosampler vials, or place directly into a compatible autosampler.

Every EasiVial kit contains 30 vials (ten of each type) that are color-coded for easy identification and are available in 4 or 2 mL vials making them suitable for most autosamplers. The kits are available for polystyrene (PS), polymethylmethacrylate (PMMA), polyethylene glycol/oxide (PEG/PEO) and polyethylene glycol (PEG). For added value, a Tri-Pack (90 vials) is offered, extending reproducibility.

Tip

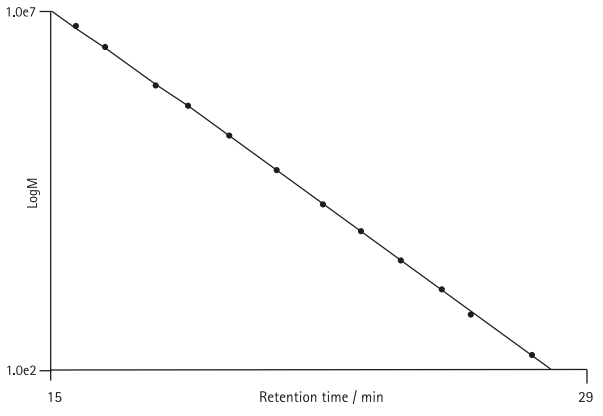
Contact gpc@varianinc.com to receive a FREE EasiVial trial kit containing three different vials each with a different mixture of highly characterized narrow polymer standards.

EasiVial PS-H



Columns: 3 x PLgel™ 10 µm MIXED-B, 300 x 7.5 mm
Eluent: THF
Flow Rate: 1.0 mL/min
Temp: 40 °C
Detector: PL-GPC 220 (RI)

Polystyrene calibration generated with EasiVials



GPC/SEC

EasiVial™

Specifications

EasiVial Color	EasiVial PS-H	EasiVial PS-M	EasiVial PS-L	EasiVial PM	EasiVial PEG/PEO	*NEW* EasiVial PEG
	Nominal Mp (g/mol)					
Red	1,300	780	580	2,000	600	282
	20,000	6,000	3,000	30,000	12,000	1,000
	500,000	50,000	10,000	300,000	125,000	6,000
	6,000,000	400,000	40,000	2,000,000	1,200,000	35,000
Yellow	580	370	370	1,000	200	194
	8,500	2,500	2,000	13,000	4,000	600
	185,000	25,000	6,000	150,000	60,000	3,750
	3,000,000	200,000	25,000	800,000	1,000,000	21,000
Green	162	162	162	600	100	106
	3,400	1,500	1,000	5,700	1,500	420
	60,000	11,000	4,000	80,000	25,000	2,000
	900,000	100,000	16,000	470,000	460,000	12,000

Ordering Information

EasiVial pre-weighed calibration kits

Description	Vial volume (mL)	Quantity (vials/kit)	Part No.
EasiVial PEG/PEO	2	30	PL2080-0201
EasiVial PEG/PEO	4	30	PL2080-0200
EasiVial PEG	2	30	PL2070-0201
EasiVial PEG	4	30	PL2070-0200
EasiVial PM	2	30	PL2020-0201
EasiVial PM	4	30	PL2020-0200
EasiVial PS-H	2	30	PL2010-0201
EasiVial PS-H	4	30	PL2010-0200
EasiVial PS-M	2	30	PL2010-0301
EasiVial PS-M	4	30	PL2010-0300
EasiVial PS-L	2	30	PL2010-0401
EasiVial PS-L	4	30	PL2010-0400
PEG/PEO Tri-Pack	2	90	PL2080-0202
PEG/PEO Tri-Pack	4	90	PL2080-0203
PEG Tri-Pack	2	90	PL2070-0202
PEG Tri-Pack	4	90	PL2070-0203
PMMA Tri-Pack	2	90	PL2020-0202
PMMA Tri-Pack	4	90	PL2020-0203
PS-H Tri-Pack	2	90	PL2010-0202
PS-H Tri-Pack	4	90	PL2010-0203
PS-M Tri-Pack	2	90	PL2010-0302
PS-M Tri-Pack	4	90	PL2010-0303
PS-L Tri-Pack	3	90	PL2010-0402
PS-L Tri-Pack	4	90	PL2010-0403

See Also

• GPC/SEC Columns, page 286

For more information, please visit www.varianinc.com/standards.html or visit www.varianinc.com/products.html to place an order.

