Malvern | Material relationships

MOLECULAR WEIGHT

MOLECULAR SIZE

MOLECULAR STRUCTURE

MALVERN
GPC/SEC SYSTEMS

SETTING THE STANDARD

WHAT CAN ADVANCED GPC/SEC OFFER YOU?

A modern research environment demands a complete understanding of a sample's molecular properties including accurate and reliable measurements of molecular weight.

Single detector GPC/SEC systems have been used for many years but cannot keep up with evermore demanding applications. The addition of advanced detection brings the greater understanding needed for today's samples.

- A **light scattering** detector: the heart of an advanced GPC/SEC system. Light scattering enables absolute molecular weight calculation, independent of structure and sample retention volume
- A **viscometer:** probes the very structure of a molecule to give a sample's intrinsic viscosity. No other detector can match its sensitivity to structural changes such as branching
- A **refractive index** or ultraviolet detector: concentration measurement is the first step in any advanced GPC/SEC mmeasurement and the Viscotek detectors include a range of options.

VISCOTEK SYSTEMS

A Viscotek system is a complete out-of-the-box solution for the characterization of synthetic and natural polymers as well as proteins.

In a single run they are capable of making accurate measurements of molecular weight and size, intrinsic viscosity and structure as well as characterize copolymers, conjugates and branching.

The pump and detector modules are designed to work together under a single software package and form a complete solution to guarantee the return on your investment into a new GPC/SEC system.

All of the detectors that make up the GPC/SEC systems in this brochure are also available as individual modules to enhance your existing chromatography system. For more information about individual GPC/SEC detectors, please refer to the separate 'Malvern GPC/SEC Detectors' brochure.

WHY BUY THE COMPLETE SOLUTION FROM MALVERN?

At Malvern, we not only provide you what is inside the box, we also like to think outside the box with our Technical and Application support, to get you up and running in the least amount of time possible.

When you purchase a complete solution from Malvern, we like to ensure the system will be a perfect match for your application needs; that's why we offer to run your samples through our highly experienced applications lab to fully understand your requirements before purchase and ensure minimum start-up time after installation.

The installation comes with entry-level training to get you up and running with the basics as soon as possible along with an invitation to one of our advanced training courses. But the support doesn't end there! With Malvern technical staff and application personnel to assist with training and method development, and Global Technical Support at the end of the phone, we'll be with you every step of the way. You'll also have access to our on-line webinars and e-learning as well as other training courses.

Consumables and maintenance of your system are both critical to your sample analysis. Malvern offers a full range of columns, standards and other consumables, as well as a complete range of support plan options to suit your needs.

In short, at Malvern we pride ourselves on providing you with a complete solution.

SYNTHETIC AND NATURAL POLYMER APPLICATIONS

The physical properties of a synthetic polymer like polystyrene, or natural polymers like starch or cellulose derivatives, are strongly dependent on their molecular properties. Molecular weight, polydispersity, structure and (for copolymers) composition all contribute to determining the final product's properties and processability.

With more and more novel polymers entering the market, conventional measurements of molecular weight using a single detector are no longer sufficient. Malvern systems are a single solution to make absolute measurements of these properties to cover a wide range of synthetic and natural polymer applications including:

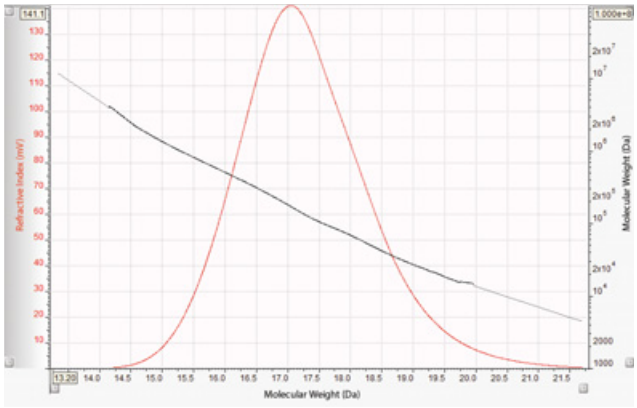
- Polymer research
- Paints and coatings
- Bulk polymers
- Food ingredients
- Drug excipients
- Tablet coatings
- Cosmetic and cosmeceuticals.

Molecular weight and molecular weight distribution can affect a polymer's **strength, durability, flexibility, toughness** and **degradation** rates. The different molecular weight moments also provide information on **flow properties** or **reactivity**.

