

## Columns for Organic GPC

Gel Permeation Chromatography (GPC) is a high performance liquid chromatography technique for the separation of components based on their molecular size in solution. It is widely used as a means of characterizing the molecular weight distribution of polymers, and can also be employed for the separation of discrete components.

Polymer Laboratories offers a comprehensive range of organic GPC columns for optimum performance and reliability, and long column lifetimes, even under the most severe operating conditions.

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## PlusPore - **NEW** High Resolution Columns for Organic GPC

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 crosslinked polystyrene/divinylbenzene (PS/DVB), for the widest applicability and solvent compatibility. Each is made using a novel polymerization process to produce particles which exhibit a specific, controlled pore structure for optimum GPC performance.

### The Ideal Choice for Polymer Analysis

For high resolution polymer analysis, the PolyPore, ResiPore, MesoPore and OligoPore columns of the PlusPore product range 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 crosslinked 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 artefacts in the shape of the molecular weight distribution.

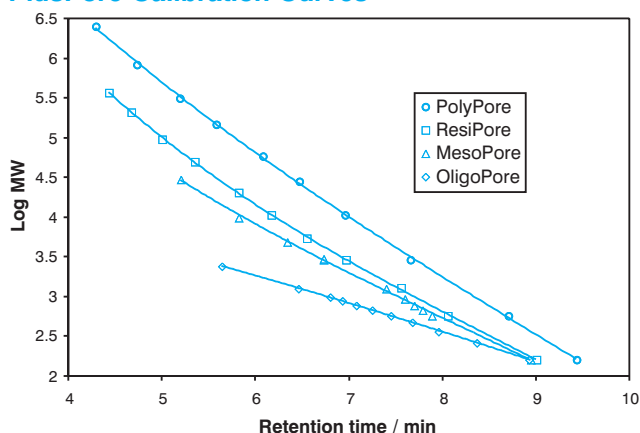


- **PolyPore** for the routine analysis of general polymers
- **ResiPore** for the analysis of resins and condensation polymers
- **MesoPore** for the analysis of prepolymers and low MW resins
- **OligoPore** for the analysis of oligomeric samples

### Features and Benefits of the PlusPore Range

- High pore volume, high resolution
- Wide pore size distribution
- Optimized separation range
- Full solvent compatibility
- No MWD dislocations

### PlusPore Calibration Curves



### PlusPore High Resolution Columns - Specifications

	<b>PolyPore</b>	<b>ResiPore</b>	<b>MesoPore</b>	<b>OligoPore</b>
<b>MW Operating Range</b>	200-2,000,000	200-400,000	Up to 25,000	Up to 4,500
<b>Nominal Particle Size</b>	5 $\mu$ m	3 $\mu$ m	3 $\mu$ m	6 $\mu$ m
<b>Typical Column Efficiency</b>	>60,000 p/m	>80,000 p/m	>80,000 p/m	>55,000 p/m
<b>Recommended Calibrants</b>	EasiCal PS-1 or EasiVial	EasiCal PS-2	Polystyrene S-L-10 Kit Polyethylene Glycol PEG-10 Kit for DMF	Individual MW Polystyrenes

# PolyPore - for the Routine Analysis of General Polymers

## Typical Applications

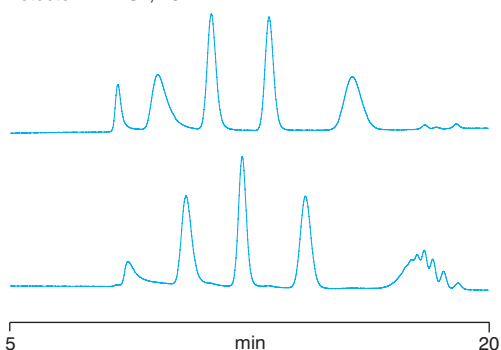
- Polystyrenes
- Polycarbonates
- Polyurethanes
- Polysiloxanes

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 $\mu$ m particle size with extremely high pore volume to give the highest possible resolution, ensuring you the most detailed information possible from your analysis.

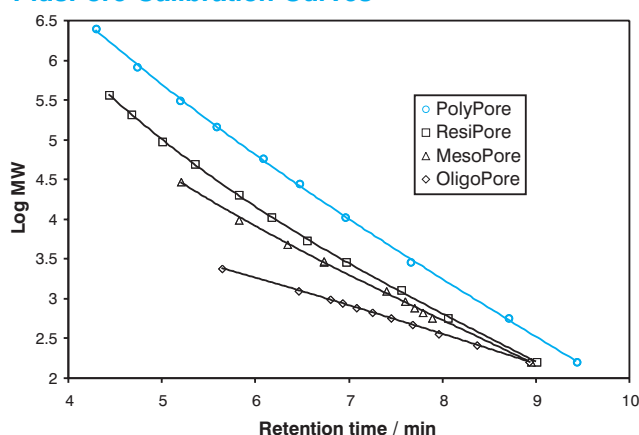


## Polystyrene Standards

Sample: EasiCal PS-1  
 Columns: 2xPolyPore, 300x7.5mm (PL1113-6500)  
 Eluent: THF  
 Flow Rate: 1.0ml/min  
 Detector: UV, 254nm

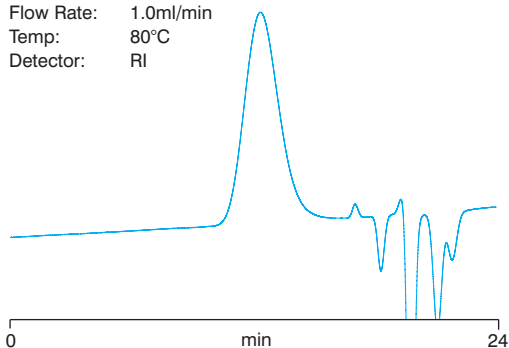


## PlusPore Calibration Curves



## Polymethylmethacrylate in DMF

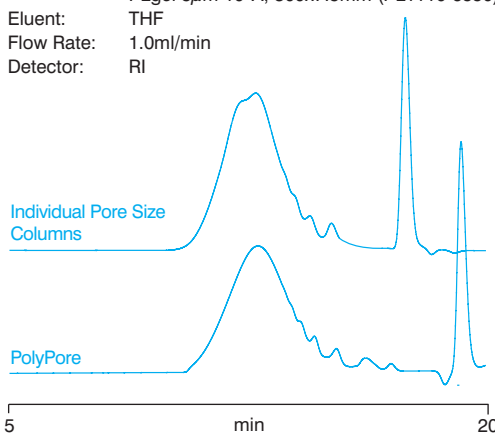
Sample: Commercial PMMA  
 Columns: 2xPolyPore, 300x7.5mm (PL1113-6500)  
 Eluent: 0.1% LiBr in DMF  
 Flow Rate: 1.0ml/min  
 Temp: 80°C  
 Detector: RI



## Comparison of PolyPore with Conventional Individual Pore Size GPC Columns

Sample: High MW Resin  
 Columns: 2xPolyPore, 300x7.5mm (PL1113-6500)  
 PLgel 5 $\mu$ m 10<sup>3</sup>Å, 300x7.5mm (PL1110-6530)  
 PLgel 5 $\mu$ m 10<sup>5</sup>Å, 300x7.5mm (PL1110-6550)

Eluent: THF  
 Flow Rate: 1.0ml/min  
 Detector: RI



## Specifications

MW Operating Range	200-2,000,000
Nominal Particle Size	5 $\mu$ m
Typical Column Efficiency	>60,000 p/m
Recommended Calibrants	EasiCal PS-1 or EasiVial

Product	Part No.
PolyPore, 300x7.5mm	PL1113-6500
PolyPore, 250x4.6mm	PL1513-5500
PolyPore Guard, 50x7.5mm	PL1113-1500
PolyPore Guard, 50x4.6mm	PL1513-1500

To order please contact Varian Polymer Laboratories, or your local distributor

# ResiPore for the Analysis of Resins and Condensation Polymers

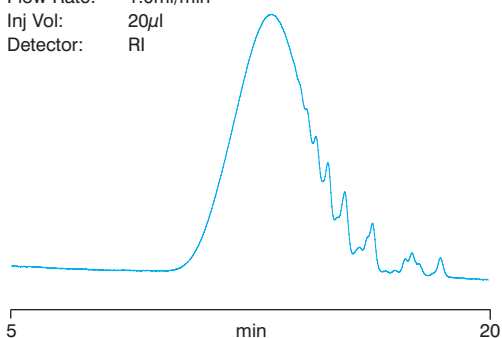
## Application Areas

- Epoxy resins
- Polyester resins
- Silicone fluids
- Polyolefin waxes

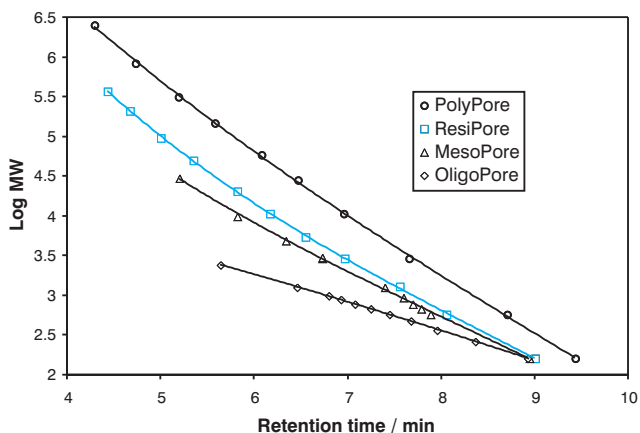
ResiPore columns are the ideal choice for the analysis of resins and condensation polymers with complex molecular weight distributions including oligomer content. By combining a low 3µm particle size and high pore volume, high efficiency ResiPore columns give the maximum resolution for the analysis of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

### Epoxy Resin

Columns: 2xResiPore, 300x7.5mm (PL1113-6300)  
 Eluent: THF  
 Flow Rate: 1.0ml/min  
 Inj Vol: 20µl  
 Detector: RI

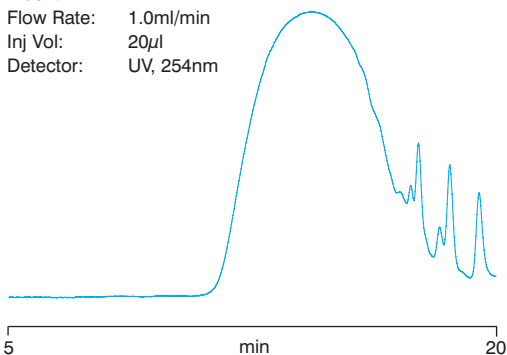


### PlusPore Calibration Curves



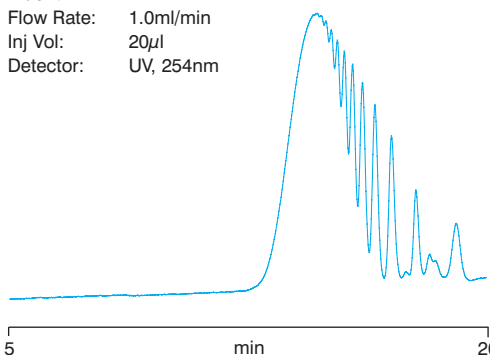
### Alkyd Resin

Columns: 2xResiPore, 300x7.5mm (PL1113-6300)  
 Eluent: THF  
 Flow Rate: 1.0ml/min  
 Inj Vol: 20µl  
 Detector: UV, 254nm



### Polyester

Columns: 2xResiPore, 300x7.5mm (PL1113-6300)  
 Eluent: THF  
 Flow Rate: 1.0ml/min  
 Inj Vol: 20µl  
 Detector: UV, 254nm



## Specifications

MW Operating Range	200-400,000
Nominal Particle Size	3µm
Typical Column Efficiency	>80,000 p/m
Recommended Calibrants	EasiCal PS-2

Product	Part No.
ResiPore, 300x7.5mm	PL1113-6300
ResiPore, 250x4.6mm	PL1513-5300
ResiPore Guard, 50x7.5mm	PL1113-1300
ResiPore Guard, 50x4.6mm	PL1513-1300

# MesoPore for the Analysis of Prepolymers and Low MW Resins

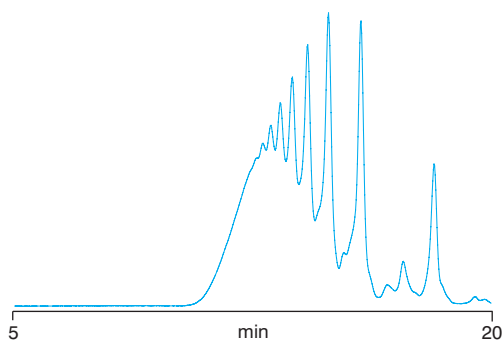
## Typical Applications

- Prepolymers
- Resins
- Polyols
- Siloxanes

MesoPore columns have been specifically designed to give optimum results for the analysis of prepolymers: polymeric materials with a large oligomeric component. By combining a 3 $\mu$ m particle size with high pore volume, MesoPore columns give the highest resolution separations for the analysis of low molecular weight polymers.