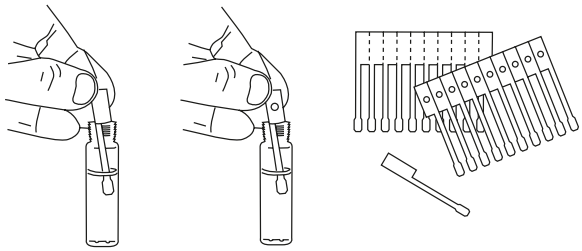
EasiCal™

Pre-prepared for Easy Use

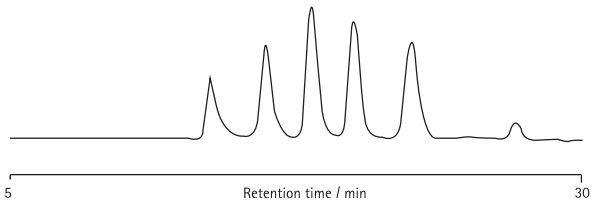
- **Easy three step process with no fuss**
- **Cost effective format saves money**
- **Only two injections for improved productivity**

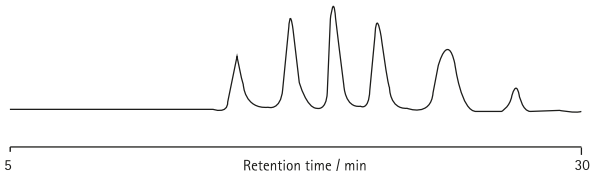
The EasiCal system for organic solvents consists of two different combs, each with ten detachable spatulas supporting a mixture of five polymer standards. The thin film of polymer (approximately 5 mg) on the tip of the PTFE spatulas rapidly dissolves when immersed in eluent to provide two GPC/SEC calibration solutions. A single pack provides ten spatulas of each type, with MWs selected to provide equidistant calibration points for greater accuracy.

Column calibration for GPC/SEC is as easy as 1, 2, 3 ...

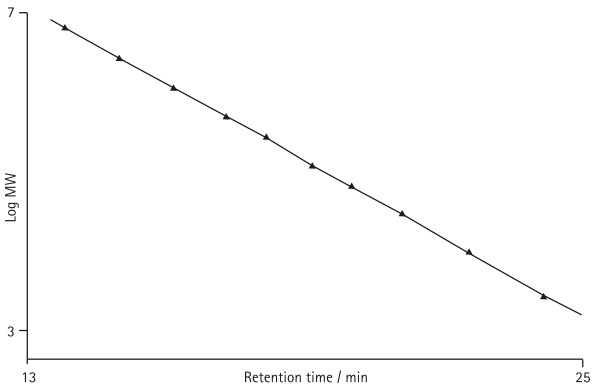


1. Place one spatula of each type into appropriate volume of solvent.





2. Chromatograph each solution, only two injections required



3. Generate a 10 point calibration

Ordering Information

EasiCal pre-prepared polystyrene kits

Polystyrene PS-1 Part No. PL2010-0501 (one pk) Part No. PL2010-0505 (five pk)	Polystyrene PS-2 Part No. PL2010-0601 (one pk) Part No. PL2010-0605 (five pk)
Spatula A, Constituent Polymers Nominal Mp (g/mol)	
3,000	1,300
30,000	5,000
150,000	20,000
850,000	100,000
7,500,000	400,000
Spatula B, Constituent Polymers Nominal Mp (g/mol)	
580	580
11,000	3,000
60,000	10,000
300,000	50,000
2,500,000	200,000

Tip

Contact gpc@varianinc.com to receive a FREE EasiCal trial kit containing one spatula from each different MW comb, for both polystyrene MW range kits.

