



**Agilent GPC/SEC Solutions**  
Comprehensively better  
**polymer analysis**



The Measure of Confidence



**Agilent Technologies**

*“We are not experts in GPC and want to have systems from a company that has the expertise to support us.”*

*“I want absolute molecular weights and sizes but the software is so complex and difficult to use. It reduces our productivity.”*

*“I need a system I can rely on to deliver high productivity, increase efficiency and reduce sample analysis cost”*

## HIGH PRECISION RESULTS WITH CONFIDENCE

Agilent Technologies offers the most comprehensive portfolio of high quality solutions for gel permeation and size exclusion chromatography. No matter what type of polymer analysis you are working on, Agilent has market- leading instrumentation, columns, standards and data analysis software to match any application and budget.

### Agilent’s portfolio gives you more

#### Versatility

From routine low temperature applications such as polybutadiene, to high temperature analysis of engineering polymers such as polyphenyl sulfide and polyolefins, Agilent’s solutions cover the widest range of conventional and advanced applications.

#### Performance

Count on all of Agilent’s solutions to deliver highest sensitivity, baseline stability and signal-to-noise response for accurate and reproducible data.

#### Confidence

Rest assured that all Agilent products are designed and manufactured to the highest engineering standards and based on over 35 years of experience in developing GPC/SEC solutions.

### Get more performance with confidence

#### Low dispersion

From the UHPLC design of the 1260 Infinity LC to integrated systems requiring minimal tubing, all Agilent solutions facilitate better chromatography through low system dead volumes. Market-leading flow cell technology minimizes band broadening for optimum GPC/SEC.

#### Information rich

Refractive index, ultra-violet and evaporative light scattering detectors are available for conventional GPC/SEC as well as dual-angle light scattering and viscometer detectors for advanced applications.

*“I have always been impressed by the quality, robustness, reliability and ease-of-use of their products, which have served me well.”*

**- John P. O’Donnell,**  
Research Scientist, FUJIFILM Imaging Colorants Ltd., Manchester, UK

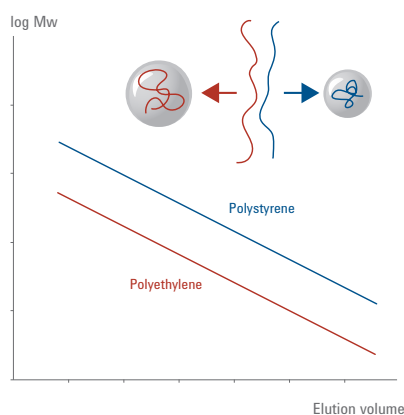
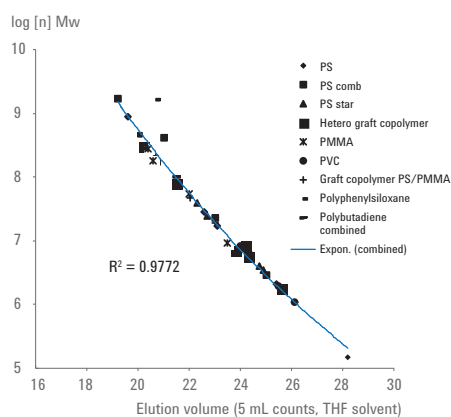
*“I can’t imagine a better company setup for helping academics and industry to carry out gel permeation chromatography measurements.”*

**- Professor Steve Howdle,**  
University of Nottingham, UK

## Boost your performance with advanced detection techniques

GPC/SEC is the only chromatographic technique that can determine the molecular weight distribution of a polymer. Adding advanced detection boosts this capability, improving both the accuracy and information content of the experiment. Dual-angle light scattering or viscometer detectors not only provide more accurate molecular weights, but also an insight into the behavior of the polymer in solution. Both these advanced detectors can be deployed to study branching or conformation changes in polymers.

- A dual-angle light scattering detector responds directly to molecular weight, thereby giving absolute results. Measuring at two angles simultaneously, makes determination of molecular size possible.
- The viscometer uses the Mark-Houwink plot to provide information on conformation, and is the basis for the Universal Calibration, which provides molecular weights independent of the chemistries used to calibrate the column.



Using the Universal Calibration (left) has clear advantages. The relative calibration (right) shows that polymers with identical molecular weights can yield different calibration curves when dissolved in solvent due to differing behavior in solution.