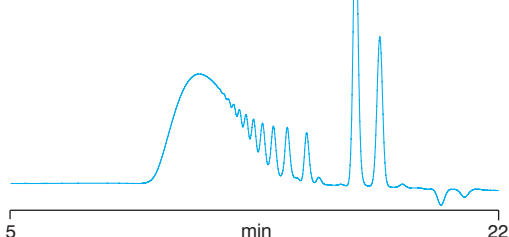
### Epoxy Resin

Columns: 2xMesoPore, 300x7.5mm (PL1113-6325)  
 Eluent: THF  
 Flow Rate: 1.0ml/min  
 Inj Vol: 20 $\mu$ l  
 Detector: RI



### Polyurethanes

Columns: 2xMesoPore, 300x7.5mm (PL1113-6325)  
 Eluent: THF  
 Flow Rate: 1.0ml/min  
 Inj Vol: 20 $\mu$ l  
 Detector: RI

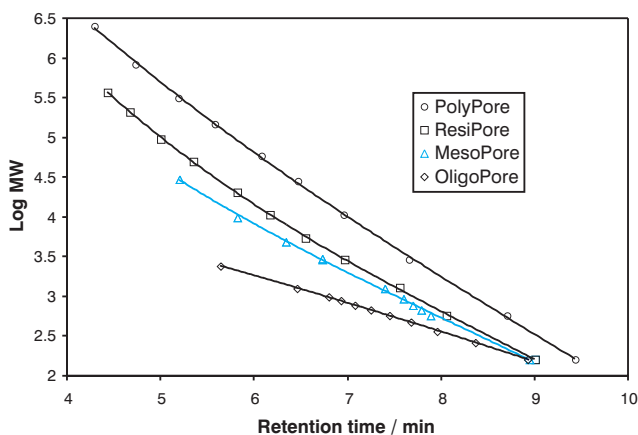


## Specifications

MW Operating Range	Up to 25,000
Nominal Particle Size	3 $\mu$ m
Typical Column Efficiency	>80,000 p/m
Recommended Calibrants	Polystyrene S-L-10 Kit Polyethylene Glycol PEG-10 Kit for DMF

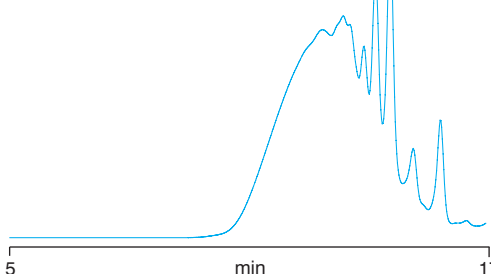


## PlusPore Calibration Curves



### Polyesterimide

Columns: 2xMesoPore, 300x7.5mm (PL1113-6325)  
 Eluent: THF  
 Flow Rate: 1.0ml/min  
 Inj Vol: 20 $\mu$ l  
 Detector: RI



Product	Part No.
MesoPore, 300x7.5mm	PL1113-6325
MesoPore, 250x4.6mm	PL1513-5325
MesoPore Guard, 50x7.5mm	PL1113-1325
MesoPore Guard, 50x4.6mm	PL1513-1325

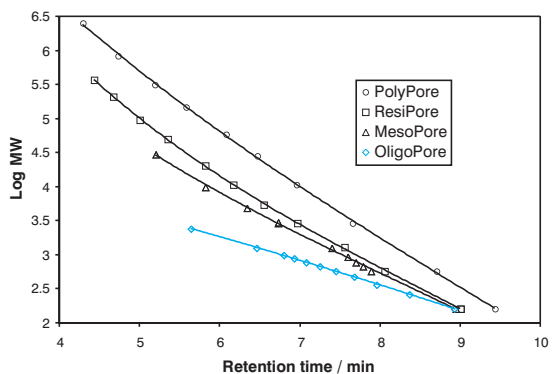
# OligoPore for the Analysis of Oligomeric Samples

## Typical Applications

- Polyurethanes
- Epoxy resins
- Polystyrenes

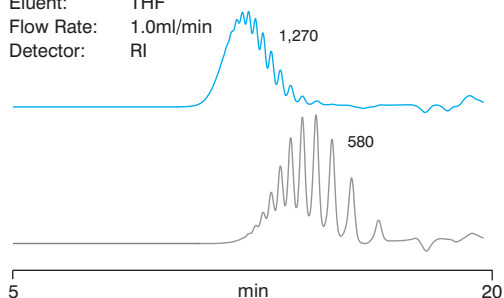
OligoPore columns have been developed from an innovative new media, which exhibits significantly increased pore volumes compared to conventional low pore size GPC columns, resulting in higher resolution in the oligomeric region.

## PlusPore Calibration Curves



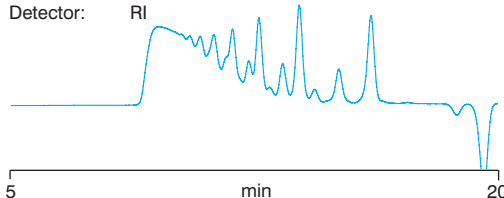
## Polystyrene Standards

Columns: 2xOligoPore, 300x7.5mm (PL1113-6520)  
 Eluent: THF  
 Flow Rate: 1.0ml/min  
 Detector: RI



## Epoxy Resin (Epikote 1001)

Columns: 2xOligoPore, 300x7.5mm (PL1113-6520)  
 Eluent: THF  
 Flow Rate: 1.0ml/min  
 Detector: RI



## Specifications

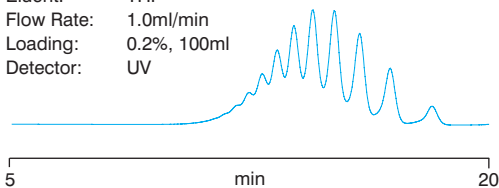
MW Operating Range	Up to 4,500
Nominal Particle Size	6µm
Typical Column Efficiency	>55,000 p/m
Recommended Calibrants	Individual MW Polystyrenes

## OligoPore Preparative Column

The 300x25mm preparative column offers high resolution at greatly increased loading for effective isolation of individual components.

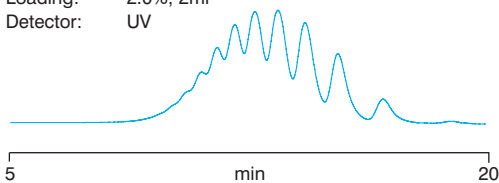
## Analytical Separation

Columns: 2xOligoPore, 300x7.5mm (PL1113-6520)  
 Eluent: THF  
 Flow Rate: 1.0ml/min  
 Loading: 0.2%, 100ml  
 Detector: UV



## Preparative Separation

Columns: 2xOligoPore, 300x25mm (PL1513-6520)  
 Eluent: THF  
 Flow Rate: 10.0ml/min  
 Loading: 2.0%, 2ml  
 Detector: UV

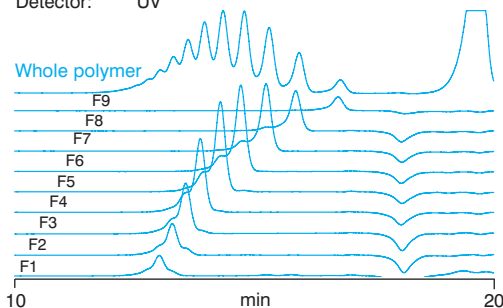


Oligomer fractions collected from the OligoPore preparative column can then be re-injected on analytical columns to check for the purity of the fractions and for comparison with the whole sample.

## Analysis of Whole Polymer and Fractions Collected from OligoPore Preparative Columns

### Polystyrene Oligomers

Columns: 2xOligoPore, 300x7.5mm (PL1113-6520)  
 Eluent: THF  
 Flow Rate: 1.0ml/min  
 Detector: UV



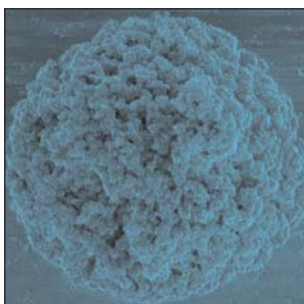
Product	Part No.
OligoPore, 300x7.5mm	PL1113-6520
OligoPore, 250x4.6mm	PL1513-5520
OligoPore, 300x25mm	PL1213-6520
OligoPore Guard, 50x7.5mm	PL1113-1320
OligoPore Guard, 50x4.6mm	PL1513-1320

# PLgel Advanced Organic GPC Columns

**PLgel is a highly crosslinked porous polystyrene/divinylbenzene matrix which is recognized as a market leader in GPC column technology.**

Manufactured and packed exclusively by Polymer Laboratories since 1976, PLgel has very special features:

- High pore volume and high efficiency for maximum resolution
- Unequaled solvent compatibility for transfers between polar and non-polar organic eluents
- Outstanding physical rigidity for extended lifetimes especially at high temperatures and in aggressive solvents
- PL's comprehensive QC/QA for total reproducibility, batch to batch, column to column
- Manufactured to ISO 9001:2000



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 standards fast and reliable.

## The PLgel Column Range Includes:

- Seven individual pore size packings, 50Å to 10<sup>6</sup>Å
- Five linear MIXED gel packings, A to E
- Four analytical particle sizes, 3µm, 5µm, 10µm, 20µm
- Column lengths 300mm and 600mm
- 4.6mm ID narrow bore columns
- 7.5mm ID analytical columns
- 25mm ID preparative columns
- 50mm guard columns
- New PolarGel-M - See page 2
- New PLgel Olexis - See page 2

## Solvent Compatibility

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

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

	Solvent Polarity	Solvent	PLgel Compatibility	
↑	Low	6.0	Perfluoralkanes	✓
		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	Dichloroethane	✓
		9.9	Acetone	✓
		10.0	o-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 pyrrolidone (NMP)	✓	
	12.0	Dimethyl sulphoxide (DMSO)	✓	
↓	High	12.1	Dimethyl formamide (DMF)	✓

## Temperature Stability to 220°C

Elevated temperature is used in GPC either to reduce eluent viscosity (eg polar solvent applications), or to maintain sample solubility (eg polyolefin applications). PLgel columns can be used at temperatures up to 220°C and operating pressures up to 150 bar (2200psi).

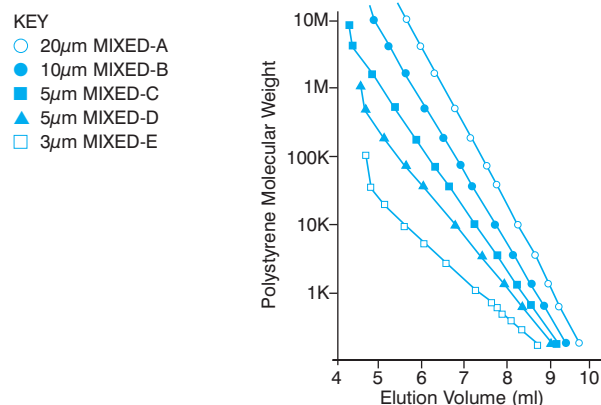
## PLgel MIXED Gel GPC Columns

A significant number of GPC applications involve the analysis of polydisperse materials. The modern approach to column selection is to choose PL's MIXED gel columns, where each 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. As market leaders in this field, Polymer Laboratories offers a comprehensive range of MIXED gel GPC columns designed for specific application areas.

