GPC/SEC standards

Product guide

The Measure of Confidence

Agilent Technologies

Contents

Over 30 years' experience in GPC/SEC

1976

PLgel columns, individual standards and standard kits
Polymer Laboratories founded to develop market-leading products for organic GPC/SEC

1981

PLgel MIXED columns, PL aquagel columns
MIXED columns improve data quality, and novel chemistries for analysis of water-soluble polymers

1984

GPC software
Dedicated software streamlines GPC/SEC calculations

1990

PL aquagel-OH columns
Vastly improve resolution and data quality in aqueous GPC

1993

EasiCal standards
New format shortens sample preparation time and the speed of calibration

Polymer standards for GPC/SEC

Standards and specialty polymers

Polymer standards from Agilent 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, Agilent 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. Agilent 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.

1999

PL-GPC 220 instrument
Market-leading high temperature GPC system for routine analysis of even the most difficult samples by multi-detector GPC at temperatures up to 220 °C

2003

PL-GPC 50 instrument with light scattering and viscometry
Cost-effective solution to low temperature polymer analysis, including multi-detector GPC/SEC

2004

PlusPore columns and EasiVial standards
New chemistries deliver high-pore-volume materials for increased resolution, and EasiVial standards simplify calibration procedures even further

2007

PLgel Olexis columns
Optimized for polyolefin analysis with highest resolution and data quality for even ultrahigh molecular weight samples

2009

1260 Infinity Multi Detector Suite and PolarGel columns
The 1260 Infinity MDS turns any LC into a powerful multi-detector GPC system, and PolarGel columns analyze polar samples in any solvent system

Polymer standards for GPC/SEC

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 to 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 Agilent office.

Calibration kits: for column and detector calibration

Agilent 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.

For more information on choosing the correct standards for a particular eluent, see page 15.

See also

- Organic GPC/SEC columns, publication 5990-7994EN
- Aqueous and polar GPC/SEC columns, publication 5990-7995EN

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 glycol (PEG)	Yes	Yes		Yes	Organic/Aqueous
Polyethylene oxide (PEO)	Yes	Yes		Yes	Organic/Aqueous

Agilent 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 Agilent 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.

Conditions

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)

Peak Identification

1. 6,035,000
2. 483,000
3. 19,720
4. 1,260
5. 3,053,000
6. 184,900
7. 8,450
8. 580
9. 915,000
10. 60,450
11. 3,370
12. 162

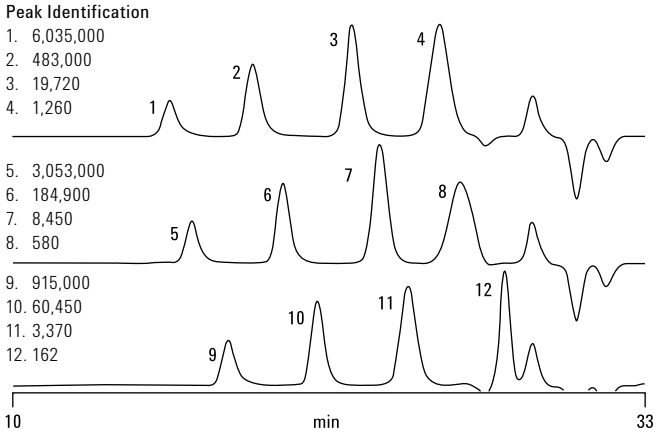


Figure 1. *EasiVial PS-H*

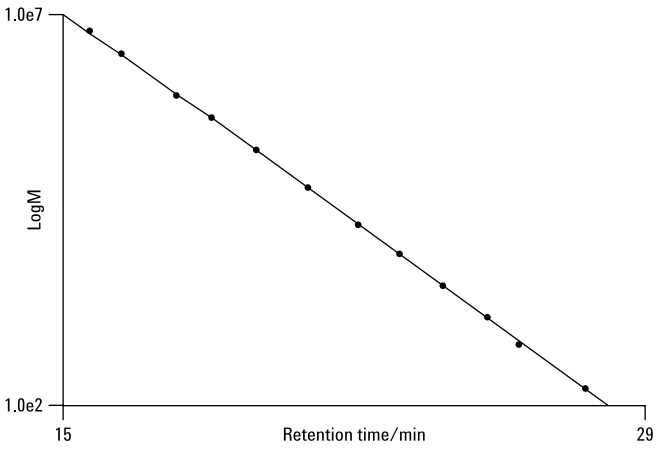


Figure 2. *Polystyrene calibration generated with EasiVials*

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

PS = polystyrene
PM = polymethylmethacrylate
H = standards to high molecular weight
M = standards to medium molecular weight
L = standards to low molecular weight

EasiVial

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	2	90	PL2010-0402
PS-L Tri-Pack	4	90	PL2010-0403

See also

- Organic GPC/SEC columns, publication 5990-7994EN

- Aqueous and polar GPC/SEC columns, publication 5990-7995EN

Agilent 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.