## A comprehensively better portfolio for all your GPC/SEC needs



**REPRODUCIBLE**  
Agilent 1260 Infinity GPC



**ACCURATE**  
Agilent 1260 Infinity MDS GPC



**DEDICATED**  
Agilent PL-GPC 50



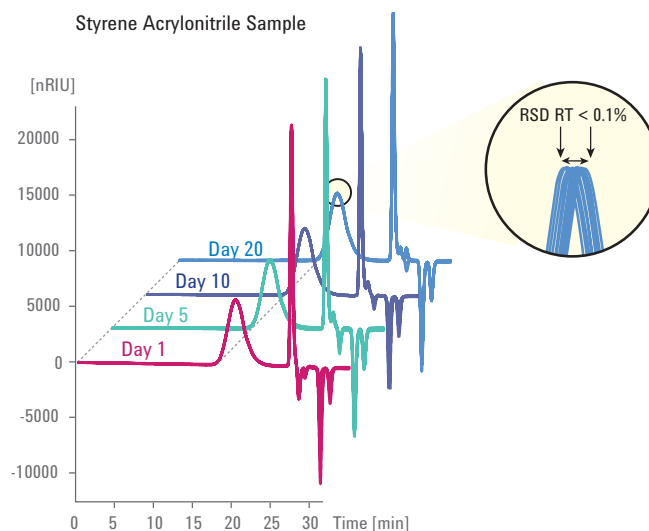
**POWERFUL**  
Agilent PL-GPC 220

## REPRODUCIBLE MOLECULAR WEIGHTS FOR ROUTINE POLYMER CHARACTERIZATION

The Agilent 1260 Infinity GPC/SEC System is a cost-effective solution for routine polymer characterization by conventional GPC/SEC separation with refractive index, UV-visible or evaporative light scattering detection. The system's unmatched flow precision and temperature stability gives you the confidence of obtaining reproducible and reliable results – day in, day out.



The Agilent 1260 Infinity GPC/SEC System can be combined with the comprehensive range of 1260 Infinity detectors such as refractive index, UV-visible or evaporative light scattering.



This overlay of 10 consecutive runs per day over 20 days shows the remarkable daily and day-to-day precision of retention times. The average RSD for retention times is 0.035%.

### A new level of precision for molecular weight data

The excellent flow precision of the 1260 Infinity Isocratic Pump and the superior temperature stability of the 1260 Infinity Column Compartment from 10 degrees below ambient to 80 °C combine to yield retention time precision less than 0.1 %RSD. The outstanding intraday and interday repeatability lets you reach a new level of precision for your molecular weight data.

### High performance GPC/SEC as standard

Choose refractive index, UV-visible or evaporative light scattering as your detection technique. The comprehensive range of 1260 Infinity detectors facilitates a high degree of tailoring to fit specific requirements. All 1260 Infinity detectors exhibit exceptional baseline stability and excellent signal-to-noise response for high performance GPC/SEC.



For a basic introduction to the techniques and application of GPC/SEC, ask your Agilent representative for a copy of Agilent's new primer "An Introduction to Gel Permeation Chromatography and Size Exclusion Chromatography", publication number 5990-6969EN.

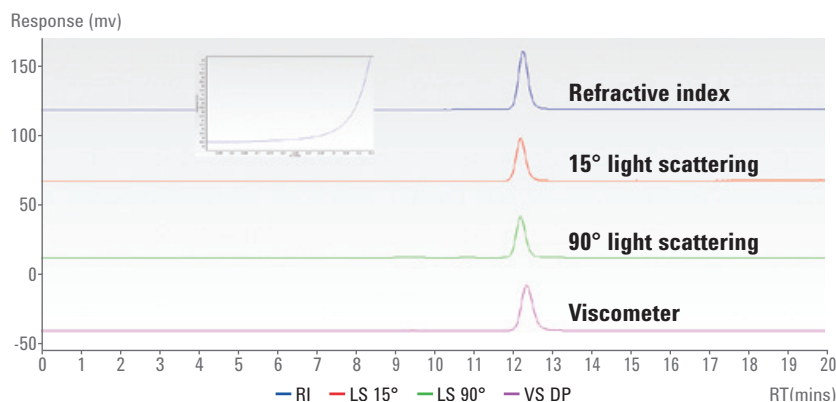
## ADVANCED, TRIPLE-DETECTION FOR ACCURATE, INFORMATION-RICH DATA

The Agilent 1260 Infinity Multi-Detector GPC/SEC System – with light scattering, refractive index and viscometry detectors – brings advanced GPC/SEC to your laboratory.

This triple-detection approach vastly improves the information your experiment delivers and facilitates determination of other polymer properties that cannot be measured by conventional, concentration-based detection techniques.