### Key Advantages of PLgel MIXED Columns Include:

- Greatly simplified column selection
- Improved confidence in the accuracy and precision of calculated data
- Optimized particle size for each application area
- Reduced replacement stock
- Elimination of mismatched column sets and spurious peaks
- Simple addition of extra column(s) for greater resolution

### PLgel MIXED Gel Calibration Curves



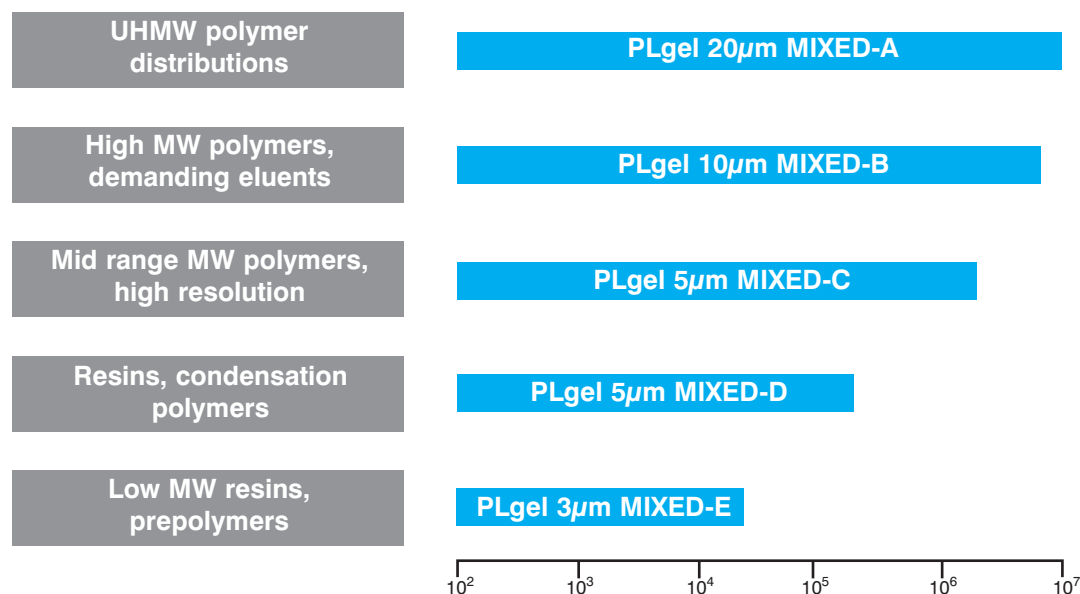
The calibration curves are designed to be linear over a specified molecular weight range, ensuring that the same degree of resolution is achieved across the full operating range of the column.

The particle size of the packing and the 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. PL has scientifically determined the minimum number of MIXED gel columns required to perform accurate MWD determinations based on specific resolution (R<sub>sp</sub>).

Ref: "Size exclusion chromatography columns from Polymer Laboratories", in Column Handbook for Size Exclusion Chromatography, ed. Chi-san Wu, Academic Press, 1999.

### PLgel MIXED Gel Column Selection Guide



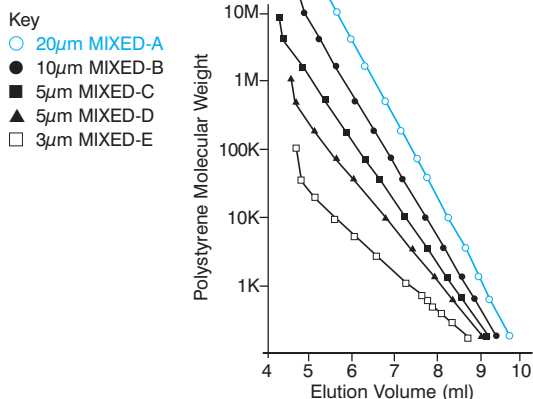


## PLgel 20µm MIXED-A Columns

## Features

- Extremely high exclusion limit (40,000,000)
- Matched frit porosity
- Large particle size
- Low shear
- Linear calibration

## PLgel MIXED Gel Calibration Curves



## PLgel 20µm MIXED-A Specifications

Linear range of MW:	2,000 - 40,000,000
Guaranteed column efficiency:	> 17,000 plates/m
Typical pressure @ 1.0ml/min (7.5mm ID):	≈3 bar (45psi) per 300mm
@ 0.3ml/min (4.6mm ID):	≈2.4 bar (35psi) per 250mm (THF @ 20°C) (TCB @ 140°C)
Maximum flow rate @ 7.5mm ID:	1.5ml/min
@ 4.6mm ID:	0.5ml/min
Maximum pressure:	150 bar
Maximum temperature:	220°C
Recommended no. of columns in set:	4 x 250mm, 4 x 300mm or 2 x 600mm
<b>Product</b>	<b>Part No.</b>
PLgel 20µm MIXED-A, 300x7.5mm	PL1110-6200
PLgel 20µm MiniMIX-A, 250x4.6mm	PL1510-5200
PLgel 20µm MIXED-A, 600x7.5mm	PL1110-8200
PLgel 20µm Guard, 50x7.5mm	PL1110-1220
PLgel 20µm MiniMIX-A Guard, 50x4.6mm	PL1510-1200

## Polystyrene Calibration

EasiVial PS-H - convenient 12 point calibration in just 3 injections  
EasiCal® PS-1 or S-H2-10 Kit - rapid 10 point calibration  
S-H-10 plus S-M2-10 Kits - accurate 19 point calibration

Product	Part No.
EasiVial PS-H	PL2010-0200
EasiCal® PS-1	PL2010-0501
Polystyrene Calibration Kit S-H-10	PL2010-0103
Polystyrene Calibration Kit S-H2-10	PL2010-0104
Polystyrene Calibration Kit S-M2-10	PL2010-0102

## Typical Applications

Polymers containing significant quantities of ultra high MW material which are relatively polydisperse

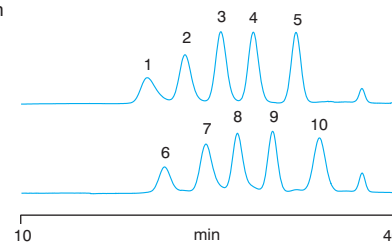
- Polyolefins
- Polybutadienes
- Starches
- Polyisoprenes

## Polystyrene Standards Separation

Sample: EasiCal PS-1  
Columns: 4xPLgel 20µm MIXED-A, 300x7.5mm (PL1110-6200)  
Eluent: THF  
Flow Rate: 1.0ml/min  
Detector: UV, 254nm

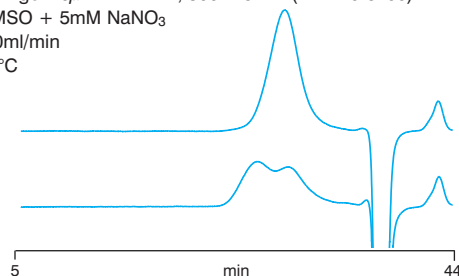
EasiCal PS-1

1. 7,500,000
2. 841,700
3. 148,000
4. 28,500
5. 2,930
6. 2,560,000
7. 320,000
8. 59,500
9. 10,850
10. 580



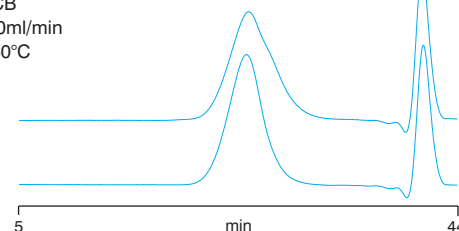
## Starches

Columns: 4xPLgel 20µm MIXED-A, 300x7.5mm (PL1110-6200)  
Eluent: DMSO + 5mM NaNO<sub>3</sub>  
Flow Rate: 1.0ml/min  
Temp: 80°C  
Detector: RI



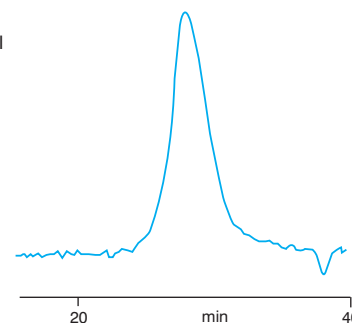
## Polyolefins

Columns: 4xPLgel 20µm MIXED-A, 300x7.5mm (PL1110-6200)  
Eluent: TCB  
Flow Rate: 1.0ml/min  
Temp: 160°C  
Detector: RI



## Polyethylene on Narrow Bore MiniMIX Columns

Columns: 4xPLgel 20µm MiniMIX-A, 250x4.6mm (PL1510-5200)  
Eluent: TCB  
Flow Rate: 0.3ml/min  
Loading: 0.1% w/v, 100µl  
Temp: 140°C  
Detector: IR



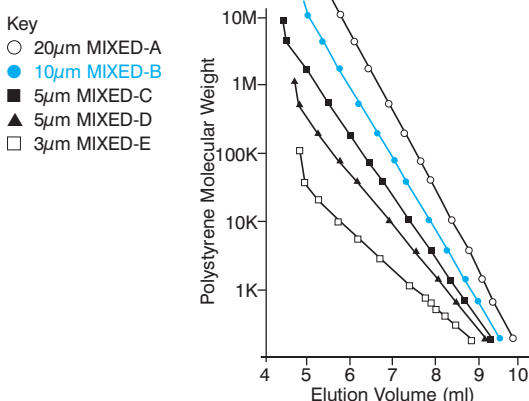
To order please contact Varian Polymer Laboratories, or your local distributor

# PLgel 10 $\mu$ m MIXED-B Columns

## Features

- Wide operating range of MW (500-10,000,000)
- Low operating pressure
- Linear calibration
- Wide range of applications

## PLgel MIXED Gel Calibration Curves



## PLgel 10 $\mu$ m MIXED-B Specifications

Linear range of MW:	500 - 10,000,000
Guaranteed column efficiency:	>35,000 plates/m
Typical pressure @ 1.0ml/min (7.5mm ID):	≈10 bar (150psi) per 300mm
@ 0.3ml/min (4.6mm ID):	≈8 bar (120psi) per 250mm (THF @ 20°C) (TCB @ 140°C)
Maximum flow rate @ 7.5mm ID:	1.5ml/min
@ 4.6mm ID:	0.5ml/min
Maximum pressure:	150 bar
Maximum temperature:	220°C
Recommended no. of columns in set:	3 x 250mm, 3 x 300mm or 1-2 x 600mm
<b>Product</b>	<b>Part No.</b>
PLgel 10 $\mu$ m MIXED-B, 300x7.5mm	PL1110-6100
PLgel 10 $\mu$ m MiniMIX-B, 250x4.6mm	PL1510-5100
PLgel 10 $\mu$ m MIXED-B, 600x7.5mm	PL1110-8100
PLgel 10 $\mu$ m Guard, 50x7.5mm	PL1110-1120
PLgel 10 $\mu$ m MiniMIX-B Guard, 50x4.6mm	PL1510-1100

## Polystyrene Calibration

EasiVial PS-H - convenient 12 point calibration in just 3 injections  
EasiCal® PS-1 or S-H2-10 Kit - rapid 10 point calibration  
S-H-10 plus S-M2-10 Kits - accurate 19 point calibration

Product	Part No.
EasiVial PS-H	PL2010-0200
EasiCal® PS-1	PL2010-0501
Polystyrene Calibration Kit S-H-10	PL2010-0103
Polystyrene Calibration Kit S-H2-10	PL2010-0104
Polystyrene Calibration Kit S-M-10	PL2010-0100
Polystyrene Calibration Kit S-M2-10	PL2010-0102