See Also

- GPC/SEC Columns, page 286

Polystyrene

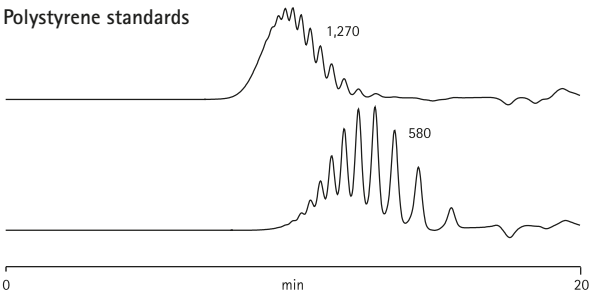
The First Choice Standard for Most Organic Applications

- **Compatible with most organic solvents**
- **Certificate of Analysis meets international protocols**
- **Calibration capability for virtually all applications**

Polystyrene standards are the first choice for many organic solvents, either for conventional GPC column calibration or for calibrating light scattering and viscosity detectors. Our organic polymers covering a range from 162 – 15 million MW, with MWs selected to provide equidistant calibration points for greater accuracy.

Polystyrene individual polymer molecular weight

Part numbers are given for 1 g quantities. (Part numbers for 5 g and 10 g quantities are obtained by replacing the last two digits, 01, with 05 or 10, respectively).



Columns: 2 x OligoPore™, 300 x 7.5 mm
Eluent: THF
Flow Rate: 1.0 mL/min
Detector: PL-GPC 50 Plus (DRI)

Ordering Information

Polystyrene individual molecular weights

Polymer Nominal Mp (g/mol)	Nominal Mw/Mn	Part No.
162	1.00	PL2012-1001
370	1.11	PL2012-0001
580	1.11	PL2012-2001
1,000	1.09	PL2012-3001
1,300	1.07	PL2012-4001
2,000	1.05	PL2012-5001
3,000	1.04	PL2012-6001
5,000	1.03	PL2012-7001
7,000	1.04	PL2012-8001
10,000	1.02	PL2012-9001
20,000	1.02	PL2013-1001
30,000	1.02	PL2013-2001
50,000	1.03	PL2013-3001
70,000	1.03	PL2013-4001
100,000	1.02	PL2013-5001
130,000	1.01	PL2013-6001
200,000	1.05	PL2013-7001
300,000	1.03	PL2013-8001
500,000	1.03	PL2013-9001
700,000	1.03	PL2014-0001
1,000,000	1.05	PL2014-1001
1,500,000	1.04	PL2014-2001
2,000,000	1.04	PL2014-3001
2,500,000	1.05	PL2014-4001
4,000,000	1.04	PL2014-6001
7,000,000	1.04	PL2014-7001
10,000,000	1.06	PL2014-8001
15,000,000	1.05	PL2014-9001

Ordering Information

Polystyrene calibration kits, (all kits 10 x 0.5 g)

S-H-10 Part No. PL2010-0103	S-H2-10 Part No. PL2010-0104	S-M-10 Part No. PL2010-0100	S-M2-10 Part No. PL2010-0102	S-L-10 Part No. PL2010-0101	S-L2-10 Part No. PL2010-0105
Constituent Polymer Nominal Mp (g/mol)					
300,000	1,000	580	580	162	162
460,000	3,000	1,450	1,400	580	370
700,000	8,600	4,000	2,400	900	580
1,100,000	25,000	10,000	4,750	1,400	800
1,700,000	73,000	27,000	9,500	2,200	1,000
2,600,000	210,000	66,000	19,000	3,400	1,500
4,000,000	600,000	180,000	38,000	5,100	1,900
6,200,000	1,780,000	460,000	75,000	8,100	2,500
9,500,000	5,000,000	1,190,000	150,000	12,800	3,200
15,000,000	15,000,000	3,000,000	300,000	20,000	4,500

For more information, please visit www.varianinc.com/standards.html or visit www.varianinc.com/products.html to place an order.

