# Malvern

Material relationships

MOLECULAR WEIGHT

MOLECULAR SIZE

MOLECULAR STRUCTURE

# VISCOTEK
# ADVANCED GPC/SEC
# DETECTORS

SETTING THE STANDARD

# WHAT CAN ADVANCED GPC/SEC DETECTION 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 independent of structure and sample retention time.

- 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 measurement and the Viscotek detectors' range includes various options.

The ultimate in advanced detection is the combination all of these detectors to get a complete understanding of the molecule being investigated.

# VISCOTEK DETECTORS
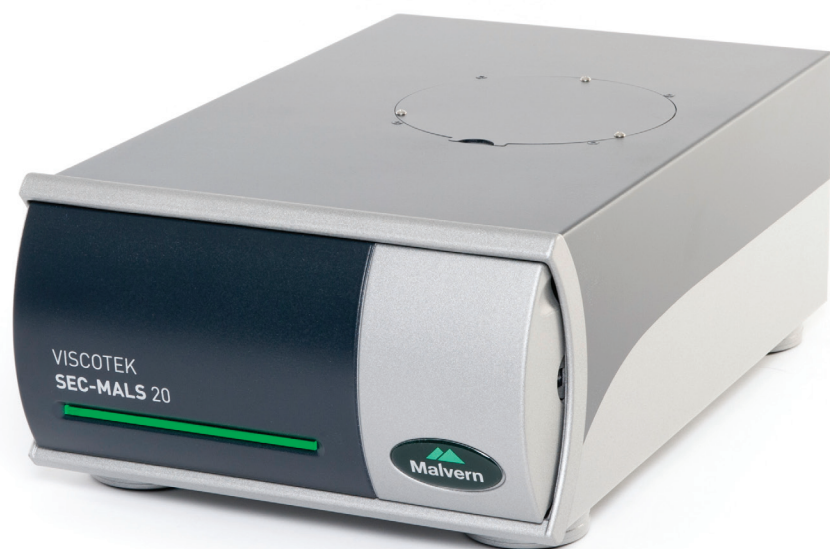
Through the innovative use of different measurement technologies, our detectors cover the full spectrum of GPC/SEC applications in the protein, polymer and polysaccharide characterization fields ensuring that we can offer a solution that gives you the highest result quality without compromise. Individually, or in combination, the Viscotek detector range can measure:

- **Absolute molecular weight**
- **Molecular weight distribution**
- **Polydispersity**
- **Intrinsic viscosity**
- **Mark-Houwink parameters**
- **Molecular size (Rh & Rg)**
- **Molecular structure**
- **Branching number and frequency**
- **Composition**
- **2nd virial coefficient $A_2$ ($B_{22}$)**

Viscotek detectors can be used to upgrade existing GPC/SEC systems to more advanced setups offering the full range of applications but without the expense of a complete new system.

Choice and versatility drive the Viscotek range and our goal is to provide an advanced detection solution tailored to your specific needs.

# SYNTHETIC AND NATURAL POLYMER APPLICATIONS

The physical properties of a synthetic polymer like polystyrene, or a natural polymer like hyaluronic acid are strongly dependent on its 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. Viscotek detectors make absolute measurements of these properties to cover a wide range of synthetic and natural polymer applications including:

- Polymer research
- Paints and coatings
- 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 TDA or the 270 Dual Detector.
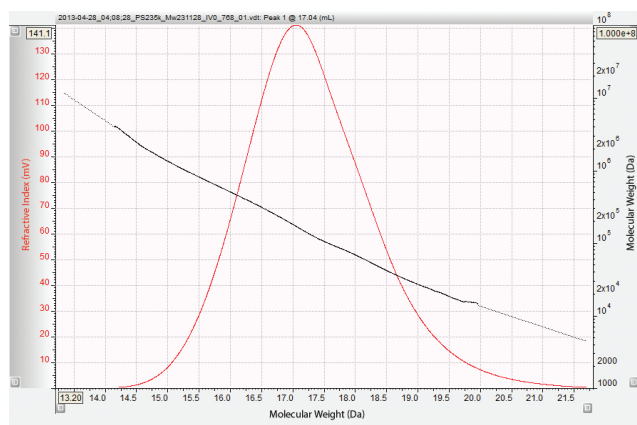