## Typical Applications

General polymer analysis covering a wide range of MW, especially applications which use demanding conditions, eg high temperature, aggressive or unusual solvents

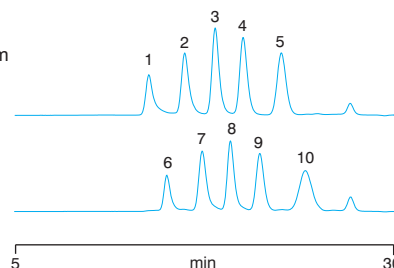
- Polyolefins
- Fluoropolymers
- Acrylics/Acrylates
- Cellulose derivatives

## Polystyrene Standards Separation

Sample: EasiCal PS-1  
Columns: 3xPLgel 10 $\mu$ m MIXED-B, 300x7.5mm (PL1110-6100)  
Eluent: THF  
Flow Rate: 1.0ml/min  
Detector: UV, 254nm

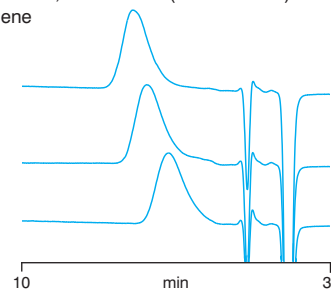
EasiCal PS-1

1. 7,500,000
2. 841,700
3. 148,000
4. 28,500
5. 2,930
6. 2,560,000
7. 320,000
8. 59,500
9. 10,850
10. 580



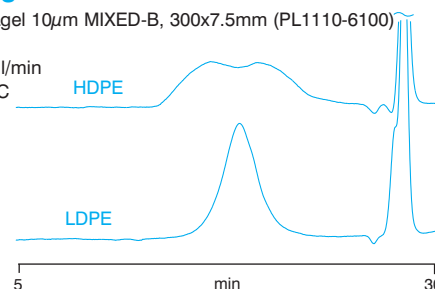
## Polyphenylene Sulfides

Columns: 3xPLgel 10 $\mu$ m MIXED-B, 300x7.5mm (PL1110-6100)  
Eluent: o-Chloronaphthalene  
Flow Rate: 1.0ml/min  
Temp: 210°C  
Detector: RI



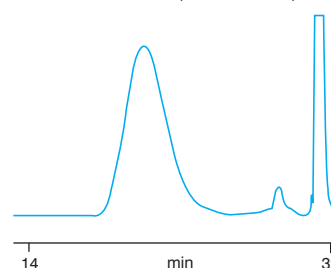
## Polyethylenes

Columns: 3xPLgel 10 $\mu$ m MIXED-B, 300x7.5mm (PL1110-6100)  
Eluent: TCB  
Flow Rate: 1.0ml/min  
Temp: 160°C  
Detector: RI



## Polystyrene on Narrow Bore MiniMIX Columns

Columns: 3xPLgel 10 $\mu$ m MiniMIX-B, 250x4.6mm (PL1510-5100)  
Eluent: THF  
Flow Rate: 0.3ml/min  
Loading: 0.2% w/v, 20 $\mu$ l  
Detector: UV, 254nm

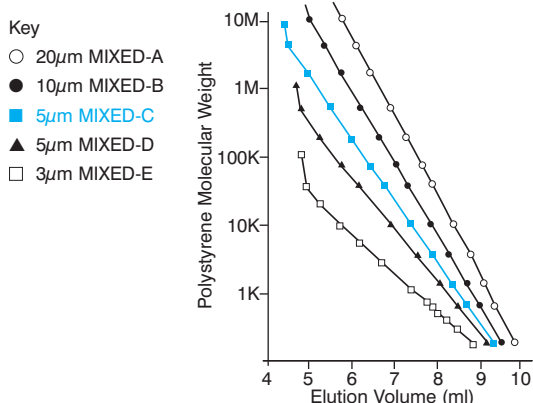


## PLgel 5µm MIXED-C Columns

## Features

- High efficiency
- Excellent solvent compatibility
- Linear calibration
- Fast analysis

## PLgel MIXED Gel Calibration Curves



## PLgel 5µm MIXED-C Specifications

Linear range of MW:	200 - 2,000,000
Guaranteed column efficiency:	>50,000 plates/m
Typical pressure @ 1.0ml/min (7.5mm ID):	≈30 bar (450psi) per 300mm
@ 0.3ml/min (4.6mm ID):	≈24 bar (350psi) per 250mm (THF @ 20°C) (TCB @ 140°C)
Maximum flow rate @ 7.5mm ID:	1.5ml/min
@ 4.6mm ID:	0.5ml/min
Maximum pressure:	150 bar
Maximum temperature:	150°C
Recommended no. of columns in set:	2 x 250mm, 2 x 300mm or 1 x 600mm

Product	Part No.
PLgel 5µm MIXED-C, 300x7.5mm	PL1110-6500
PLgel 5µm MiniMIX-C, 250x4.6mm	PL1510-5500
PLgel 5µm MIXED-C, 600x7.5mm	PL1110-8500
PLgel 5µm Guard, 50x7.5mm	PL1110-1520
PLgel 5µm MiniMIX-C Guard, 50x4.6mm	PL1510-1500

## Calibration

Polystyrene EasiVial PS-H  
Polystyrene EasiCal® PS-1  
Polystyrene S-M-10 Kit  
Polyethylene Oxide/Glycol PEO-10 / PEG-10 Kits for DMF

Product	Part No.
EasiVial PS-H	PL2010-0200
EasiCal® PS-1	PL2010-0501
Polystyrene Calibration Kit S-M-10	PL2010-0100
Polyethylene Oxide Kit PEO-10	PL2080-0101
Polyethylene Glycol Kit PEG-10	PL2070-0100

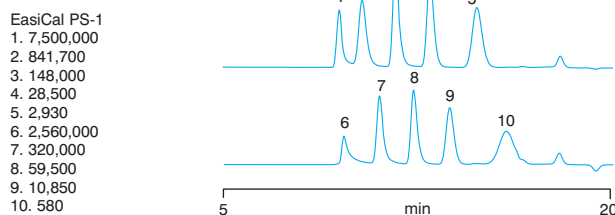
## Typical Applications

For polymer analysis up to 2 million MW, especially polymers containing small molecule additives

- Polystyrenes
- Polyurethanes
- Polycarbonates
- Polysiloxanes

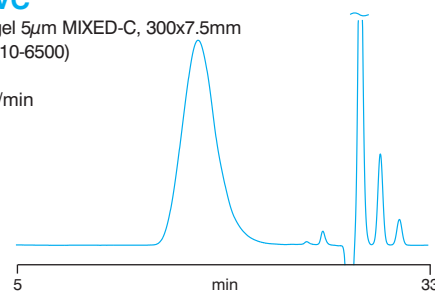
## Polystyrene Standards Separation

Sample: EasiCal PS-1  
Columns: 2xPLgel 5µm MIXED-C, 300x7.5mm (PL1110-6500)  
Eluent: THF  
Flow Rate: 1.0ml/min  
Detector: UV, 254nm



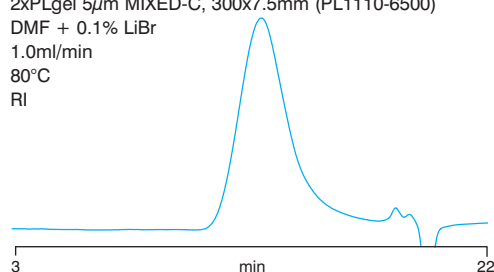
## Plasticized PVC

Columns: 3xPLgel 5µm MIXED-C, 300x7.5mm (PL1110-6500)  
Eluent: THF  
Flow Rate: 1.0ml/min  
Detector: RI



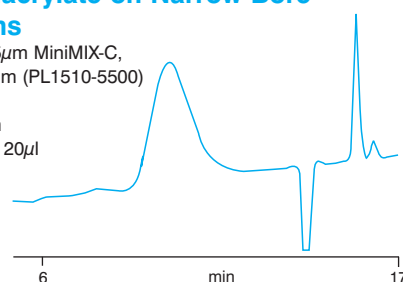
## Polyurethane

Columns: 2xPLgel 5µm MIXED-C, 300x7.5mm (PL1110-6500)  
Eluent: DMF + 0.1% LiBr  
Flow Rate: 1.0ml/min  
Temp: 80°C  
Detector: RI



## Polymethylmethacrylate on Narrow Bore MiniMIX Columns

Columns: 2xPLgel 5µm MiniMIX-C, 250x4.6mm (PL1510-5500)  
Eluent: DMF  
Flow Rate: 0.3ml/min  
Loading: 0.1% w/v, 20µl  
Detector: RI

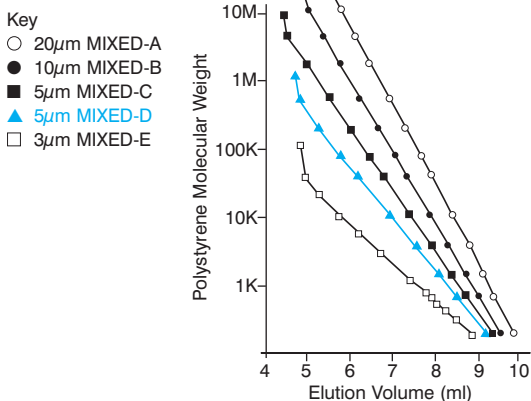


## PLgel 5µm MIXED-D Columns

## Features

- High efficiency
- High pore volume
- Optimized linear resolving range
- Polymer plus some oligomer resolution

## PLgel MIXED Gel Calibration Curves



## PLgel 5µm MIXED-D Specifications

Linear range of MW:	200 - 400,000
Guaranteed column efficiency:	>50,000 plates/m
Typical pressure @ 1.0ml/min (7.5mm ID):	≈50 bar (450psi) per 300mm
@ 0.3ml/min (4.6mm ID):	≈24 bar (350psi) per 250mm (THF @ 20°C) (TCB @ 140°C)
Maximum flow rate @ 7.5mm ID:	1.5ml/min
@ 4.6mm ID:	0.5ml/min
Maximum pressure:	150 bar
Maximum temperature:	150°C
Recommended no. of columns in set:	2 x 250mm, 2 x 300mm or 1 x 600mm
<b>Product</b>	<b>Part No.</b>
PLgel 5µm MIXED-D, 300x7.5mm	PL1110-6504
PLgel 5µm MiniMIX-D, 250x4.6mm	PL1510-5504
PLgel 5µm MIXED-D, 600x7.5mm	PL1110-8504
PLgel 5µm Guard, 50x7.5mm	PL1110-1520
PLgel 5µm MiniMIX-D Guard, 50x4.6mm	PL1510-1504

## Calibration

EasiVial PS-M  
EasiCal® PS-2  
Polystyrene S-M2-10 Kit  
Polyethylene Oxide/Glycol PEO-10 / PEG-10 Kits for DMF

<b>Product</b>	<b>Part No.</b>
EasiVial PS-M	PL2010-0200
EasiCal® PS-2	PL2010-0601
Polystyrene Calibration Kit S-M2-10	PL2010-0102
Polyethylene Oxide Kit PEO-10	PL2080-0101
Polyethylene Glycol Kit PEG-10	PL2070-0100

## Typical Applications

Ideal for condensation polymers, paints and resins which may contain some low molecular weight oligomeric species

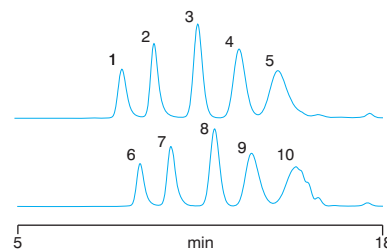
- Epoxy resins
- Polyester resins
- Silicone fluids
- Polyolefins

## Polystyrene Standards Separation

Sample: EasiCal PS-2  
Columns: 2xPLgel 5µm MIXED-D, 300x7.5mm (PL1110-6504)  
Eluent: THF  
Flow Rate: 1.0ml/min  
Detector: UV, 254nm