Polymethylmethacrylate

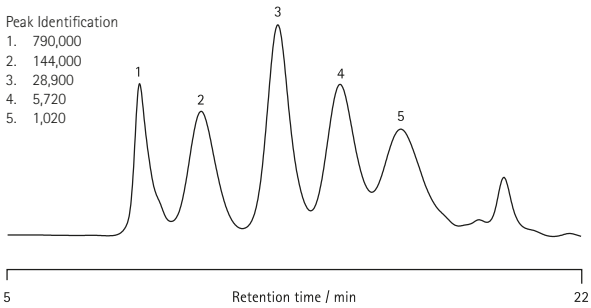
Extreme Versatility in Solvent Choice

- **Many solvent options increase applicability**
- **Stringent quality control improves performance**
- **Proprietary manufacturing methods ensure consistent supply**

Polymethylmethacrylate (PMMA) standards are extremely versatile as they can be used for organic GPC with a wide range of medium polarity eluents, such as tetrahydrofuran, toluene, methyl ethyl ketone, and ethyl acetate. They also work well with more polar organic eluents, for example dimethylformamide, dimethylacetamide, and hexafluoroisopropanol. The MWs are selected to provide equidistant calibration points for greater accuracy, covering from 600 – 1.5 million MW. Every kit contains 0.5 g of ten different molecular weight standards.

Polymethylmethacrylate individual polymer molecular weight
Part numbers are given for 1 g quantities. (Part numbers for 5 g and 10 g quantities are obtained by replacing the last two digits, 01, with 05 or 10, respectively).

Polymethylmethacrylate standards



Columns: 2 x PL HFIPgel™, 300 x 7.5 mm
Eluent: HFIP + 20mM NaTFAc
Flow Rate: 1.0 mL/min
Temp: 40 °C
Detector: PL-GPC 50 Plus (RI)

See Also

- EasiVial™ Calibration Kit, pre-weighed to save time, page 317
- GPC/SEC Columns, page 286

Ordering Information

Polymethylmethacrylate calibration kits, (all kits 10 x 0.5 g)

M-L-10 Part No. PL2020-0100	M-M-10 Part No. PL2020-0101
Constituent Polymer Nominal Mp (g/mol)	
600	1,000
840	2,200
1,400	5,000
2,350	11,200
3,900	25,500
6,400	58,000
10,800	130,000
18,000	290,000
30,000	660,000
50,000	1,500,000

Ordering Information

Polymethylmethacrylate individual molecular weights

Polymer Nominal Mp (g/mol)	Nominal Mw/Mn	Part No.
500	1.19	PL2022-2001
1,000	1.26	PL2022-3001
2,000	1.08	PL2022-5001
3,000	1.08	PL2022-6001
5,000	1.09	PL2022-7001
7,000	1.08	PL2022-8001
10,000	1.03	PL2022-9001
13,000	1.03	PL2023-0001
20,000	1.03	PL2023-1001
30,000	1.02	PL2023-2001
50,000	1.02	PL2023-3001
70,000	1.02	PL2023-4001
100,000	1.02	PL2023-5001
130,000	1.05	PL2023-6001
200,000	1.02	PL2023-7001
300,000	1.02	PL2023-8001
500,000	1.06	PL2023-9001
700,000	1.03	PL2024-0001
1,000,000	1.09	PL2024-1001
1,500,000	1.09	PL2024-2001

Polyethylene Glycol/Oxide

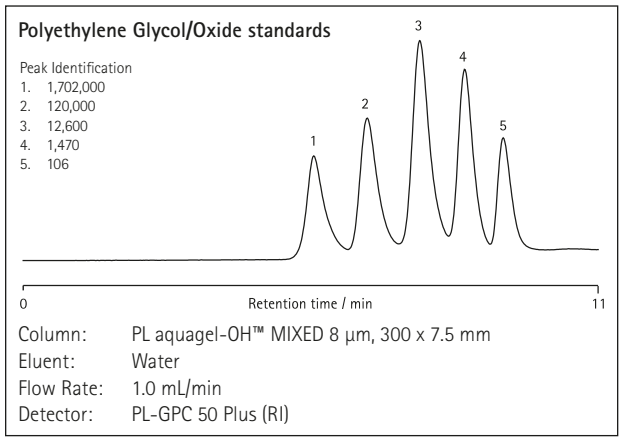
Use With Aqueous and Organic Solvents

- **Simple to use kit form**
- **Combine glycols and oxides to extend the MW range and cover more applications**
- **MWs selected to provide equidistant calibration points for greater accuracy**