The Agilent 1260 Infinity Multi-Detector GPC/SEC System combines the precision of the LC modules with the accurate, information-rich data delivered by the Multi-Detector Suite.



Refractive index, dual-angle light scattering and viscometer detectors all deliver stable baselines with highest signal-to-noise performance. Low dispersion results in excellent peak shapes – even for light scattering detection thanks to the 10  $\mu$ L volume of the detection cell.

### Light scattering detection for absolute molecular weights

The powerful dual-angle light scattering detector measures the scattering of monochromatic laser light by polymer molecules at 15° and 90° angles. Combined with data from a concentration detector, light scattering detection gives:

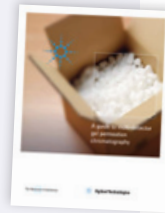
- Absolute molecular weights without the need for column calibration
- Accurate assessment of molecular size and radius of gyration (R<sub>g</sub>)
- Direct determination of long-chain branching

### Viscometry measurement for more insight about polymer behavior

The viscometer is a robust and sensitive module that measures the viscosity of polymer molecules in solution. Using the viscosity measurements with the data from a concentration detector gives:

- Accurate molecular weights regardless of the standards used to generate the column calibration
- Determine conformation
  - Mark-Houwink parameters
  - Accurate branching measurements across a broad range of molecular weights

For further details of how multi-detection can boost your GPC/SEC performance, ask your Agilent representative for a copy of Agilent's new primer "A guide to multi-detector gel permeation chromatography", publication number 5990-7196EN.