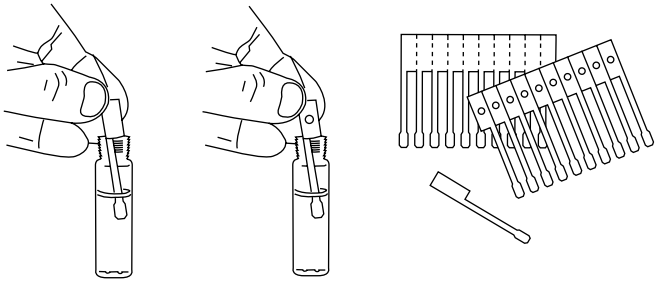
See also

- Organic GPC/SEC columns, publication 5990-7994EN
- Aqueous and polar GPC/SEC columns, publication 5990-7995EN

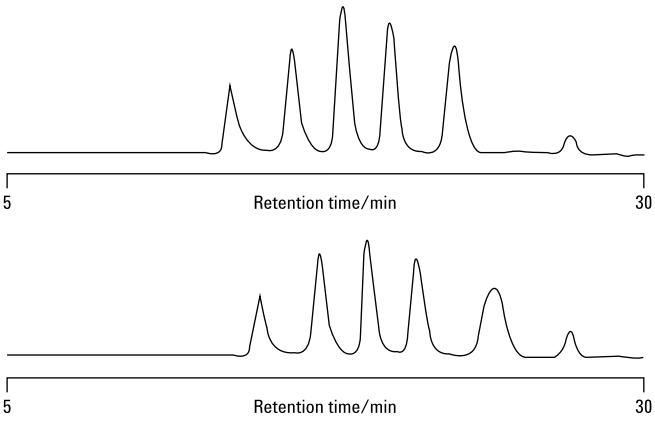
Ordering information

EasiCal pre-prepared polystyrene kits

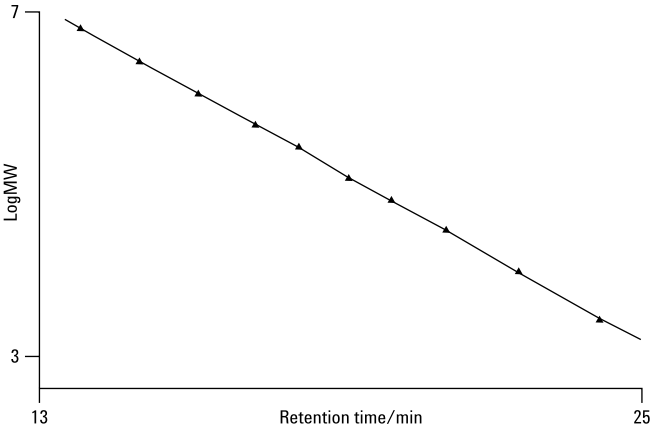
Polystyrene PS-1 Part No. PL2010-0501 (one pk) Part No. PL2010-0505 (five pk)	Polystyrene PS-2 Part No. PL2010-0601 (one pk) Part No. PL2010-0605 (five pk)
Spatula A, Constituent Polymers Nominal Mp (g/mol)	
3,000	1,300
30,000	5,000
150,000	20,000
850,000	100,000
7,500,000	400,000
Spatula B, Constituent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



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

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

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 to 15 million MW, with MWs selected to provide equidistant calibration points for greater accuracy.

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

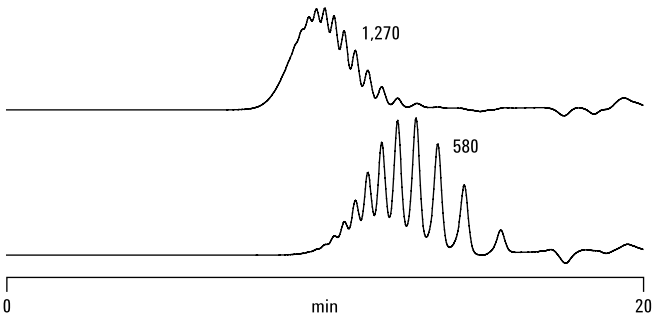


Figure 4. *Polystyrene standards*

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

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).

Polystyrene

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

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 to 1.5 million MW. Every kit contains 0.5 g of ten different molecular weight standards.