These hydrophilic polymers are suitable for both aqueous SEC and organic GPC using the majority of polar organic solvents. The oxides are available in high molecular weights, while the glycols cover the lower molecular weight range. The two types are chemically similar and so they can be used together across a wider molecular weight range, with aqueous and organic polymers from 106 – 1 million MW. Every kit contains 0.2 g or 0.5 g of ten different molecular weight standards.

Polyethylene Glycol/Oxide individual polymer molecular weight

Part numbers are given for 1 g quantities. (Part numbers for 5 g and 10 g quantities are obtained by replacing the last two digits, 01, with 05 or 10, respectively).



Ordering Information

Polyethylene glycol individual molecular weights

Polymer Nominal Mp (g/mol)	Nominal Mw/Mn	Part No.
106	1.00	PL2070-1001
194	1.00	PL2070-2001
238	1.00	PL2071-2001
282	1.00	PL2071-3001
420	1.09	PL2070-3001
600	1.06	PL2070-4001
1,000	1.04	PL2070-5001
1,500	1.04	PL2070-6001
4,000	1.03	PL2070-7001
7,000	1.04	PL2070-8001
10,000	1.05	PL2070-9001
13,000	1.07	PL2071-0001
20,000	1.07	PL2071-1001

Polyethylene oxide individual molecular weights

Polymer Nominal Mp (g/mol)	Nominal Mw/Mn	Part No.
20,000	1.05	PL2083-1001
30,000	1.07	PL2083-2001
50,000	1.05	PL2083-3001
70,000	1.05	PL2083-4001
100,000	1.06	PL2083-5001
130,000	1.07	PL2083-6001
200,000	1.07	PL2083-7001
300,000	1.07	PL2083-8001
500,000	1.06	PL2083-9001
700,000	1.07	PL2084-0001
1,000,000	1.12	PL2084-1001
1,500,000	1.13	PL2084-2001

GPC/SEC

See Also

- EasiVial™ Calibration Kit, pre-weighed to save time, page 317
- GPC/SEC Columns, page 286

Ordering Information

Polyethylene glycol/oxide calibration kits

PEG-10 (10 x 0.5 g) Part No. PL2070-0100	PEO-10 (10 x 0.2 g) Part No. PL2080-0101
Constituent Polymer Nominal Mp (g/mol)	
106	20,000
194	30,000
400	50,000
600	70,000
1,000	100,000
2,000	200,000
4,000	300,000
7,000	400,000
13,000	700,000
20,000	1,000,000

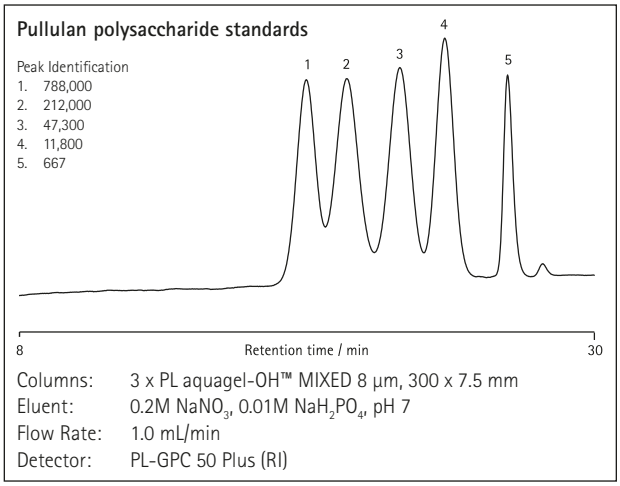
Polysaccharides

For Use with Aqueous and Organic Solvents

- **Comprehensive format provides the full MW range in one handy kit**
- **Also available as individual standards**
- **Expert technical support only a phone call away**

The pullulan polysaccharide kit consists of several simple sugars together with some relatively narrow polydispersity linear macromolecules of maltotriose units.