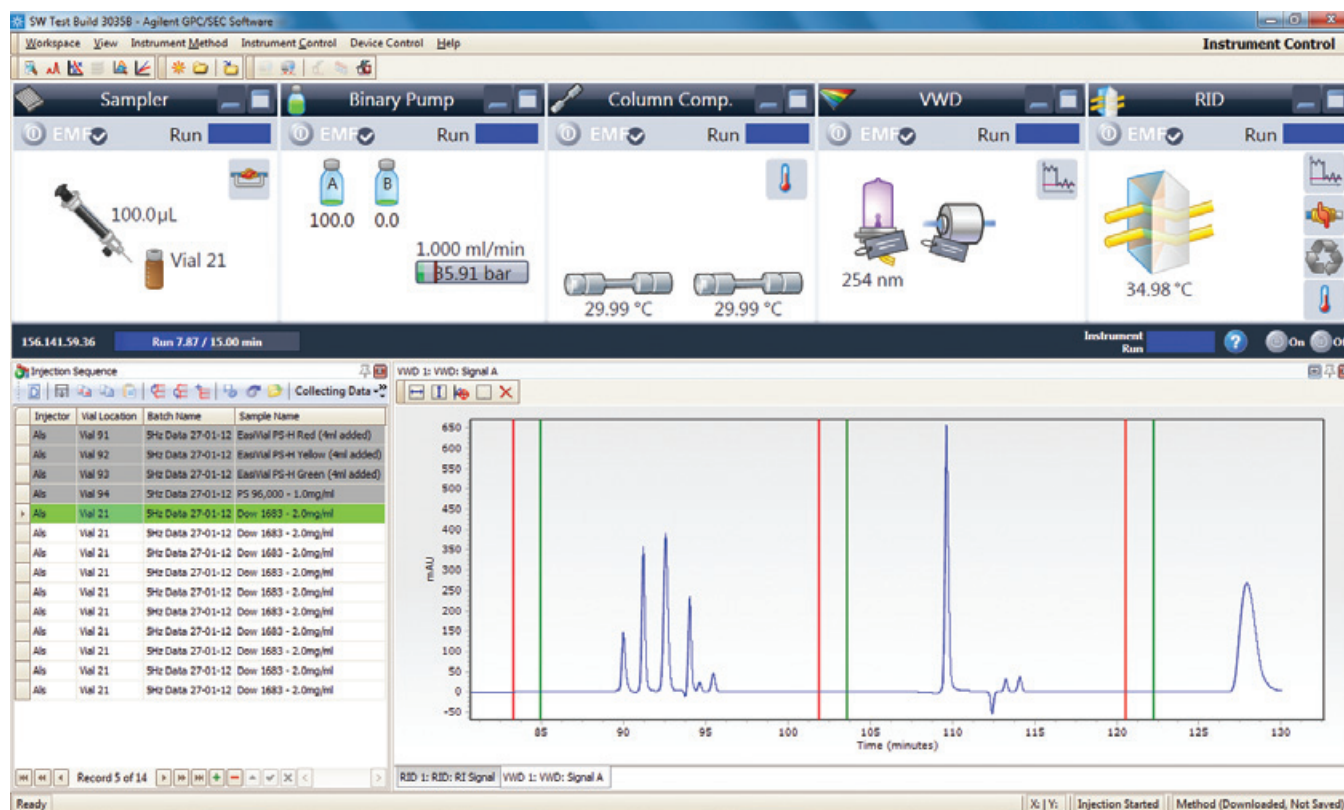


## A SINGLE, VERSATILE SOLUTION FOR RAPID, EASY ANALYSIS AND REPORTING

New software from Agilent provides all the functionality required for conventional and advanced GPC/SEC within one simple yet powerful package.

### Controls

The Agilent GPC/SEC software includes the Agilent Instrument Control Framework (ICF) – a software component that facilitates full control of and data collection from all instrumentation using RC.net technology. This includes all Agilent 1100 and 1200 Series modules, the Agilent PL-GPC 50, as well as certain non-Agilent instruments. The uncluttered design of the software makes instrument control and data collection an easy task. The same look-and-feel as the Agilent OpenLAB CDS ChemStation Edition software makes it easy to switch between GPC/SEC and HPLC.

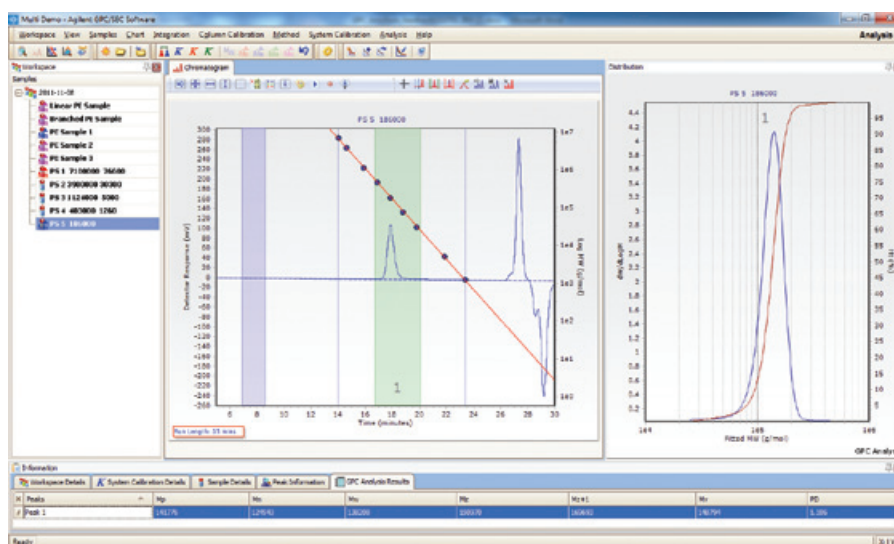


The Agilent GPC/SEC software has exactly the same look-and-feel as Agilent OpenLAB CDS ChemStation Edition software for HPLC. That means it's easy for you to move from one system to another when you deploy both techniques in your laboratory.



## Collects

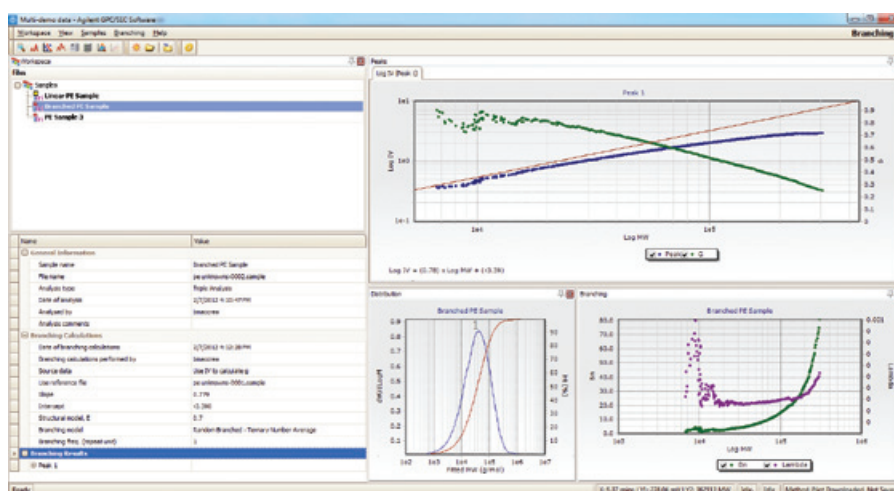
The Agilent GPC/SEC software can collect multiple data channels – either directly from the detector using RC.net or from the PL-DataStream. All common detection data can be handled, from conventional techniques such as refractive index, multiple wavelength UV and evaporative light scattering, through advanced detector techniques such as multi-angle light scattering and viscometry. The software collects all channels and collates the raw data and calculated results in a single location.