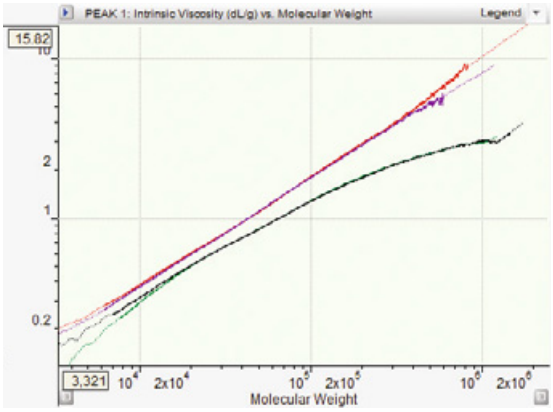
Intrinsic viscosity is a direct measure of molecular structure and can be used to assess **branching**, which also affects **processability** and **flow viscosity**.

Copolymers combine the properties of their components. Measuring their **composition** will therefore help to understand the contribution of the individual components.

If you are interested in understanding these polymer properties better, take a look at the OMNISEC or the Viscotek TDAmax systems.



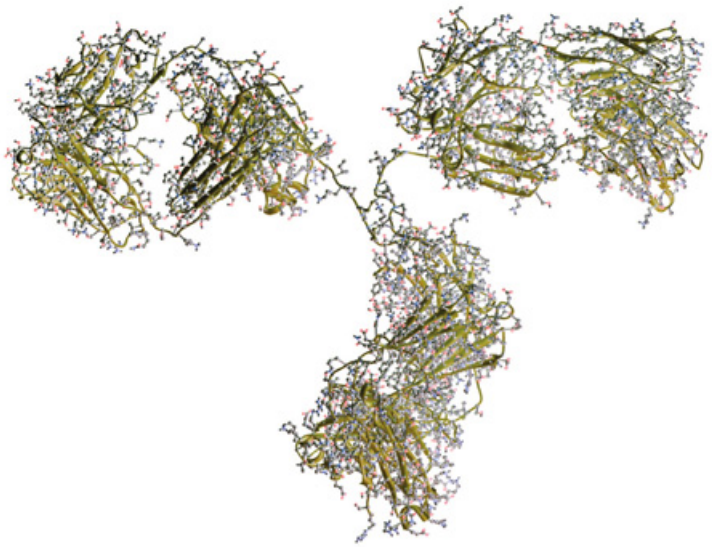
Absolute molecular weight measured by light scattering overlaid on the RI chromatogram



Mark-Houwink plot of intrinsic viscosity vs molecular weight for polymer structural elucidation.

PROTEIN APPLICATIONS

A protein's activity is strongly dependent on it being in the correct conformation and oligomeric state. Biopharmaceutical drugs must be aggregate-free and protein conjugates must be well-controlled during research and as manufactured drugs. Single-detector GPC/SEC cannot meet the growing demands in this field but advanced GPC/SEC detection can assist the protein scientist with all of these parameters, helping them to better understand the behavior of their protein of interest.



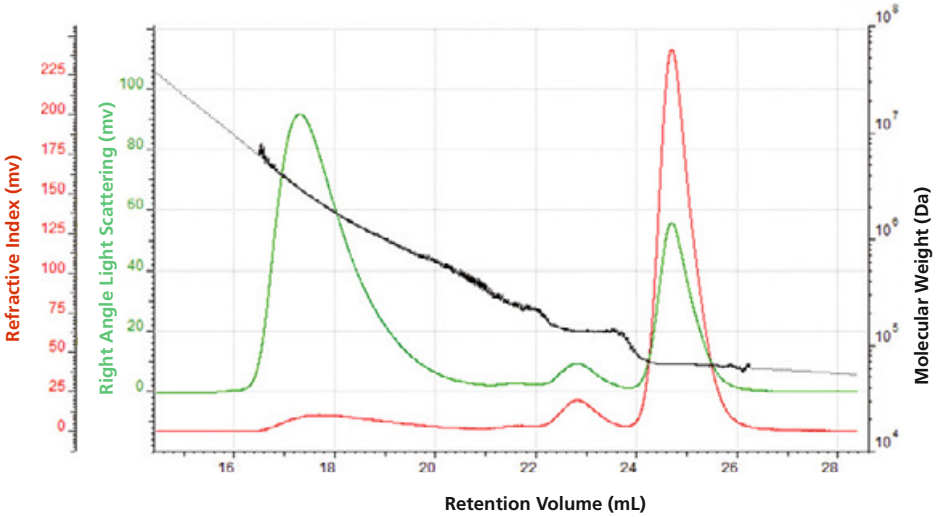
The molecular weight and size of a protein directly identifies its **oligomeric state** while polydispersity gives an indication of the **purity** of a sample peak.

Aggregates can be identified and their molecular weight, polydispersity and quantity all measured.

Conjugates such as PEGylated, glycosylated and membrane proteins can be characterized for their composition and molecular weight.