*Absolute molecular weight measured by light scattering overlaid on the RI chromatogram*
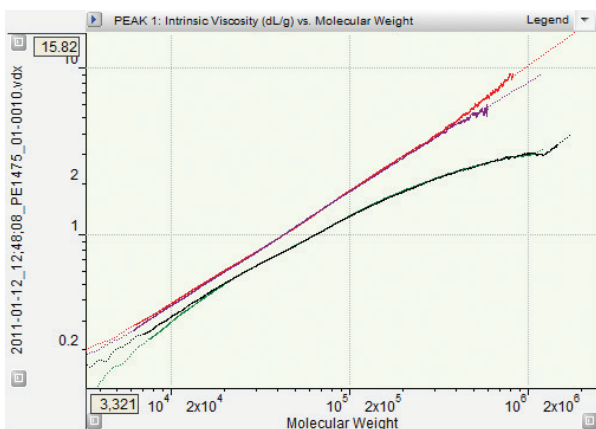


*Mark-Houwink plot of molecular weight vs intrinsic viscosity for polymer structural elucidation.*

# 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 help the protein scientist with all of these parameters, helping them to better understand the behavior of their protein of interest.
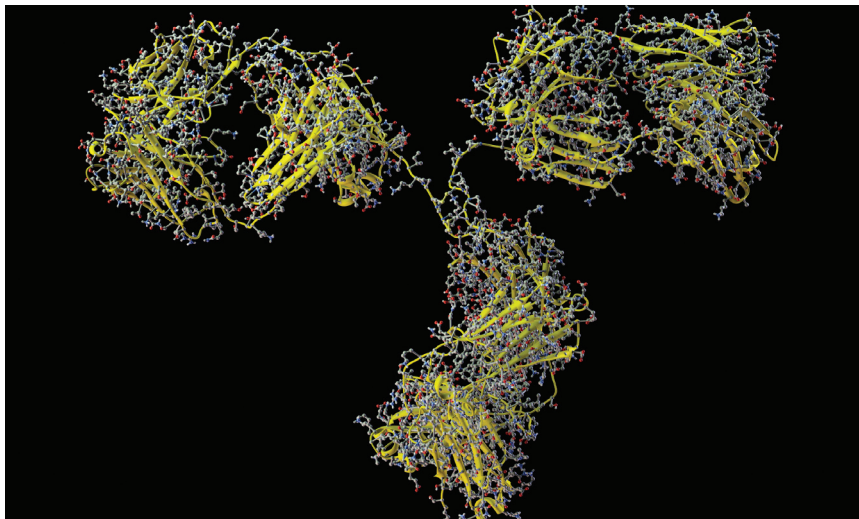


The molecular weight and size of a protein directly identifies its oligomeric state while polydispersity gives an indication of the purity of a sample peak.

**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 SEC-MALS 20, TDA or the Zetasizer µV.
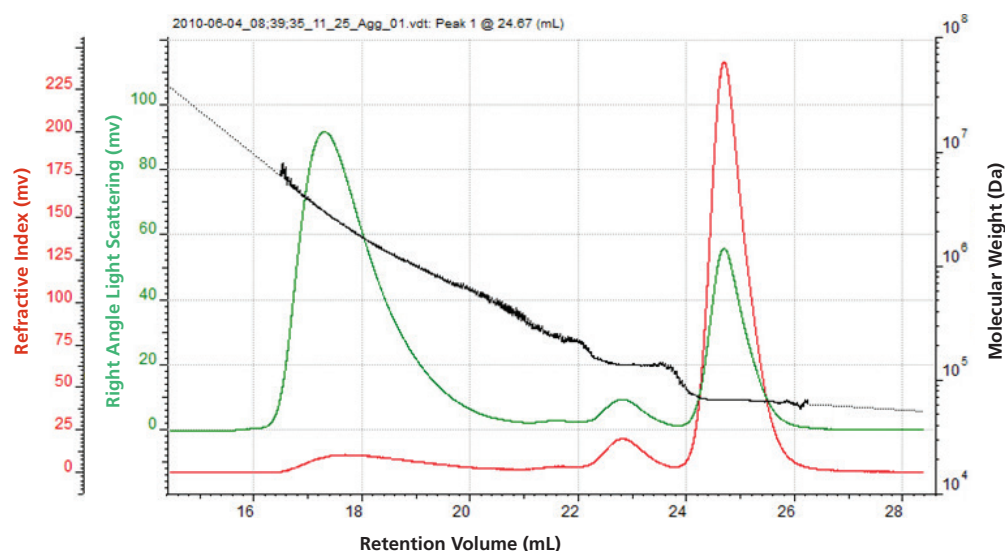