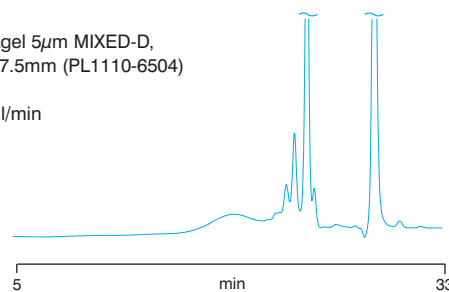
EasiCal PS-2

1. 380,000
2. 96,000
3. 22,000
4. 5,050
5. 1,320
6. 156,000
7. 49,900
8. 11,600
9. 2,950
10. 580



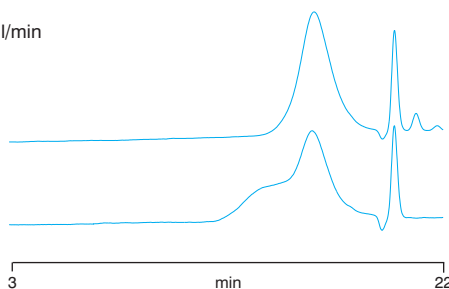
## Epoxy Resin

Columns: 3xPLgel 5µm MIXED-D,  
300x7.5mm (PL1110-6504)  
Eluent: THF  
Flow Rate: 1.0ml/min  
Detector: RI



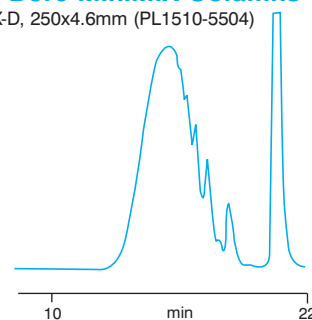
## Asphalts

Columns: 2xPLgel 5µm MIXED-D, 300x7.5mm (PL1110-6504)  
Eluent: THF  
Flow Rate: 1.0ml/min  
Detector: RI



## Epoxy Resin on Narrow Bore MiniMIX Columns

Columns: 2xPLgel 5µm MiniMIX-D, 250x4.6mm (PL1510-5504)  
Eluent: THF  
Flow Rate: 0.3ml/min  
Loading: 0.1% w/v, 20µl  
Detector: UV, 254nm

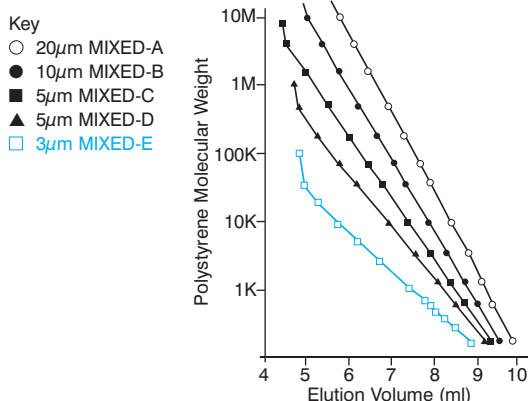


PLgel 3 $\mu$ m MIXED-E Columns

## Features

- Ultra high efficiency
- Fast analysis
- Outstanding resolution

## PLgel MIXED Gel Calibration Curves

PLgel 3 $\mu$ m MIXED-E Specifications

Linear range of MW: Up to 30,000

Guaranteed column efficiency	Up to 30,000
300x7.5mm:	> 80,000 plates/m
250x4.6mm:	> 70,000 plates/m

Highest efficiency/resolution will only be achieved on high performance, low dead volume equipment

Typical pressure @ 1.0ml/min (7.5mm ID):	≈50 (750psi) per 300mm
@ 0.3ml/min (4.6mm ID):	≈42 bar (610psi) per 250mm (THF @ 20°C)

Maximum flow rate @ 7.5mm ID:	1.5ml/min
@ 4.6mm ID:	0.5ml/min

Maximum pressure: 180 bar

Maximum temperature: 110°C

Recommended no. of columns in set:	1-3 x 250mm 1-3 x 300mm
------------------------------------	----------------------------

Product	Part No.
PLgel 3 $\mu$ m MIXED-E, 300x7.5mm	PL1110-6300
PLgel 3 $\mu$ m MiniMIX-E, 250x4.6mm	PL1510-5300
PLgel 3 $\mu$ m Guard, 50x7.5mm	PL1110-1320
PLgel 3 $\mu$ m MiniMIX-E Guard, 50x4.6mm	PL1510-1300

## Calibration

Polystyrene S-L-10 Kit  
Polyethylene Glycol Kit PEG-10 for DMF

Product	Part No.
Polystyrene Calibration Kit S-L-10	PL2010-0101
Polyethylene Glycol Kit PEG-10	PL2070-0100

## Typical Applications

Ideal for low molecular weight samples which contain oligomeric fractions as well as polymers up to 30,000 MW

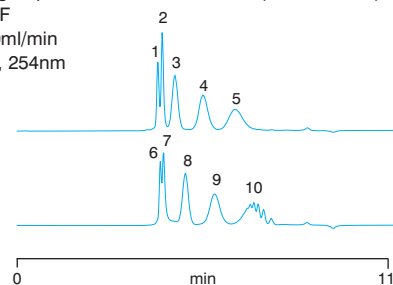
- Prepolymers
- Polyols
- Resins
- Siloxanes

## Polystyrene Standards Separation

Sample: EasiCal PS-2  
Column: PLgel 3 $\mu$ m MIXED-E, 300x7.5mm (PL1110-6300)  
Eluent: THF  
Flow Rate: 1.0ml/min  
Detector: UV, 254nm

EasiCal PS-2

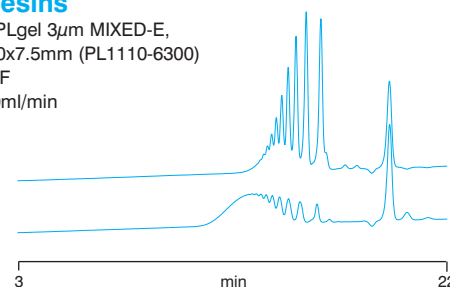
1.	380,000
2.	96,000
3.	22,000
4.	5,050
5.	1,320
6.	156,000
7.	49,900
8.	11,600
9.	2,950
10.	580



## Polyester Resins

Columns: 2xPLgel 3 $\mu$ m MIXED-E,  
300x7.5mm (PL1110-6300)

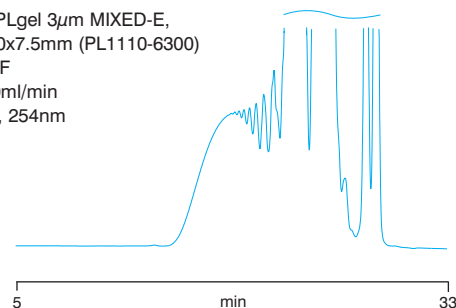
Eluent: THF  
Flow Rate: 1.0ml/min  
Detector: RI



## Polyol

Columns: 3xPLgel 3 $\mu$ m MIXED-E,  
300x7.5mm (PL1110-6300)

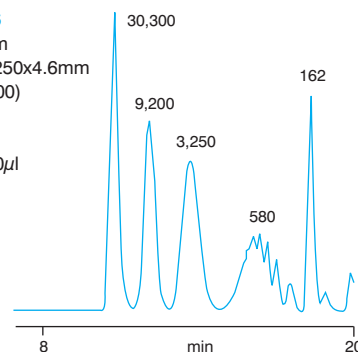
Eluent: THF  
Flow Rate: 1.0ml/min  
Detector: UV, 254nm



## Polystyrene Standards on Narrow Bore MiniMIX Columns

Columns: 2xPLgel 3 $\mu$ m  
MiniMIX-E, 250x4.6mm  
(PL1510-5300)

Eluent: THF  
Flow Rate: 0.3ml/min  
Loading: 0.1% w/v, 20 $\mu$ l  
Detector: UV, 254nm



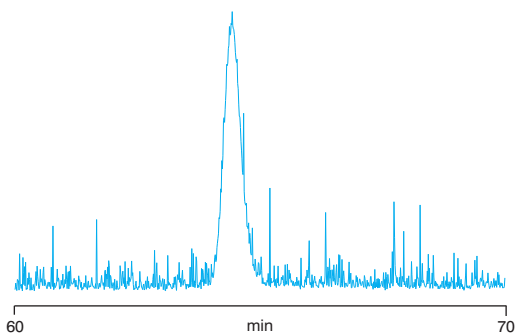
To order please contact Varian Polymer Laboratories, or your local distributor

## PLgel LS Columns for Light Scattering & Viscosity

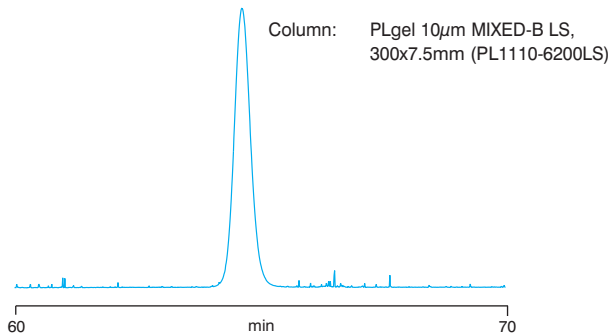
When using online molecular weight sensitive detectors in GPC, particularly light scattering detectors, excessive baseline noise arising from particulates in the eluent stream can significantly deteriorate the quality of the data. Traditionally, GPC columns can be one source of particulates, especially columns containing large pore size packing materials which, when new, bleed microparticles from their structure. This means that a new column set needs a 'conditioning' process, involving pumping the columns to waste to remove the particulates.

Polymer Laboratories has developed the PLgel LS series, 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 LS columns in place of conventional GPC columns. The light scattering chromatograms below were obtained after flushing the columns for one hour in THF at 1.0ml/min. A polystyrene standard (Mp 210,000) was injected at 1mg/ml in order to illustrate the dramatic improvement in signal to noise with the PLgel LS column.

### Conventional GPC Column



### PLgel LS Column



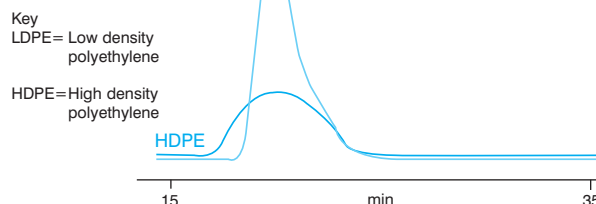
Polymer Laboratories has matched the performance of its PLgel LS columns to its very successful PLgel 20 $\mu$ m MIXED-A and PLgel 10 $\mu$ m MIXED-B columns in terms of calibration, column efficiency, wide solvent compatibility and operating temperature.

PLgel 5 $\mu$ m and PLgel 3 $\mu$ m GPC columns all exhibit very low particle shedding and these regular columns are ideal for all detector operations.

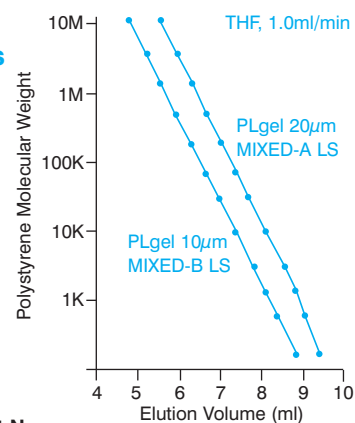
PLgel 20 $\mu$ m MIXED-A LS and PLgel 10 $\mu$ m MIXED-B LS columns are also ideal for online viscosity detection, minimizing the risk of capillary blockage. They can be used with regular PLgel guard columns which are packed with rigid low pore size gels (see page 23), which do not exhibit particle bleed.