See also

- EasiVial Calibration Kit, pre-weighed to save time, page 5
- Organic GPC/SEC columns, publication 5990-7994EN
- Aqueous and polar GPC/SEC columns, publication 5990-7995EN

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

Conditions

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 (RI)

Peak Identification

1. 790,000
2. 144,000
3. 28,900
4. 5,720
5. 1,020

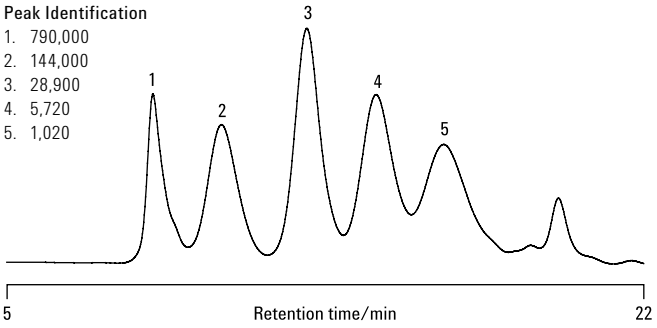


Figure 5. *Polymethylmethacrylate standards*

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

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).

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 to 1 million MW. Every kit contains 0.2 g or 0.5 g of ten different molecular weight standards.

Conditions

Column: PL aquagel-OH MIXED 8 µm, 300 x 7.5 mm
Eluent: Water
Flow Rate: 1.0 mL/min
Detector: PL-GPC 50 (RI)

Peak Identification

1. 1,702,000
2. 120,000
3. 12,600
4. 1,470
5. 106

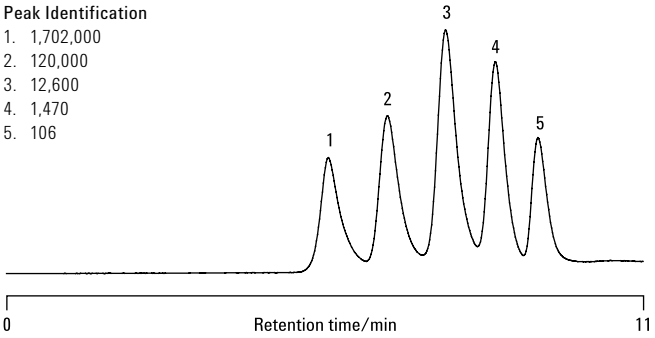


Figure 6. *Polyethylene glycol/oxide standards*

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

Polyethylene glycol/oxide

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
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

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).

See also

- EasiVial Calibration Kit, pre-weighed to save time, page 5
- Organic GPC/SEC columns, publication 5990-7994EN
- Aqueous and polar GPC/SEC columns, publication 5990-7995EN

Other polymer standards

A wide range of other polymer standards such as polyethylene, polyacrylic acid and pullulan polysaccharides are available. Please contact your local Agilent office or distributor for details and ordering information, or visit www.agilent.com/chem/gpcsec

Selection guide

GPC and SEC are liquid chromatographic techniques that separate individual polymer chains on the basis of their size in solution and not on their chemistry.

Gel permeation chromatography (GPC) and size exclusion chromatography (SEC) are techniques for measuring the molecular weight distribution of natural and synthetic polymers, a property that affects many of the physical parameters of materials such as strength, toughness and chemical resistance.

We use GPC to describe the analysis of polymers in organic solvents, such as tetrahydrofuran, and SEC to describe the analysis of polymers in water and water-based solvents, such as buffer solutions. GPC/SEC is the only established method for obtaining a comprehensive understanding of a polymer's molecular weight distribution.

How to use this selection guide

There are many standards available for the analysis of polymers by GPC/SEC. The purpose of this guide is to help you find a set of standards for the analysis of most common polymer types. A series of questions helps to narrow the choice down to the appropriate set. Some applications are not so easy to define and the required information may not be known, so consult your local expert in GPC/SEC for advice.