*Protein oligomers and aggregates shown by Right Angle Light Scattering (RALS) (green) and Refractive Index (RI) (red) chromatograms overlaid with the absolute molecular weight (black).*

# VISCOTEK **SEC-MALS 20**

Absolute Molecular Weight, Molecular Size

The SEC-MALS 20 is a modular multi-angle light scattering detector that can easily be combined with any existing GPC/SEC system, for direct measurements of absolute molecular weight and size.
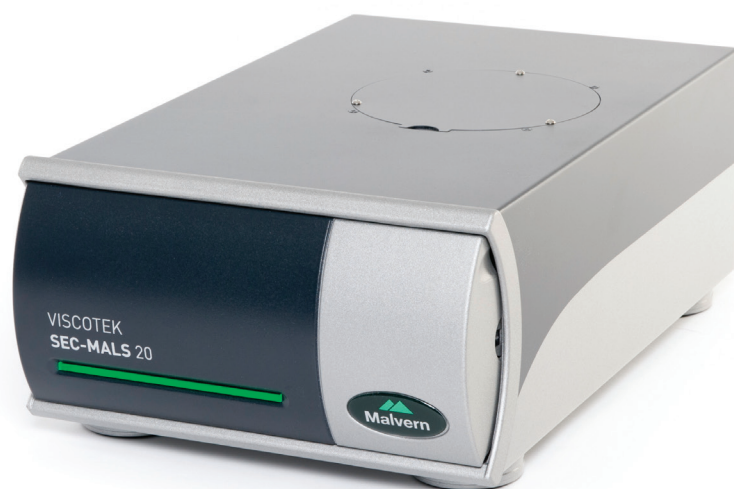
For proteins, the SEC-MALS 20 offers:

- 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)

- 2nd 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

- 2nd virial coefficient $A_2$ $(B_{22})$
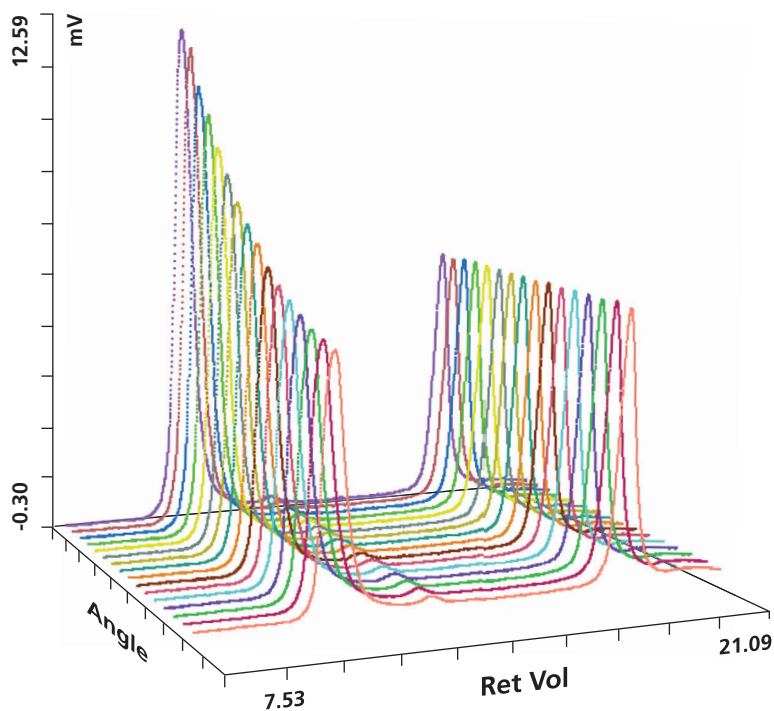


*MALS signals from an aggregated protein and monomer*

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.