Intrinsic viscosity can be used to give an idea of **broad conformational changes** that relate to ligand binding.

If you are interested in understanding these protein properties better, take a look at the Viscotek SEC-MALS 20 or OMNISEC systems.



Protein oligomers and aggregates shown by Right Angle Light Scattering (RALS) (green) and Refractive Index (RI) (red) chromatograms overlaid with the absolute molecular weight (black).

OMNISEC SYSTEM

Absolute Molecular Weight, Intrinsic Viscosity, Molecular Size, Concentration

Malvern's expertise and experience with GPC/SEC has enabled the development of the most sensitive and accurate multi-detector system available for the characterization of any polymer or protein. The system includes:

OMNISEC RESOLVE has been designed using our 30 years of experience in GPC/SEC instrument development to achieve the highest possible standard in chromatographic performance.

OMNISEC REVEAL is the integrated multi-detector platform. It is available with refractive index, UV/Vis absorbance, light scattering and viscosity detectors to make a wide range of measurements that meet the needs of a many applications.

The low volume degasser allows rapid solvent and buffer changeover. Improved degassing efficiency combined with a low pulsation isocratic pump provides excellent flow rate stability and reduced baseline noise on all detectors.

The temperature controlled (4-60°C) autosampler can make injections from vials or 96-well microtiter plates with zero overhead to prevent wastage of your most precious samples, and the integrated column oven maintains a stable separation temperature up to 65°C.

For detailed information about the OMNISEC system, and a full list of specifications, please refer to the separate brochure.

OMNISEC **REVEAL** TECHNOLOGY

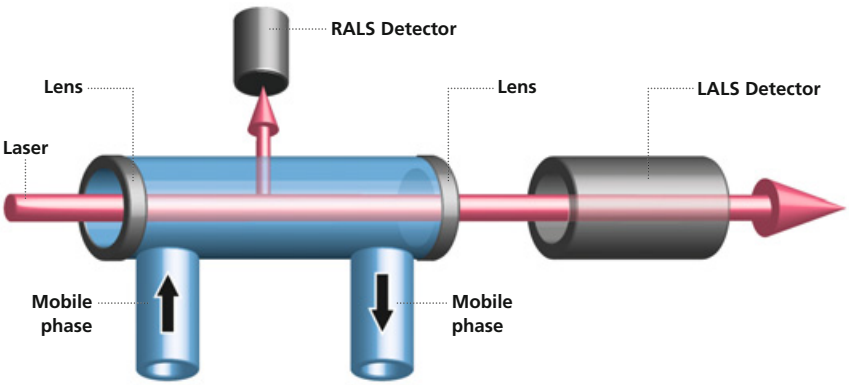
Absolute Molecular Weight, Intrinsic Viscosity, Molecular Size, Concentration

OMNISEC REVEAL's **refractive index detector** measures sample concentration. Its robust flow cell is kept in series with the other detectors for maximum sensitivity.

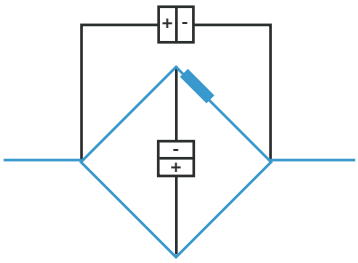
The **UV/Vis photodiode array** (200-900nm) opens up absorbance measurements to a wider application range.

The **light scattering detector** combines the sensitivity of 90° Right Angle Light Scattering (RALS) with the accuracy of 7° Low-Angle Light Scattering (LALS). Its superior sensitivity makes it ideal for measuring low molecular weight, low concentration or low dn/dc samples, while its 18 µL flow cell minimizes band broadening.

OMNISEC REVEAL's **digital differential viscometer** includes a disposable self-balancing bridge for simple and rapid user replacement. Its new 316 stainless steel pressure transducers improve baseline stability, sensitivity and robustness and means few limitations with salts or pH.