Polysaccharide individual polymer molecular weights
Available in 0.2 g and 0.5 g quantities.



See Also

- GPC/SEC Columns, page 286

Ordering Information

Polysaccharides calibration kit

SAC-10 (all kits 10 x 0.2 g) Part No. PL2090-0100
Constituent Polymer Nominal Mp (g/mol)
180
738
5,000
10,000
20,000
50,000
100,000
200,000
400,000
700,000

Ordering Information

Polysaccharides individual molecular weights

Polymer Nominal Mp (g/mol)	Quantity (g)	Part No.
1,500	0.2	PL2091-2000
2,000	0.2	PL2091-3000
3,000	0.2	PL2091-4000
5,000	0.5	PL2090-1000
20,000	0.5	PL2090-3000
50,000	0.5	PL2090-4000
100,000	0.5	PL2090-5000
200,000	0.5	PL2090-6000
700,000	0.5	PL2090-8000
1,660,000	0.2	PL2091-1000

Polyethylene

Ideal for Polyolefin Polymer Analysis

- **Robust particles provide reliable high temperature calibrations**
- **Two linear molecular weight ranges maximize choice**
- **Short chain branching kit, for FT-IR calibration and TREF/CRYSTAF reference**

Linear polyethylene standards with low polydispersities (1.01 to 1.9) deliver accurate GPC/SEC calibration curves, from 170 – 1.5 million MW. The E-MW-10 kit is recommended for polyolefins, and is designed for direct column calibration in solvents such as trichlorobenzene and o-dichlorobenzene from 135 - 180 °C.

Polyethylene individual polymer molecular weight

Available in 1 g quanities. This range of polyethylene standards consists of several linear hydrocarbons together with some relatively narrow polydispersity polymers.

Ordering Information

Polyethylene calibration kits

E-M-10 (10 x 0.2 g) Part No. PL2650-0101		E-MW-10 (10 x 0.1 g) Part No. PL2650-0102	
Constituent Polymer Nominal Mp (g/mol)	Nominal Mw/Mn	Constituent Polymer Nominal Mp (g/mol)	Nominal Mw/Mn
170	1.00	5,000	1.02
282	1.00	20,000	1.02
394	1.00	30,000	1.01
540	1.09	50,000	1.01
750	1.18	100,000	1.01
1,100	1.20	200,000	1.03
2,155	1.14	300,000	1.06
14,000	1.20	400,000	1.11
32,000	1.11	700,000	1.15
120,000	1.19	1,500,000	1.90

Ordering Information

Polyethylene individual molecular weights

Nominal Mp (g/mol)	Mw/Mn	Quantity (g)	Part No.
170	1.00	1.0	PL2650-8001
282	1.00	1.0	PL2650-9001
394	1.00	1.0	PL2650-0001
540	1.09	1.0	PL2650-4001
750	1.18	1.0	PL2650-1001
1,100	1.09	1.0	PL2650-2001
2,155	1.14	1.0	PL2650-3001
14,000	1.20	0.2	PL2650-5000
32,000	1.11	0.2	PL2650-6000
120,000	1.19	0.2	PL2650-7000

Short chain branching standards

Determination of short chain branching (SCB) as a function of MWD in polyethylene is now possible using high temperature GPC coupled with FT-IR. This series of well-characterized polyethylene SCB standards is a valuable reference set for temperature rising elution fractionation/crystallization analysis fractionation (TREF/CRYSTAF).

See Also

- GPC/SEC Columns, page 286

Ordering Information

Polyethylene short chain branching calibration kit

E-SCB (10 x 0.1 g) Part No. PL2650-0103
Constituent Polymer Nominal Methyl/1000 Total Carbons (NMR)
1.27
1.36
1.76
2.19
11.60
14.00
21.90
40.00
55.50
62.50

Two well characterized broad MWD polyethylene standards with varying degrees of SCB are also available for system verification.