### Signal to Noise

Columns: 3xPLgel 20 $\mu$ m MIXED-A LS, 300x7.5mm (PL1110-6200LS)  
 Eluent: TCB  
 Flow Rate: 1.0ml/min  
 Temp: 150°C  
 Detector: LS 15°



### PLgel MIXED-LS Calibration Curves



### PLgel MIXED-LS Specifications

Column	Linear Operating Range (PS equivalent)	Guaranteed Column Efficiency (plates/m)	Part No.
PLgel 10 $\mu$ m MIXED-B LS, 300x7.5mm	500-10,000,000	>35,000	PL1110-6100LS
PLgel 20 $\mu$ m MIXED-A LS, 300x7.5mm	2,000-40,000,000	>17,000	PL1110-6200LS
PLgel 10 $\mu$ m Guard, 50x7.5mm	-	-	PL1110-1120
PLgel 10 $\mu$ m Guard, 50x7.5mm	-	-	PL1110-1220

# Polymer Laboratories' Narrow Bore GPC Columns

## PLgel MiniMIX & PlusPore Columns

- High Performance Comparable to PL's Conventional ID Columns
- Benefit of ~70% Reduction in Solvent Consumption
- Increased Operator Safety
- Reduced Solvent and Solvent Disposal Costs

### Safety and Cost Benefits

The result is two ranges of exceptional performance narrow bore GPC columns, ideal for laboratories wishing to reduce solvent costs, solvent usage and solvent disposal, with reduced risk from the minimized use of unpleasant solvents.

For reduced solvent cost and consumption, Polymer Laboratories manufactures both new PlusPore high pore volume/high resolution columns and industry standard PLgel MiniMIX mixed gel columns in 250x4.6mm narrow bore dimensions. PL's narrow bore GPC 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 0.3ml/min in line with the column cross sectional area, resulting in *significantly lower solvent consumption*.

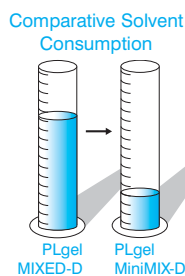
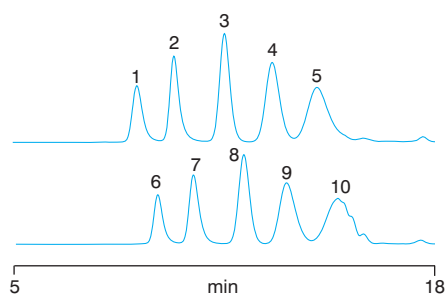
Sample loadings should be scaled down in line with reduced column volume, and system dead volume should be minimized to avoid excessive band broadening.

### Safety and Cost Benefits

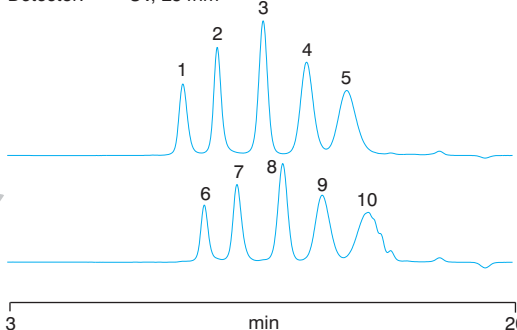
The result is two ranges of exceptional performance narrow bore GPC columns, ideal for laboratories wishing to reduce solvent costs, solvent usage and solvent disposal, with reduced risk from the minimized use of unpleasant solvents.

## Comparison of Conventional and Narrow Bore Columns

Sample: EasiCal PS-2  
Columns: 2xPLgel 5 $\mu$ m MIXED-D, 300x7.5mm (PL1110-6504)  
Eluent: THF  
Flow Rate: 1.0ml/min  
Inj Vol: 100 $\mu$ l  
Detector: UV, 254nm



Sample: EasiCal PS-2  
Columns: 2xPLgel MiniMIX-D, 250x4.6mm (PL1510-5504)  
Eluent: THF  
Flow Rate: 0.3ml/min  
Inj Vol: 20 $\mu$ l  
Detector: UV, 254nm



KEY  
1. 380,000  
2. 96,000  
3. 22,000  
4. 5,050  
5. 1,320  
6. 156,000  
7. 49,900  
8. 11,600  
9. 2,950  
10. 580

## PLgel MiniMIX - Specifications

Column Type	Linear MW Range (PS)	Guaranteed Efficiency (p/m)	Part No.
PLgel 20 $\mu$ m MiniMIX-A, 250x4.6mm	2,000-40,000,000	>17,000	PL1510-5200
PLgel 10 $\mu$ m MiniMIX-B, 250x4.6mm	500-10,000,000	>35,000	PL1510-5100
PLgel 5 $\mu$ m MiniMIX-C, 250x4.6mm	200-2,000,000	>50,000	PL1510-5500
PLgel 5 $\mu$ m MiniMIX-D, 250x4.6mm	200-400,000	>50,000	PL1510-5504
PLgel 3 $\mu$ m MiniMIX-E, 250x4.6mm	up to 30,000	>70,000	PL1510-5300

## PlusPore - Specifications

Column Type	MW Range (PS)	Guaranteed Efficiency (p/m)	Part No.
PolyPore, 250x4.6mm	200-2,000,000	>50,000	PL1513-5500
ResiPore, 250x4.6mm	200-400,000	>70,000	PL1513-5300
MesoPore, 250x4.6mm	up to 25,000	>70,000	PL1513-5325
OligoPore, 250x4.6mm	up to 4,500	>50,000	PL1513-5520

To order please contact Varian Polymer Laboratories, or your local distributor

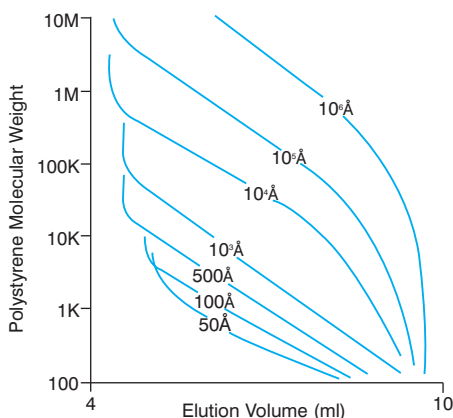
US 800 767 3963 UK / International (+44) 01694 723581 Germany (+49) 06151 703292 Benelux (+31) 011 8671500 France (+33) 01 69 86 38 64

## PLgel Individual Pore Size GPC Columns

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 molecular weight region over which optimum resolution will be achieved.

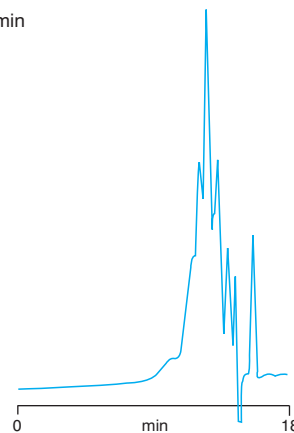
### Calibration Curves

Calibrants: Polystyrene  
Eluent: THF  
Flow Rate: 1.0ml/min



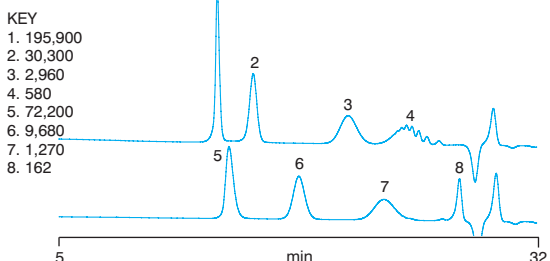
### Phenolic Resin Analysis

Column: PLgel 5 $\mu$ m 100 $\text{\AA}$ , 600x7.5mm (PL1110-8520)  
Eluent: DMF  
Flow Rate: 1.0ml/min  
Temp: 80°C  
Detector: RI



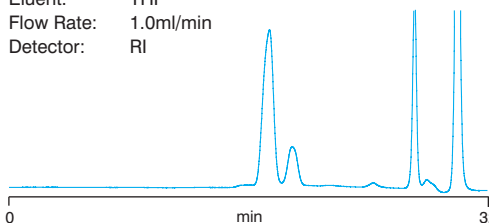
### Polystyrene Standards Separation

Columns: 3xPLgel 5 $\mu$ m 10<sup>3</sup> $\text{\AA}$ , 300x7.5mm (PL1110-6530)  
Eluent: THF  
Flow Rate: 1.0ml/min  
Detector: RI



### Kraton Analysis

Columns: 3xPLgel 5 $\mu$ m 10<sup>5</sup> $\text{\AA}$ , 300x7.5mm (PL1110-6550)  
Eluent: THF  
Flow Rate: 1.0ml/min  
Detector: RI



### PLgel Individual Pore Size Columns - Specifications

Column Type	Effective MW Range (PS)	Guaranteed Efficiency (p/m)	Part No. 300x7.5mm	Part No. 600x7.5mm
PLgel 3 $\mu$ m 100 $\text{\AA}$	up to 4,000	> 100,000	PL1110-6320	-
PLgel 5 $\mu$ m 50 $\text{\AA}$	up to 2,000	> 60,000	PL1110-6515	PL1110-8515
PLgel 5 $\mu$ m 100 $\text{\AA}$	up to 4,000	> 60,000	PL1110-6520	PL1110-8520
PLgel 5 $\mu$ m 500 $\text{\AA}$	500-30,000	> 60,000	PL1110-6525	PL1110-8525
PLgel 5 $\mu$ m 10 <sup>3</sup> $\text{\AA}$	500-60,000	> 50,000	PL1110-6530	PL1110-8530
PLgel 5 $\mu$ m 10 <sup>4</sup> $\text{\AA}$	10,000-600,000	> 50,000	PL1110-6540	PL1110-8540
PLgel 5 $\mu$ m 10 <sup>5</sup> $\text{\AA}$	60,000-2,000,000	> 50,000	PL1110-6550	PL1110-8550
PLgel 10 $\mu$ m 50 $\text{\AA}$	up to 2,000	> 35,000	PL1110-6115	PL1110-8115
PLgel 10 $\mu$ m 100 $\text{\AA}$	up to 4,000	> 35,000	PL1110-6120	PL1110-8120
PLgel 10 $\mu$ m 500 $\text{\AA}$	500-30,000	> 35,000	PL1110-6125	PL1110-8125
PLgel 10 $\mu$ m 10 <sup>3</sup> $\text{\AA}$	500-60,000	> 35,000	PL1110-6130	PL1110-8130
PLgel 10 $\mu$ m 10 <sup>4</sup> $\text{\AA}$	10,000-600,000	> 35,000	PL1110-6140	PL1110-8140
PLgel 10 $\mu$ m 10 <sup>5</sup> $\text{\AA}$	60,000-2,000,000	> 35,000	PL1110-6150	PL1110-8150
PLgel 10 $\mu$ m 10 <sup>6</sup> $\text{\AA}$	600,000-10,000,000	> 35,000	PL1110-6160	PL1110-8160



# PLgel Individual Pore Size GPC Columns

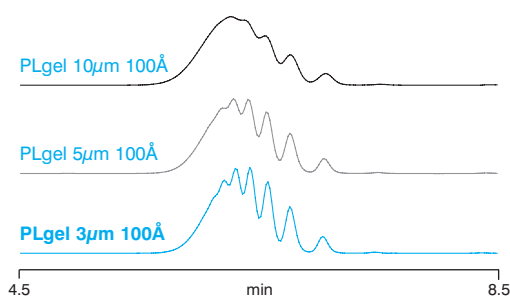
## PLgel 3 $\mu$ m 100Å Low MW Columns

PLgel low pore size columns are the choice for high resolution GPC separations of low molecular weight compounds.

Column efficiency increases as the particle size of the packing is reduced. For low molecular weight separations, the resolution of individual species is dramatically improved.