A RALS/LALS detector

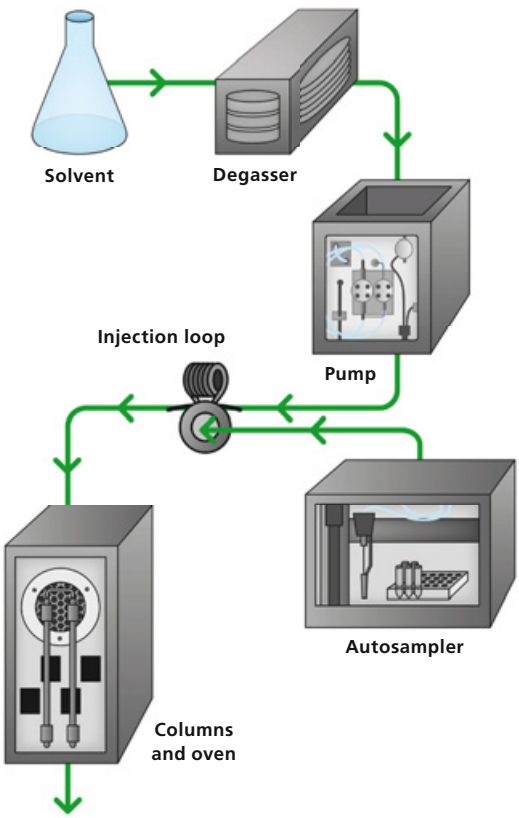


Intrinsic viscosity

OMNISEC **RESOLVE** TECHNOLOGY

OMNISEC RESOLVE achieves the highest possible standard in chromatographic performance with the aid of an efficient degasser, low-pulsation pump and integrated column oven.

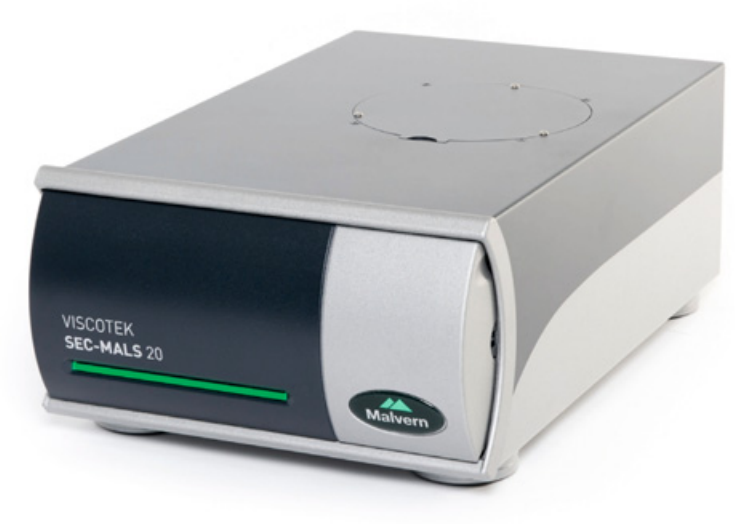
- Efficient degasser and pump flow rate stability ensures superior baseline stability
- Low injection volumes and waste-free injections reduce sample usage
- Cooled autosampler protects thermolabile samples from aggregation
- Low-volume degasser and automated pump priming allows rapid solvent and buffer changeover.



VISCOTEK **SEC-MALS 20** SYSTEM

Absolute Molecular Weight, Molecular Size

The SEC-MALS 20 is a modular multi-angle light scattering detector for direct measurements of absolute molecular weight and size. It can easily be combined with a column oven, modular RI detector and GPCmax to form a complete SEC-MALS 20 system, offering a turnkey solution with control of data acquisition and analysis using a single software package.
The SEC-MALS 20 can also be added to the OMNISEC or TDAmax systems if MALS is required.

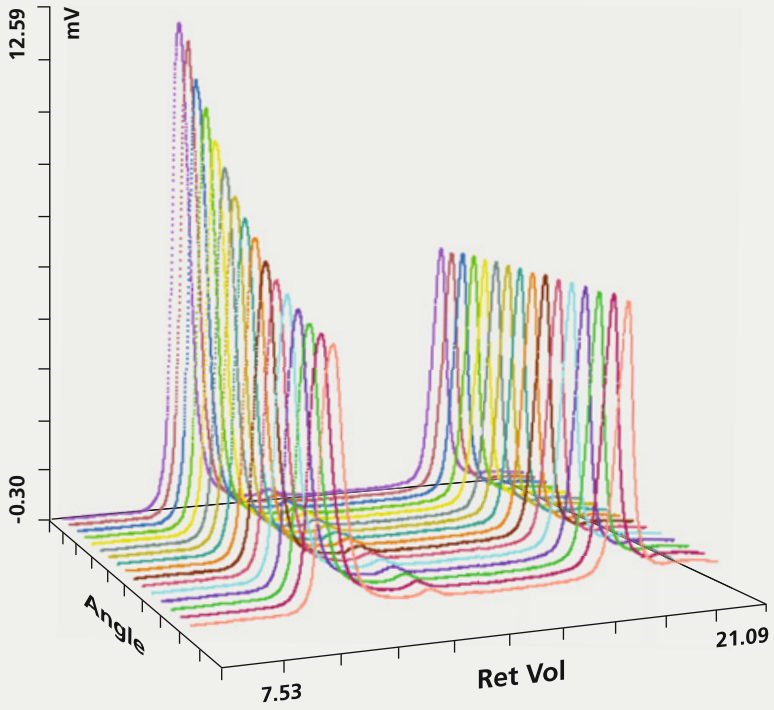


For proteins, the SEC-MALS 20 offers:

- Absolute molecular weight and oligomeric state
- Aggregate quantity, molecular weight and size (where applicable)
- Conjugation in samples such as PEGylated or membrane proteins (with two concentration detectors)
- Second virial coefficient A_2 (B_{22}).