Chromatogram and molecular weight distribution from analysis of a polystyrene sample.

## Calculates

The Agilent GPC/SEC software can perform all required molecular weight and branching calculations to define the size and shape of your polymer. From conventional calculations using a column calibration to advanced calculations using viscometry and dual-angle light scattering, the software stores all results in a single file for instant access to all experimental data. All traces can be easily overlaid and arranged for clear, easy-to-read reports. The experimental data can be exported in a variety of formats, including ASCII or Microsoft Excel.



Branching analysis of a polyethylene sample.

The Agilent GPC/SEC software is highly adaptable and can be customized or expanded to meet your requirements now or in future.

## INDUSTRY STANDARD FOR ROUTINE, HIGH TEMPERATURE ANALYSIS OF ENGINEERING POLYMERS

The Agilent PL-GPC 220 is the ultimate GPC/SEC system, capable of handling almost all polymer, solvent and temperature combinations – with advanced detection – from ambient up to 220 °C.

### Maintain sample solubility

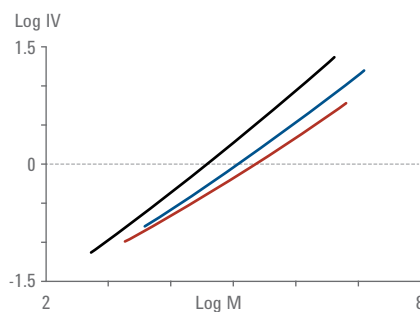
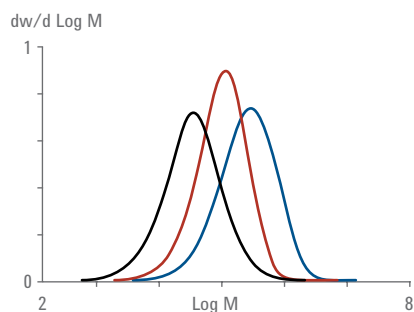
The PL-GPC 220 is a fully integrated solution. The entire sample flow path is heated up to 220 °C to maintain sample solubility, eliminating costly downtime due to blockages from precipitated samples.

### Achieve highest quality results

The unique design of the dual-zone autosampler ensures your samples are protected against degradation. The full range of detectors have industry-leading, low-volume flow cells that reduce dispersion and minimize band broadening for highest data integrity.

### Benefit from ultimate flexibility

The PL-GPC 220 is the most powerful solution for polymer analysis. Advanced detectors based on dual-angle light scattering or viscometry give you the flexibility to deploy the system for the widest range of GPC/SEC applications.



Molecular weight distributions (left) and Mark-Houwink plots (right) for three different grades of polyethylene.

- HDPE, linear polymer, no branching
- LDPE #1, branched
- LDPE #2, more branching

**Accurately controlled column oven** with integrated injection system, columns and detectors

**Dual temperature zone autosampler** prevents sample degradation

The Agilent PL-GPC 220 is the industry standard for high temperature GPC/SEC analysis, giving you full confidence in data integrity and operator safety.



**Temperature controlled solvent delivery module** with solvent reservoirs, pump and degasser

**The 1260 Infinity pump** with integrated degasser delivers precise flow for reproducible retention times – even with highly viscous solvents



## Agilent PL-SP 260VS Sample Preparation System

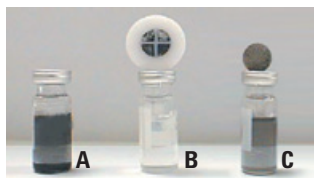
The PL-SP 260VS is designed for the dissolution and filtration of samples prior to GPC/SEC analysis, making sure no insolubles enter any part of the main system. The system combines controlled heating from 30 to 260 °C with gentle agitation at speeds from 85 to 230 rpm to avoid shearing, making it ideal for the preparation of a wide range of polymer types.



The aluminum heating blocks are available in different formats to accommodate a variety of vial types.

## Everything you need for sample preparation

A wide range of accessories such as sample vials and filters are available for sample preparation with the PL-SP 260VS. Correct filtering of samples prior to analysis is vital to ensure high quality results.