### Effect of Particle Size on Resolution

Sample: Polystyrene 580  
Columns: 300x7.5mm  
Eluent: THF  
Flow Rate: 1.0ml/min  
Inj Vol: 20 $\mu$ l  
Detector: RI



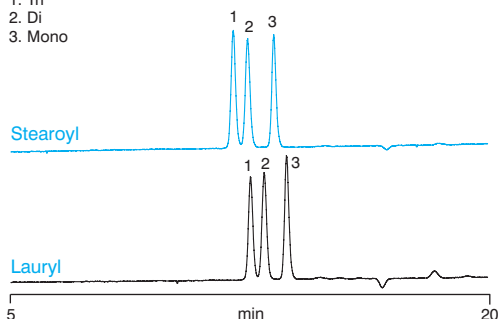
The increased efficiency of the 3 $\mu$ m packing material offers two benefits:

- Improved resolution for the same column length
- Faster separation with the same resolution

### Mono-, di- and triglycerides

Columns: 2xPLgel 3 $\mu$ m 100Å, 300x7.5mm (PL1110-6320)  
Eluent: THF  
Flow Rate: 1.0ml/min  
Detector: RI

KEY  
1. Tri  
2. Di  
3. Mono



### Features

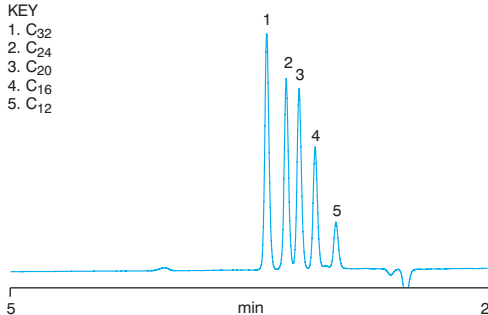
- Unrivalled solvent compatibility
- Excellent mechanical stability
- Very high efficiency
- Faster analysis time, fewer columns required

### Linear Hydrocarbons

Columns: 2xPLgel 3 $\mu$ m 100Å, 300x7.5mm (PL1110-6320)  
Eluent: THF  
Flow Rate: 1.0ml/min  
Detector: RI

KEY

1. C<sub>32</sub>  
2. C<sub>24</sub>  
3. C<sub>20</sub>  
4. C<sub>16</sub>  
5. C<sub>12</sub>

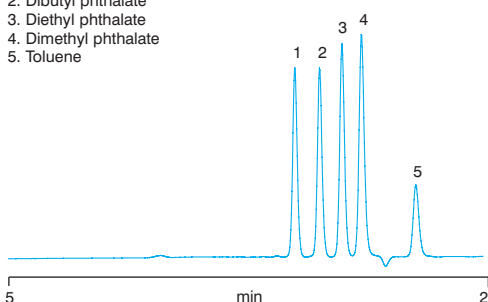


### Dialkyl Phthalates

Columns: 2xPLgel 3 $\mu$ m 100Å, 300x7.5mm (PL1110-6320)  
Eluent: THF  
Flow Rate: 1.0ml/min  
Detector: RI

KEY

1. Dioctyl phthalate  
2. Dibutyl phthalate  
3. Diethyl phthalate  
4. Dimethyl phthalate  
5. Toluene



### Guard Columns

Choose from PLgel 3 $\mu$ m, 5 $\mu$ m, 10 $\mu$ m and 20 $\mu$ m guard columns for all PLgel 300x7.5mm column types, simply matching the particle size of the packing.

Guard Column Type	Part No.
PLgel 20 $\mu$ m Guard, 50x7.5mm	PL1110-1220
PLgel 10 $\mu$ m Guard, 50x7.5mm	PL1110-1120
PLgel 5 $\mu$ m Guard, 50x7.5mm	PL1110-1520
PLgel 3 $\mu$ m Guard, 50x7.5mm	PL1110-1320

## PLgel Preparative GPC Columns

Preparative GPC is widely used for the fractionation of a wide variety of samples based on their molecular size in solution. The technique is generally used for the fractionation of polymers, to isolate components in a polymer formulation or simplify mixtures of relatively small molecules in complex matrices. Mixtures of materials can be easily separated on the basis of size, preferably in a low boiling organic solvent, collected as a series of discrete fractions and isolated by simple evaporation of the solvent.

### Applications Include

- Deformulation of competitors' products
- Sample clean-up / extraction
- Polymer fractionation

### High Performance, High Capacity

PLgel Preparative columns are packed with the same rigid, high performance media as the analytical column range. The 10 $\mu$ m particle size provides high column efficiency (>25,000 plates/m) for optimum resolution and loading characteristics.

PLgel 25mm ID preparative columns offer more than a 10x scale up compared to PLgel 7.5mm analytical columns. In comparison with other vendors' preparative columns, PL's increased ID and column volume permit even higher loadings per injection.

Column ID	Column Volume per 300mm Length	Minimum Scale Up
7.5mm	13	x1
19mm	85	x6
21mm	104	x8
25mm	147	x11

### High Load

The large internal diameters of preparative columns, with their correspondingly larger bed volumes, mean that the injection volume can be significantly increased.

When fractionating low molecular weight materials, the sample concentration can also be significantly increased, enabling milligram quantities of very pure material to be isolated for further study. The actual loading is ultimately controlled by the sample and its molecular weight.

PLgel Preparative GPC columns are available in seven individual pore sizes and two MIXED gel types, and in column lengths of 300mm and 600mm. A Preparative Guard column (25x25mm) is also available.

*Not sure which prep column to use?  
Call us for PL's free application service.*

### PLgel Preparative GPC Columns

Description	Effective MW Range (PS)	Part No. 300x25mm	Part No. 600x25mm
PLgel 10 $\mu$ m MIXED-B	500-10,000,000	PL1210-6100	PL1210-8100
PLgel 10 $\mu$ m MIXED-D	200-400,000	PL1210-6104	PL1210-8104
PLgel 10 $\mu$ m 50Å	up to 2,000	PL1210-6115	PL1210-8115
PLgel 10 $\mu$ m 100Å	up to 4,000	PL1210-6120	PL1210-8120
PLgel 10 $\mu$ m 500Å	500-30,000	PL1210-6125	PL1210-8125
PLgel 10 $\mu$ m 10 <sup>3</sup> Å	500-60,000	PL1210-6130	PL1210-8130
PLgel 10 $\mu$ m 10 <sup>4</sup> Å	10,000-600,000	PL1210-6140	PL1210-8140
PLgel 10 $\mu$ m 10 <sup>5</sup> Å	60,000-2,000,000	PL1210-6150	PL1210-8150
PLgel 10 $\mu$ m 10 <sup>6</sup> Å	600,000-10,000,000	PL1210-6160	PL1210-8160
	<b>Part No.</b>		
PLgel Prep Guard, 25x25mm	PL1210-1120		

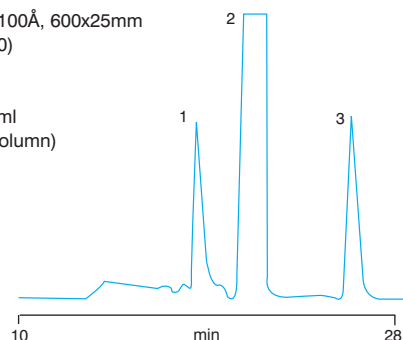
## PLgel Preparative GPC

### Identification of Contaminants

This phenol product was found to contain small amounts of two contaminant species. By using very high loading, sufficient quantities of fractions 1 and 3 were collected to permit identification by infra-red spectroscopy.

Column: PLgel 10 $\mu$ m 100 $\text{\AA}$ , 600x25mm (PL1210-8120)  
 Eluent: Acetone  
 Flow Rate: 10.0ml/min  
 Loading: 100mg/ml, 2ml (200mg on column)  
 Detector: RI

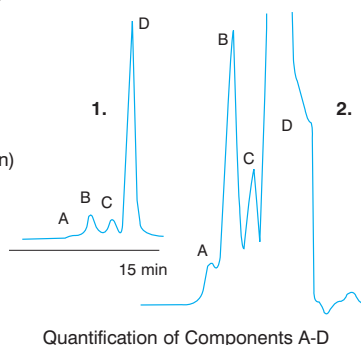
KEY  
 1. & 3. Contaminants  
 2. Phenol



### Product Deformulation

Loading in preparative GPC is molecular weight dependent and is much greater for low MW materials than for polymers. Even for polymers, a minimum of 10x scale up is routine but for very low molecular weight materials, the loading can be significantly increased.

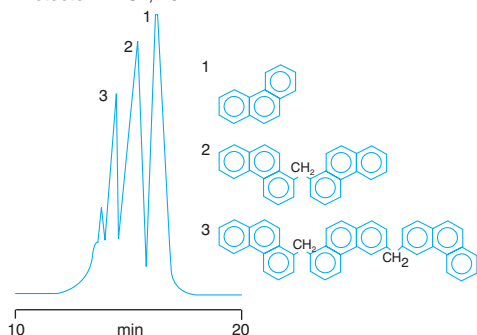
Column: PLgel 10 $\mu$ m 100 $\text{\AA}$ , 600x25mm (PL1210-8120)  
 Eluent: THF  
 Flow Rate: 9.0ml/min  
 Loading: 1. 5mg/ml, 1ml (5mg on column)  
 2. 100mg/ml, 3ml (300mg on column)  
 Detector: RI



### Fractionation

Each fraction of this phenanthrene-formaldehyde resin was collected using a 'heart-cut' technique to avoid cross-fraction contamination. Identification was carried out using mass spectroscopy and infra-red spectroscopy.

Column: PLgel 10 $\mu$ m 500 $\text{\AA}$ , 600x25mm (PL1210-8125)  
 Eluent: Dichloromethane  
 Flow Rate: 9.0ml/min  
 Loading: 100mg/ml, 2ml (200mg on column)  
 Detector: UV, 254nm



## PL EnviroPrep Columns

### NEW Columns for Sample Clean-up

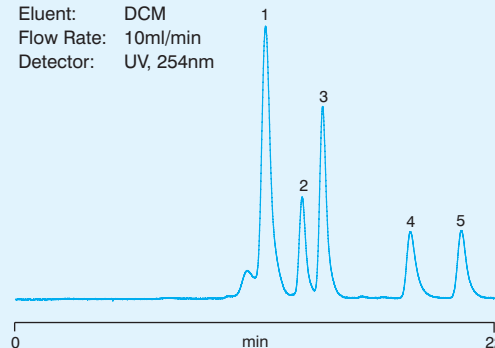
For environmental sample clean-up according to EPA Methods, Polymer Laboratories is launching PL EnviroPrep high resolution preparative GPC columns. PL EnviroPrep columns permit a simple, one stage clean-up procedure for the determination of pesticides in a variety of organic matrices, eg soil, animal tissue, etc. The matrix is extracted and the higher molecular weight fractions such as lipids, polymers, natural resins and dispersed high molecular weight components are easily eliminated in the GPC analysis.

This application of preparative GPC in the clean-up of soil extracts is described in EPA Method 3640A and is in the US EPA CLP Statement of Work for Organics Analysis, Document Number OLM01.0. Preparative GPC using a 300x25mm and a 150x25mm column is preferred, since higher sample loadings and fraction yields can be obtained, particularly useful for looking at low levels of pollutants.

Low pore size PL EnviroPrep columns are ideal for this application. PL EnviroPrep columns have a 10 $\mu$ m particle size and 100 $\text{\AA}$  pore size for high resolution, with an exclusion limit of 4000 molecular weight. The PL EnviroPrep 10 $\mu$ m preparative columns offer high resolution and high loading through optimization of the particle size distribution. As a means of evaluating the performance of the GPC column and system, a separation of a test solution is suggested. The GPC calibration solution is prepared in dichloromethane containing the following analytes (in elution order):

Compound/KEY	mg/l
1. Corn Oil	25,000
2. Bis(2-ethylhexyl) phthalate	1,000
3. Methoxychlor	200
4. Perylene	20
5. Sulfur	80

Column: PL EnviroPrep, 300x25mm (PL1210-6120EPA)  
 PL EnviroPrep, 150x25mm (PL1210-3120EPA)  
 Eluent: DCM  
 Flow Rate: 10ml/min  
 Detector: UV, 254nm



## PL HFIPgel Columns for GPC Applications in HFIP

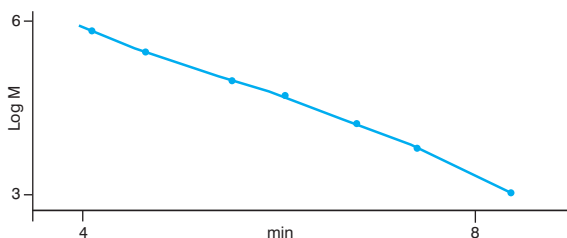
Hexafluoroisopropanol (HFIP) has been used as a solvent in GPC for many years for the analysis of important industrial polymers such as polyesters and polyamides. Conventional PS/DVB based GPC columns have been used with HFIP for this type of application. Unfortunately, the high solvent polarity generally leads to the production of unsatisfactory data. Excessive curvature of GPC calibration curves, dislocations/shoulders on peaks for polydisperse samples and poor resolution in the low MW region are commonly observed in HFIP.