# VISCOTEK **TDA**

Absolute Molecular Weight, Intrinsic Viscosity, Molecular Size, Concentration

The Viscotek TDA sets the standard for GPC/SEC technology and is the world's leading multi-detector platform. It uses 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
- 2nd virial coefficient, $A_2$ ($B_{22}$)
- Copolymer and conjugate composition (with the PDA)

The integrated platform has these advantages:

- All columns and detector cells are housed in a single temperature-controlled compartment (up to 80 °C) for maximum baseline stability and solvent range
- Inter-detector tubing is minimized reducing band broadening and tailing



*The TDA as part of a complete system*

# 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.
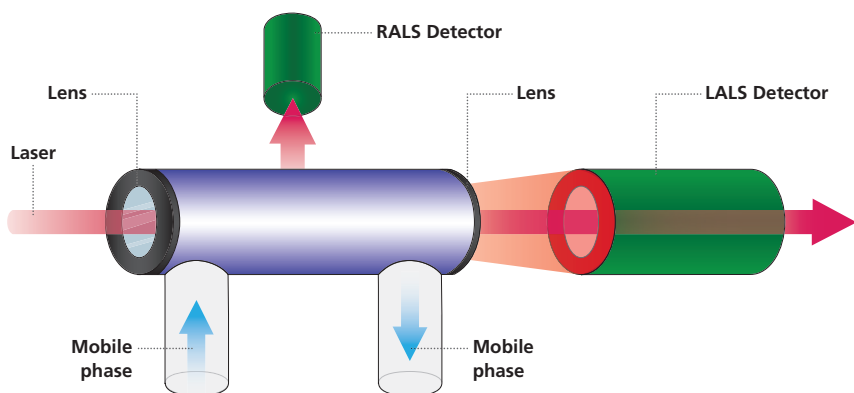


*A RALS/LALS detector*

The unique **light scattering detector** combines the sensitivity of 90° Right Angle Light Scattering (RALS) with the accuracy of 7° Low-Angle Light Scattering (LALS) to achieve the ultimate sensitivity and accuracy. 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 faster, more sensitive response to viscosity changes than older systems, and 316 stainless steel construction means few sample limitations with salts or pH.

# VISCOTEK **270 DUAL DETECTOR**

Absolute Molecular Weight, Intrinsic Viscosity, Molecular Size

The Viscotek 270 Dual Detector is an advanced detection module perfect for upgrading an existing GPC/SEC system to enable multi-detection. It adds light scattering and intrinsic viscosity detectors to a concentration detector, in order to measure:

• Absolute molecular weight

• Intrinsic viscosity

• Molecular size (Rh & Rg)

• Molecular structure/branching

• Mark-Houwink parameters

The modular platform can accept analog signals from a concentration detector and trigger signals from a manual injector or autosampler to fully integrate it into the existing system.
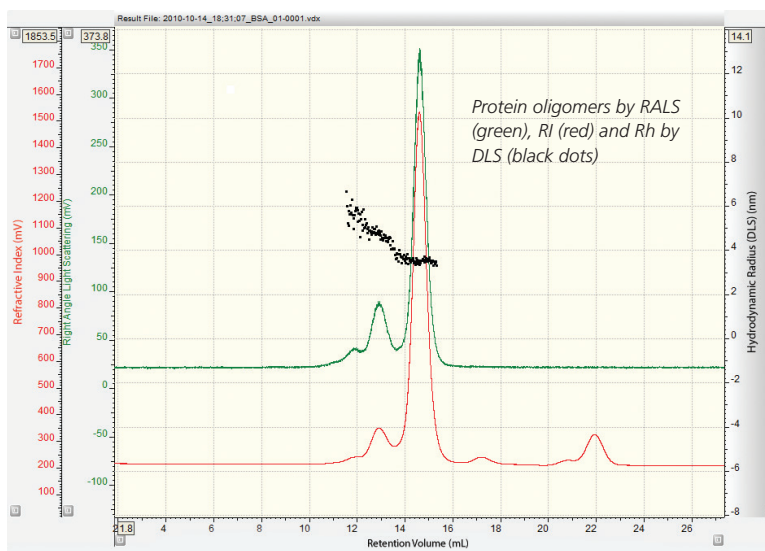
# ZETASIZER μV

Absolute Molecular Weight, Molecular Size

The dual capability Zetasizer μV offers unmatched versatility for protein analysis. It combines measurements of molecular weight by Static Light Scattering (SLS) with measurements of molecular size (Rh) by Dynamic Light Scattering (DLS). It can also perform both of these measurements in batch and GPC/SEC flow modes.

The detector is optimized for the measurement of smaller molecules that scatter less light, making it ideal for protein measurements.