Mechanisms of GPC/SEC

- Polymer molecules dissolve in solution to form spherical coils with size dependent on molecular weight
- Polymer coils introduced to eluent flowing through a column
- Column packed with insoluble porous beads with well-defined pore structure
- Size of pores similar to that of polymer coils
- Polymer coils diffuse in and out of the pores
- Result is elution based on size – large coils first, smaller coils last
- Size separation converted to molecular weight separation by use of a calibration curve constructed by the use of polymer standards

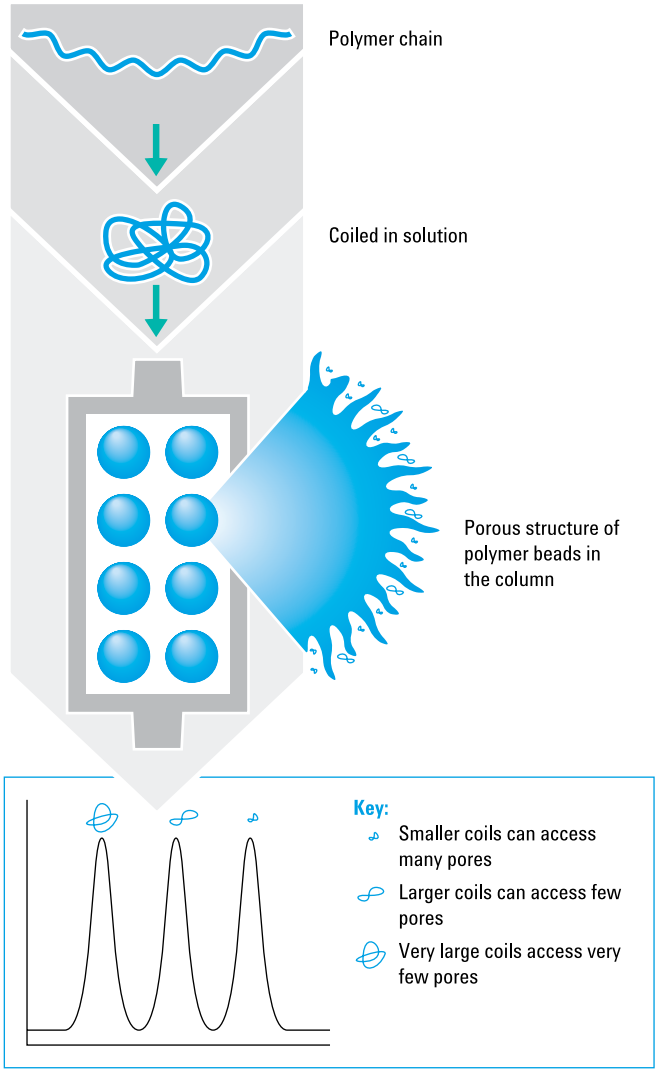


Figure 7. *Mechanism of gel permeation chromatography/size exclusion chromatography (GPC/SEC)*

What standards should I use?			
Question	**Answer**	**Recommendation**	**Comments**
1. What is the eluent? *Standards are polymers, so the choice of standard mainly reflects solubility in the chosen eluents.*	Water or water buffer with up to 50% methanol	**Polyethylene glycol (PEG)/ oxide (PEO)** or polysaccharides (SAC)	These standards perform in all water-based systems in convenient Agilent EasiVial format
	Typical organic solvent such as THF, chloroform, toluene	**Polystyrene (PS)** or polymethylmethacrylate (PMMA)	Polystyrene is the most commonly used standard in convenient EasiVial format
	Organic/water mixtures or polar organics such as DMF, NMP	**Polyethylene glycol/oxide** or polymethylmethacrylate	Polar standards perform well
Question	**Answer**	**Recommendation**	**Comments**
2. What format of standards are recommended? *Different formats of standards are available depending on customer preference.*	For the quickest and simplest approach where accurate concentrations are not required	Easiest option – **EasiVial** or Agilent EasiCal	Simple to use, EasiVial preferred before EasiCal because of the wider choice of polymer types
	If accurate concentrations are required	Accurate concentrations required – **EasiVial** or individual standards	Both formats allow accurate sample concentrations, EasiVials are simpler to use

Standards shown in bold are the best initial choice

Further reading

GPC/SEC publication	Publication number
Application compendia	
Excipient analysis by GPC/SEC and other LC techniques	5990-7771EN
Biodegradable polymers - analysis of biodegradable polymers by GPC/SEC	5990-6920EN
Analysis of engineering polymers by GPC/SEC	5990-6970EN
Analysis of elastomers by GPC/SEC	5990-6866EN
Analysis of polyolefins by GPC/SEC	5990-6971EN
Low molecular weight resins - Analysis of low molecular weight resins and prepolymers by GPC/SEC	5990-6845EN
Primer	
An Introduction to Gel Permeation Chromatography and Size Exclusion Chromatography	5990-6969EN
Selection guide	
Quick guide for selecting columns and standards for gel permeation chromatography and size exclusion chromatography	5990-6868EN
Wallchart	
GPC/SEC Reference Guide	5990-6882EN
Product guides	
Organic GPC/SEC columns	5990-7994EN
Aqueous and polar GPC/SEC columns	5990-7995EN

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