Ordering Information

Polyethylene broad MWD individual molecular weights

Polymer Nominal Mp (g/mol)	Nominal Mw/Mn	SCB/1000TC	Part No.
250,000	9.50		PL2660-7001

Polyethylene broad MWD/SCB individual molecular weights

Polymer Nominal Mp (g/mol)	Nominal Mw/Mn	SCB/1000TC	Part No.
35,000	5.0	0.0	PL2660-8001
400,000	5.0	4.0	PL2660-9001

Polyacrylic Acid Specialty Polymers

For Use With Aqueous Solvents

- **Compatible with all aqueous columns for wide applicability**
- **Aqueous polymers 1,000 – 1 million MW**
- **Well characterized Mp values ensure wide utility**

Polyacrylic Acid individual polymer molecular weight

Part numbers are given for 0.2 g quantities. (Part numbers for 1 g are obtained by replacing the last two digits, 00, with 01).

Ordering Information

Polyacrylic acid - Na salt calibration kit

PAA-10 (all kits 10 x 0.2 g) Part No. PL2140-0100
Constituent Polymer Nominal Mp (g/mol)
1,000
3,000
7,000
13,000
30,000
70,000
100,000
300,000
700,000
1,000,000

Ordering Information

Polyacrylic acid - Na salt individual molecular weights

Polymer Nominal Mp (g/mol)	Part No.
1,000	PL2142-3000
2,000	PL2142-5000
3,000	PL2142-6000
5,000	PL2142-7000
7,000	PL2142-8000
13,000	PL2143-0000
30,000	PL2143-2000
50,000	PL2143-3000
70,000	PL2143-4000
100,000	PL2143-5000
130,000	PL2143-6000
200,000	PL2143-7000
300,000	PL2143-8000
500,000	PL2143-9000
700,000	PL2144-0000
1,000,000	PL2144-1000
1,500,000	PL2144-2000
2,000,000	PL2144-3000

Designed to Meet Your Needs

Varian has extensive knowledge and experience in ionic polymerization techniques gained over 30 years. We are able to work very closely with you to deliver novel polymers that meet your specific requirements. Confidential enquiries for customized synthesis are welcomed.

Block Copolymers

We manufacture a range of AB di-block copolymers and ABA tri-block copolymers with narrow polydispersities. Typical examples include Polystyrene/Polymethylmethacrylate, Polystyrene/Polymethylmethacrylate-d8, Polystyrene/Polyethylene Oxide, Polystyrene-d8/Polymethylmethacrylate, Polystyrene/Polybutadiene and Polystyrene-d8/Polymethylmethacrylate-d8.

Deuterated Polymers

Our range of deuterated polymers has a variety of applications, such as neutron scattering and NMR. These polymers exhibit the same narrow molecular weight distribution characteristics as our protonated polymer standards, with typical polydispersities around 1.05, and include Deuterated Polystyrene–d8 and Deuterated Polymethylmethacrylate–d8.

Methoxy Polyethylene Glycols (MPEGs)

Varian offers a range of highly characterized, very narrow polydispersity methoxy polyethylene glycols. These very pure polymers are ideal as molecular weight reference materials or for further modification where cross linking should be avoided.

Custom Synthesis Service

Although we offer a range of materials from stock we recognize that some customers may wish to purchase a "made to order" copolymer. Confidential enquiries for customized synthesis are welcome.

See Also

- GPC/SEC Columns, page 286

Ordering Information

Methoxy polyethylene glycols (MPEGs)

Polymer Nominal Mp (g/mol)	Nominal Mw/Mn	Part No.
5,000	1.03	PL2570-5001
10,000	1.05	PL2571-0001
20,000	1.05	PL2572-0001
30,000	1.06	PL2573-0001
40,000	1.06	PL2574-0001
50,000	1.06	PL2575-0001