For natural and synthetic polymers, the SEC-MALS 20 offers:

- Absolute molecular weight and molecular weight distribution
- Molecular size (Rg) for structural comparisons through conformation plots
- Second virial coefficient A_2 (B_{22})
- Temperature control as standard (ambient - 60°C).



MALS signals from an aggregated protein and monomer

OmniSEC software v5 simplifies MALS data:

- To view the slice-by-slice data, simply open the fit view and move the slider across the chromatogram peak to see the MALS data from any point on the chromatogram
- Switching between models (Zimm, Berry, Debye) and fit orders (1-5) is performed easily using the fit view. The results are updated immediately making it possible to compare results in seconds
- The 3 dimensional MALS view (left) makes visualizing isotropic and anisotropic scattering easy.

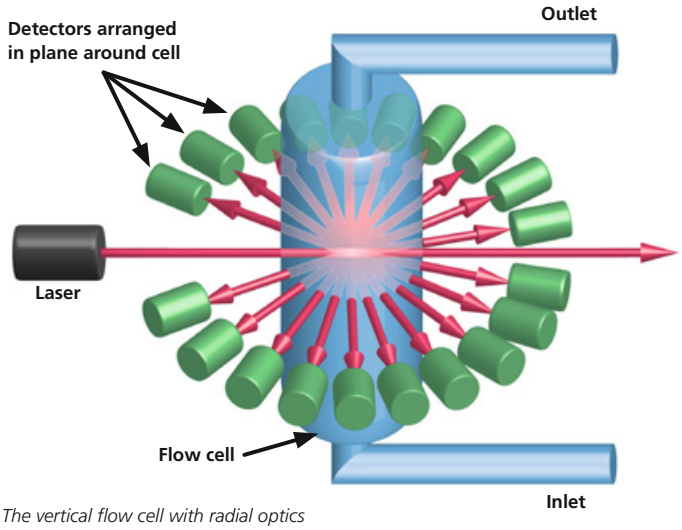
SEC-MALS 20 TECHNOLOGY

Absolute Molecular Weight, Intrinsic Viscosity, Molecular Size, Concentration

The key to the performance of the SEC-MALS 20 is the vertical flow cell with radial optics:

- Reduced detector noise at low angles
- Reduced need to clean the detector
- Fixed, constant and known measurement angles, regardless of solvent type
- One cell for all solvents means never having to switch or remove the cell
- Reduced band broadening and tailing compared with other MALS detectors, thanks to the low volume cell.

The overall result is minimized noise and the most accurate MALS data available.



The vertical flow cell with radial optics

VISCOTEK **TDAmax** SYSTEM

Absolute Molecular Weight, Intrinsic Viscosity, Molecular Size, Concentration

The Viscotek TDAmax is a complete stand-alone, temperature controlled, multi-detector GPC/SEC system. The detector module, the Triple Detector Array (TDA), is paired with the GPCmax to form a complete solution for macromolecular characterization. The detector can contain any combination of refractive index, light scattering and viscometer detectors to measure:

- Sample concentration
- Absolute molecular weight and molecular weight distribution
- Polydispersity
- Intrinsic viscosity
- Molecular size (Rh & Rg)
- Molecular structure/branching
- Mark-Houwink parameters
- Refractive Index increment, dn/dc
- Second virial coefficient, A_2 (B_{22})
- Copolymer and conjugate composition (with the additional UV detector).

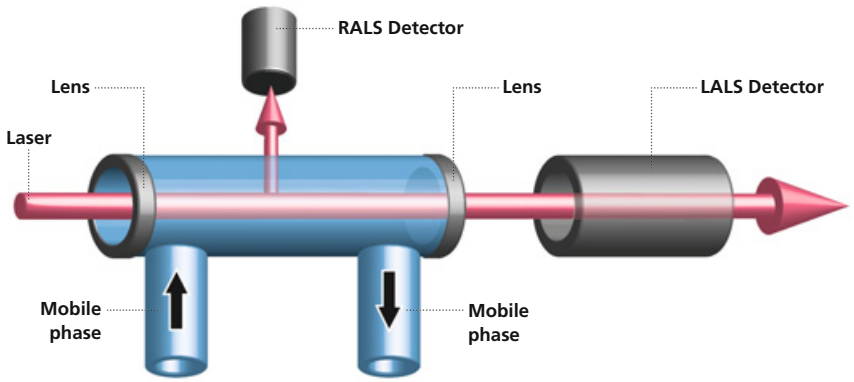
The TDAmax system offers the following benefits:

- An all-in-one chromatography solution for separation, acquisition and analysis
- All columns and detectors are housed in a single temperature-controlled compartment (up to 80°C) for improved baseline stability and solvent range
- Inter-detector tubing is minimized reducing band broadening and tailing.