**A** – Unfiltered sample with carbon black  
**B** – Filtered (1 µm glass fiber membrane)  
**C** – Filtered (0.5 µm stainless steel frit)

*"I have no hesitation in recommending the high temperature GPC systems to anybody who is interested in polymer characterization."*

*"We also heavily use the PL-SP 260 VS. This reduces our sample preparation time and thus produces cost reduction for the laboratory."*

**- Dr Steve Holding,**  
Smithers Rapra Ltd., Shrewsbury, UK

## Agilent PL-GPC 50 Integrated GPC/SEC System

The Agilent PL-GPC 50 is an integrated system and features everything you need to perform ambient-to-medium temperature GPC/SEC – in both aqueous and organic media – in a single, compact unit. The column oven provides temperature control up to 50 °C and a refractive index detector is included as standard for universal polymer detection. Optional integrated, dual-angle light scattering and viscometer detectors are available to provide further information about the polymer analyte.



## Agilent PL-GPC 50 Autosampler

The PL-GPC 50 autosampler is an XY-sampler that operates at ambient temperature and has a capacity of 156 vials. Sample injection is through a flushed fixed loop, giving an excellent reproducibility for injections up to 250 µL. Software control provides the flexibility to program automated wash cycles as well as up to nine injections per vial for maximum lab productivity.



## EVERYTHING YOU NEED FROM THE LEADERS IN POLYMER ANALYSIS

Agilent is your one-stop solution partner for GPC/SEC. As well as an extensive array of instrument options, Agilent also manufactures a leading line of consumables for polymer separations, including columns and standards for use in all solvent types.

### Extensive, high performance column portfolio

Agilent's column portfolio contains columns for use in organic, aqueous and polar solvents, and covers the complete range of applications. With a rich heritage and recognized brand quality, PLgel, PL aquagel-OH and PolarGel columns, along with specialist columns for specific applications, means that no application is out of reach.

- Trusted products with a rich heritage
- Excellent resolution with robustness and durability
- Columns for all applications across the temperature and solvent range



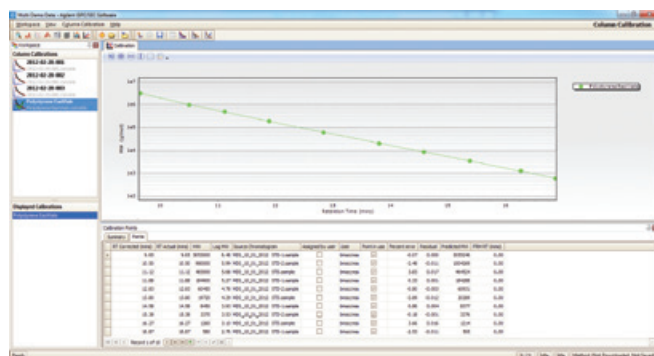
Agilent offers a complete range of GPC/SEC columns for all types of characterization of synthetic and bio-molecular polymers.

### Over 35 years of innovative contributions to GPC/SEC technology – we are the polymer analysis people

- 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/SEC
- 1993**  
**EasiCal standards**  
New format shortens sample preparation time and the speed of calibration
- 1999**  
**PL-GPC 220 instrument**  
Market-leading high temperature GPC system for routine analysis of even the most difficult samples by multi-detector GPC/SEC at temperatures up to 220 °C



Agilent's 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.



Conventional column calibration generated using the quick and easy-to-use polystyrene EasiVials.

## Highest quality polymer standards

Polymer standards in a range of chemistries are available for calibrating GPC/SEC columns and instruments, from conventional calibration to more advanced techniques such as the universal calibration using viscometry and light scattering. Available in polystyrene, polymethyl methacrylate, polyethylene glycol/oxide, polysaccharide and other chemistries to suit different eluent choices.

- High purity standards specifically manufactured for GPC/SEC
- Extensive QC including GPC/SEC, viscometry and light scattering analysis
- Available as EasiVials and EasiCals for convenient calibration, kits and as individual standards

Within this combined instrument and consumable portfolio, Agilent has a solution to any GPC/SEC requirement, making Agilent your indispensable partner for polymer characterization.

**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 ultra-high molecular weight samples

**2009**  
**Multi Detector Suite and PolarGel columns**  
 The MDS turns any LC into a powerful multi-detector GPC/SEC system, and PolarGel columns analyze polar samples in any solvent system

**2012**  
**Agilent GPC/SEC software**  
 Creating a complete and comprehensive GPC/SEC instrumentation portfolio

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