For improved performance in extremely polar solvents such as HFIP and TFE, Polymer Laboratories has applied novel "multipore" technology to produce PL HFIPgel, a PS/DVB packing featuring:

- Monodisperse particle size
- Optimized separation range
- High pore volume
- High resolution
- Low column operating pressure

### GPC Calibration Curve

Column: PL HFIPgel, 300x7.5mm  
 Eluent: HFIP + 20mM NaTFAc  
 Flow Rate: 1.0ml/min  
 Temp: 40°C  
 Calibrants: Polymethylmethacrylate  
 Detector: RI



PL HFIPgel columns are available in regular 7.5mm ID and solvent-efficient 4.6mm ID hardware. 7.5mm ID columns are normally operated at 1ml/min and the 4.6mm ID columns at 0.3ml/min, providing a 70% reduction in solvent consumption.

#### Description

Description	Part No.
PL HFIPgel, 300x7.5mm	PL1114-6900HFIP
PL HFIPgel Guard, 50x7.5mm	PL1114-1900HFIP
PL HFIPgel, 250x4.6mm	PL1514-5900HFIP
PL HFIPgel Guard, 50x4.6mm	PL1514-1900HFIP

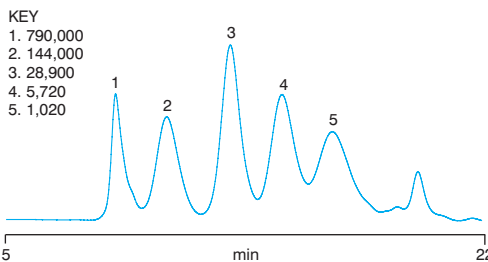
### Applications

- Polyesters
- Polyamides
- Polylactide/glycolide copolymers

PL HFIPgel columns are packed and tested in methanol but shipped ready to use in HFIP. Column efficiency is guaranteed >30,000 plates/m and columns are very durable, with a maximum operating pressure of 1450psi.

### Polymethylmethacrylate Standards

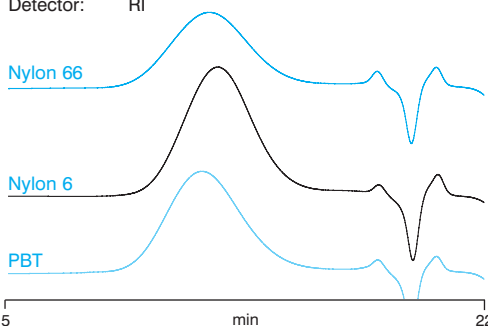
Columns: 2xPL HFIPgel, 300x7.5mm (PL1114-6900HFIP)  
 Eluent: HFIP + 20mM NaTFAc  
 Flow Rate: 1.0ml/min  
 Temp: 40°C  
 Detector: RI



For details of PL's Polymethylmethacrylate Standards, see page 44

### Polyamides

Columns: 2xPL HFIPgel, 300x7.5mm (PL1114-6900HFIP)  
 Eluent: HFIP + 20mM NaTFAc  
 Flow Rate: 1.0ml/min  
 Temp: 40°C  
 Detector: RI



## Organic GPC Columns - Ordering Information

## PlusPore Columns, pages 4-8

Product	300x7.5mm Part No.	250x4.6mm Part No.	300x25mm Part No.	Guard 50x7.5mm Part No.	Guard 50x4.6mm Part No.
PolyPore	PL1113-6500	PL1513-5500		PL1113-1500	PL1513-1500
ResiPore	PL1113-6300	PL1513-5300		PL1113-1300	PL1513-1300
MesoPore	PL1113-6325	PL1513-5325		PL1113-1325	PL1513-1325
OligoPore	PL1113-6520	PL1513-5520	PL1213-6520	PL1113-1320	PL1513-1320






## PLgel MIXED Gel Columns, pages 10-17

Product	300x7.5mm Part No.	PLgel MiniMIX 250x4.6mm Part No.	600x7.5mm Part No.	Guard 50x7.5mm Part No.	PLgel MiniMIX Guard 50x4.6mm Part No.
PLgel 20 $\mu$ m MIXED-A	PL1110-6200	PL1510-5200	PL1110-8200	PL1110-1220	PL1510-1200
PLgel 20 $\mu$ m MIXED-A LS	PL1110-6200LS			PL1110-1220	
PLgel 10 $\mu$ m MIXED-B	PL1110-6100	PL1510-5100	PL1110-8100	PL1110-1120	PL1510-1100
PLgel 10 $\mu$ m MIXED-B LS	PL1110-6100LS			PL1110-1120	
PLgel 5 $\mu$ m MIXED-C	PL1110-6500	PL1510-5500	PL1110-8500	PL1110-1520	PL1510-1500
PLgel 5 $\mu$ m MIXED-D	PL1110-6504	PL1510-5504	PL1110-8504	PL1110-1520	PL1510-1504
PLgel 3 $\mu$ m MIXED-E	PL1110-6300	PL1510-5300		PL1110-1320	PL1510-1300

## PLgel Individual Pore Size Columns, pages 18-19

Product	300x7.5mm Part No.	600x7.5mm Part No.	Guard 50x7.5mm Part No.
PLgel 3 $\mu$ m 100Å	PL1110-6320		PL1110-1320
PLgel 5 $\mu$ m 50Å	PL1110-6515	PL1110-8515	PL1110-1520
PLgel 5 $\mu$ m 100Å	PL1110-6520	PL1110-8520	PL1110-1520
PLgel 5 $\mu$ m 500Å	PL1110-6525	PL1110-8525	PL1110-1520
PLgel 5 $\mu$ m 10 <sup>3</sup> Å	PL1110-6530	PL1110-8530	PL1110-1520
PLgel 5 $\mu$ m 10 <sup>4</sup> Å	PL1110-6540	PL1110-8540	PL1110-1520
PLgel 5 $\mu$ m 10 <sup>5</sup> Å	PL1110-6550	PL1110-8550	PL1110-1520
PLgel 10 $\mu$ m 50Å	PL1110-6115	PL1110-8115	PL1110-1120
PLgel 10 $\mu$ m 100Å	PL1110-6120	PL1110-8120	PL1110-1120
PLgel 10 $\mu$ m 500Å	PL1110-6125	PL1110-8125	PL1110-1120
PLgel 10 $\mu$ m 10 <sup>3</sup> Å	PL1110-6130	PL1110-8130	PL1110-1120
PLgel 10 $\mu$ m 10 <sup>4</sup> Å	PL1110-6140	PL1110-8140	PL1110-1120
PLgel 10 $\mu$ m 10 <sup>5</sup> Å	PL1110-6150	PL1110-8150	PL1110-1120
PLgel 10 $\mu$ m 10 <sup>6</sup> Å	PL1110-6160	PL1110-8160	PL1110-1120

To order please contact Varian Polymer Laboratories, or your local distributor

 US 800 767 3963   
  UK / International (+44) 01694 723581   
  Germany (+49) 06151 703292   
  Benelux (+31) 011 8671500   
  France (+33) 01 69 86 38 64

## Organic GPC Columns &amp; Accessories - Ordering Information

## PLgel Preparative Columns, pages 20-21

Column Type	300x25mm Part No.	600x25mm Part No.
PLgel 10 $\mu$ m MIXED-B	PL1210-6100	PL1210-8100
PLgel 10 $\mu$ m MIXED-D	PL1210-6104	PL1210-8104
PLgel 10 $\mu$ m 50Å	PL1210-6115	PL1210-8115
PLgel 10 $\mu$ m 100Å	PL1210-6120	PL1210-8120
PLgel 10 $\mu$ m 500Å	PL1210-6125	PL1210-8125
PLgel 10 $\mu$ m 10 <sup>3</sup> Å	PL1210-6130	PL1210-8130
PLgel 10 $\mu$ m 10 <sup>4</sup> Å	PL1210-6140	PL1210-8140
PLgel 10 $\mu$ m 10 <sup>5</sup> Å	PL1210-6150	PL1210-8150
PLgel 10 $\mu$ m 10 <sup>6</sup> Å	PL1210-6160	PL1210-8160

PLgel Prep Guard	Part No.
25x25mm	PL1210-1120

## PL EnviroPrep Columns, page 21

Column Type	Part No.
PL EnviroPrep, 300x25mm	PL1210-6120EPA
PL EnviroPrep, 150x25mm	PL1210-3120EPA

## PL HFIPgel Columns, page 22

Column Type	Part No.
PL HFIPgel, 300x7.5mm	PL1114-6900HFIP
PL HFIPgel, 250x4.6mm	PL1514-5900HFIP
PL HFIPgel Guard, 50x7.5mm	PL1114-1900HFIP
PL HFIPgel Guard, 50x4.6mm	PL1514-1900HFIP

- PL offers a rapid column repair service – call us for details
- PL has the expertise and flexibility to design and manufacture custom GPC columns for specialty applications – call us to discuss your individual requirements

Media Type	Frit porosity ( $\mu$ m)
PLgel 3 $\mu$ m	2
PLgel 5 $\mu$ m	2
PLgel 10 $\mu$ m	5
PLgel 20 $\mu$ m	10
PL HFIPgel	5
OligoPore	2
MesoPore	2
ResiPore	2
PolyPore	2

## GPC Column Accessories Ordering Information

Item	Part No.
Frit Removal Tool - threaded columns only	PL1310-0001
End Fitting for threaded columns, 4.6mm ID	PL1310-0034
Frit (2 $\mu$ m) Kit (Pk of 5) for Narrow Bore MiniMIX columns, 4.6mm ID	PL1310-0041
Frit (5 $\mu$ m) Kit (Pk of 5) for Narrow Bore MiniMIX columns, 4.6mm ID	PL1310-0042
Frit (10 $\mu$ m) Kit (Pk of 5) for Narrow Bore MiniMIX columns, 4.6mm ID	PL1310-0043
End Fitting for threaded columns, 7.5mm ID	PL1310-0004
Frit (2 $\mu$ m) Kit (Pk of 5) for threaded columns, 7.5mm ID	PL1310-0002
Frit (5 $\mu$ m) Kit (Pk of 5) for threaded columns, 7.5mm ID	PL1310-0012
Frit (10 $\mu$ m) Kit (Pk of 5) for threaded columns, 7.5mm ID	PL1310-0036
PLgel 20 $\mu$ m Column Repair Gel	PL1410-0201
PLgel 10 $\mu$ m Column Repair Gel	PL1410-0101
PLgel 5 $\mu$ m Column Repair Gel	PL1410-0501
PLgel 3 $\mu$ m Column Repair Gel	PL1410-0301
OligoPore Column Repair Gel	PL1413-0320
MesoPore Column Repair Gel	PL1413-0325
ResiPore Column Repair Gel	PL1413-0300
PolyPore Column Repair Gel	PL1413-0500
Column Connecting Nuts (Pk of 5), 1/16" tube	PL1310-0007
Tubing Ferrules (Pk of 5), 1/16" tube	PL1310-0008
LDV Intercolumn SS Connector	PL1310-0005
Column End Plugs (Pk of 10), 1/16"	PL1310-0003
Connecting Tubing (Pk of 10), 10cm length, 0.010" ID	PL1310-0048
Connecting Tubing (Pk of 10), 5cm length, 0.010" ID	PL1310-0047
Replacement Frit and End Fitting, 25mm ID	PL1310-0011