VISCOTEK **TDA** TECHNOLOGY

Absolute Molecular Weight, Intrinsic Viscosity, Molecular Size, Concentration

The TDA's **refractive index (RI) detector** measures the concentration of almost any solute. The proprietary RI detector in the TDA has a robust flow cell keeping all detectors in series and maximizing their sensitivity.



A RALS/LALS detector

The **light scattering detector** inside the TDA combines the sensitivity of 90° Right Angle Light Scattering (RALS) with the accuracy of 7° Low Angle Light Scattering (LALS). The software automatically chooses the best angle for the sample at every data slice. Its flow cell is just 18 µL minimizing band broadening.

Viscotek invented and patented the first **differential viscometer**. The TDA's digital transducers give a fast, sensitive response to viscosity changes, and the 316 stainless steel construction means few sample limitations with salts or pH.

GPCmax

Integrated Pump, Degasser & Autosampler

The separation side of the Viscotek systems is best supported by the GPCmax: a combined pump, degasser and autosampler.

The isocratic pump has exceptional flow rate accuracy and minimal pulsation for improved baseline stability. The integrated degasser optimizes pump performance by removing dissolved gases and the autosampler allows for the unattended measurement of up to 120 samples.

The GPCmax, like the detectors, is controlled using the OmniSEC software v5, meaning only a single software suite is required for data collection and analysis.

VISCOTEK **RImax** SYSTEM

Conventional Calibration

The RImax is a conventional calibration system for the measurement of relative molecular weight based on sample retention volume compared with molecular weight standards. The RImax system can be upgraded later with any of the Viscotek modular detectors.

The system comprises:

- A GPCmax to combine the pump, degasser, and autosampler
- A column oven to improve separation efficiency and quality
- A sensitive and stable modular RI detector for the measurement of sample retention volume. The detector cell temperature can be controlled from ambient up to 55°C for improved baseline stability and is also compatible with sub-ambient measurements in a cold room or refrigerated cabinet. A 9 µL cell minimizes band-broadening
- OmniSEC software v5 includes advanced conventional calibration and analysis.

WHICH SYSTEM IS RIGHT FOR ME?

The table below highlights the differences between the three different types of GPC/SEC system, from the top-of-the-range OMNISEC multi-detector system to the conventional calibration only RImax system with a single detector.

For further information about the different system configurations, please visit the Malvern website or contact your local Malvern representative.

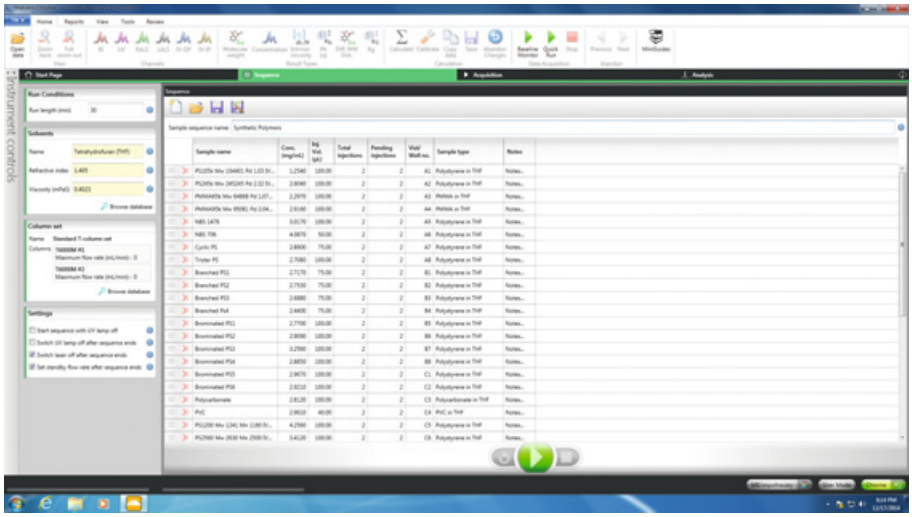
	OMNISEC	TDAmax	RImax
Parameters measured	Concentration, dRI, dn/dc, dUV, dA/dc, Light scattering intensity (SLS), Absolute molecular weight (Mn, Mw, Mz), Polydispersity, Radius of Gyration, Intrinsic viscosity, Mark-Houwink a & K, Hydrodynamic radius		Concentration, dRI, dn/dc, Relative molecular weight
System Components			
Light Scattering detector (RALS/LALS)	✓	✓	×
4-capillary differential viscometer	✓	✓	×
Diode-array based UV/Vis spectrometer	✓	×	×
Single wavelength UV detector	×	✓	×
Differential refractive index detector	✓	✓	✓
Optional SEC-MALS detector add-on	✓	✓	✓
Continuous pump seal washing	✓	×	×
Auto-balancing viscometer bridge with user exchangeable capillaries	✓	×	×
Zero-waste autosampler	✓	×	×
Autosampler temperature control	4 - 60° C	Ambient or 60° C	Ambient or 60° C
Viscometer delay column bypass	✓	×	×
Specifications			
Detector temperature control range	20 - 65° C	Ambient - 80° C	Ambient - 55° C
Autosampler capacity	96 vials, or 2 x 96-well plates	120 vials	120 vials
Autosampler injection volume	1 – 150, or 300 µL	20 - 150 µL	20 - 150 µL
Absolute Molecular weight range	200Da to 10MDa	1000Da to 10MDa	-
Minimum sample mass for light scattering (polystyrene)	100 ng	1 µg	-
Minimum samples mass for light scattering (BSA)	100 ng	1 µg	-
Software			
OMNISEC v10	✓	×	×
OmniSEC v5	×	✓	✓

OMNISEC SOFTWARE v10

Workflow oriented software

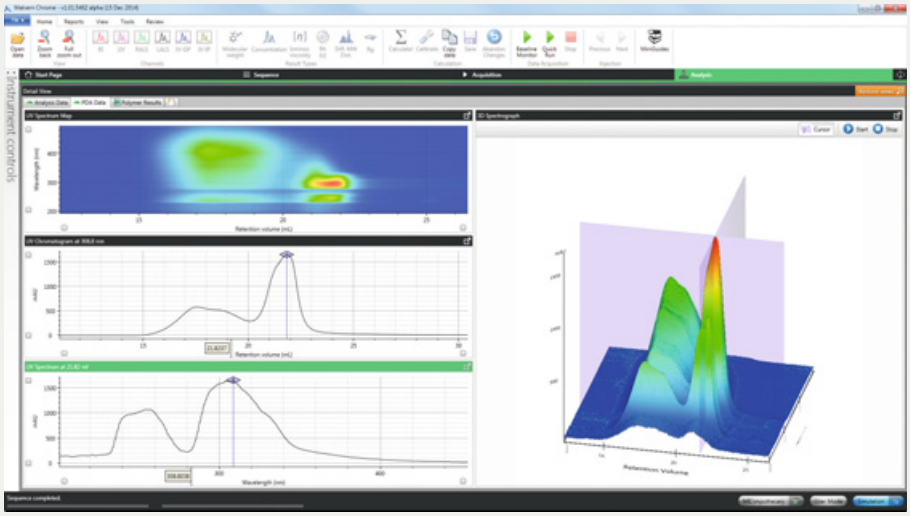
OMNISEC software v10 has been designed with you and your priorities in mind. It makes GPC/SEC analysis as easy and intuitive as possible. The software is laid out to guide the user through setup, data acquisition and analysis in an intuitive workflow.

The software's advanced user interface reduces training requirements for new users.



With OmniSEC software v10 you can:

- Determine molecular weight and molecular weight distribution by light scattering
- Calculate intrinsic viscosity, hydrodynamic radius and Mark-Houwink parameters
- Be sure of the most accurate results thanks to proven band-broadening corrections
- Overlay multiple chromatograms or results
- Reanalyze entire datasets in a few clicks
- Calculate dn/dc and dA/dc (extinction coefficient)
- View all the angular data from a MALS measurement in a single plot with just one click of the mouse



Software features

Key features that make multi-detector analysis more valuable than ever include:

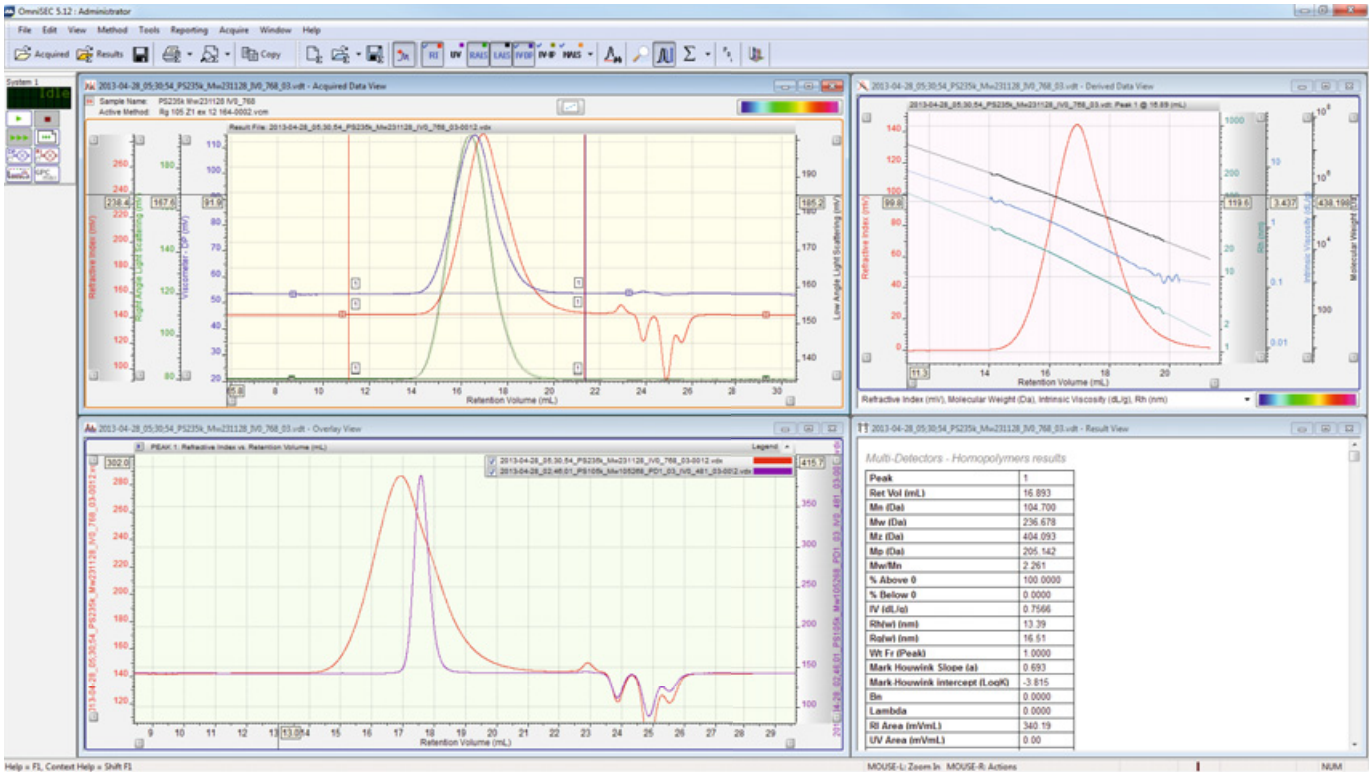
- Intuitive look and feel based upon the latest software tools
- Simple and customizable reporting to present only the data that is most important to you
- Overlay multiple injections and results quickly and easily
- Easy exporting of data
- 1-click from data to results!

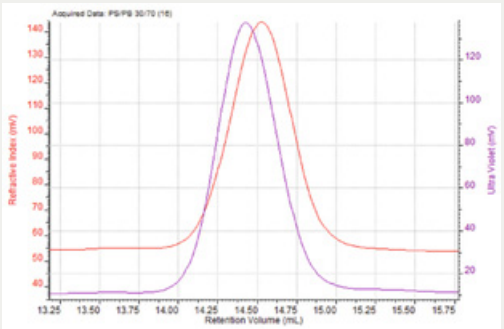
OMNISEC SOFTWARE v5

Control and analysis in a single package

OmniSEC software v5 is the GPC/SEC software package required for the Viscotek products.

With its clear user interface, OmniSEC software v5 is used to control Viscotek systems, acquire data from all Viscotek detectors and perform GPC/SEC data analysis.





By combining RI and UV signals from a copolymer or conjugated sample, the software can calculate the concentration of each component and then measure the complex molecular weight and composition.

In this way, these samples can be fully characterized. Such samples include:

- Styrene/butadiene copolymers
- Conjugated protein samples such as PEGylated or membrane proteins.

Malvern Instruments Limited
Grovewood Road, Malvern,
Worcestershire, UK, WR14 1XZ

Tel +44 1684 892456
Fax +44 1684 892789

www.malvern.com

MRK2039-04

Malvern Solutions: Advanced technology made simple - distributor details

Particular Sciences Ltd.
2 Birch House, Ballycoolin Road
Rosemount Business Park
Dublin, D11 T327, Ireland

phone: +353 (1) 8205395
e-mail: info@particular.ie
www.particularsciences.ie