## SEC Mode

In flow mode, as a modular SEC-DLS detector, the Zetasizer μV measures the intensity of scattered light from which is calculated the absolute molecular weight of small macromolecules like proteins. It can also continually collect correlation functions to make measurements of Rh by DLS at the same time. As a GPC/SEC detector, the Zetasizer μV can measure:

- Absolute molecular weight and oligomeric state
- Aggregation levels
- Molecular size (Rh)
- Conjugate composition and molecular weight (with RI & PDA)
- 2nd virial coefficient $A_2$ ($B_{22}$)



*Protein oligomers by RALS (green), RI (red) and Rh by DLS (black dots)*

*Chromatographic data from the Zetasizer μV in SEC mode*

## Batch Mode

In batch mode, using a cuvette, the Zetasizer μV can perform all of the DLS-based measurements you would expect from a Zetasizer instrument. Its temperature control allows you to perform the common temperature ramp, aggregation point, and stability experiments - all controlled using Malvern's Zetasizer software. In batch mode, the Zetasizer μV can measure:
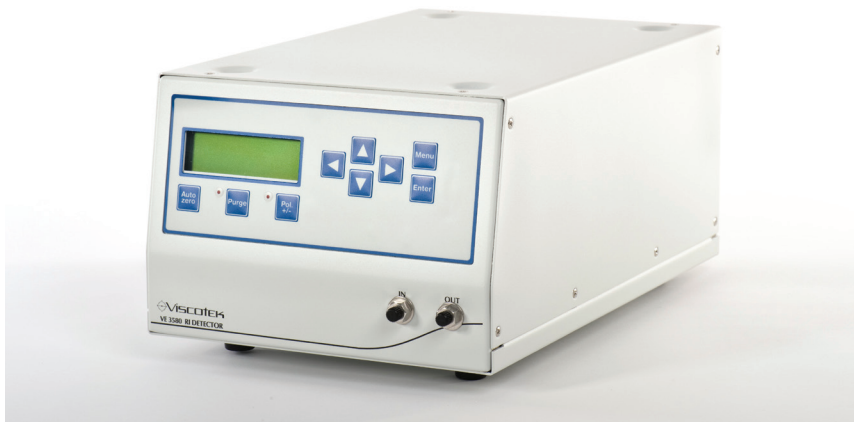
- Hydrodynamic radius
- Aggregate detection
- Aggregation temperature studies

*DLS data from the Zetasizer μV in batch mode*



*Typical protein size distributions*
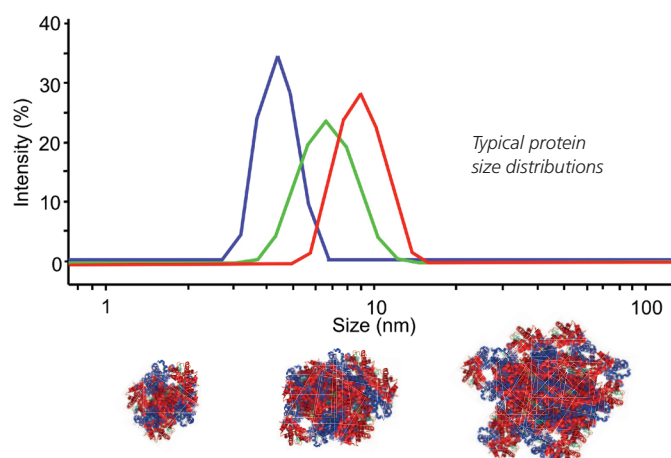
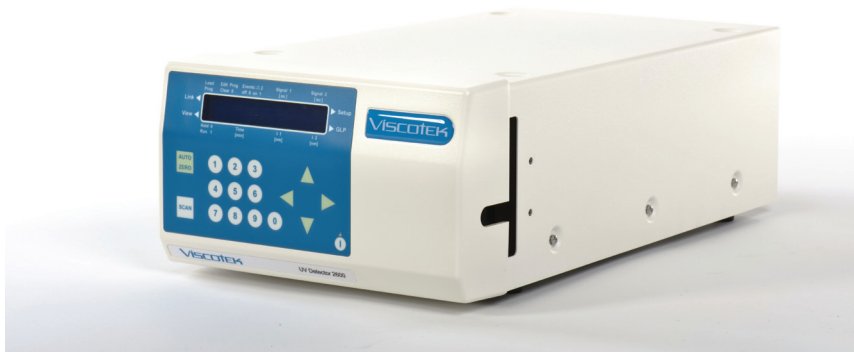# VISCOTEK **RI DETECTOR**
Concentration

A modular differential refractive index detector for the measurement of sample concentration during GPC/SEC experiments.

The detector can be temperature 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.

The system includes analog outputs of the measured signal and digital connections to a manual injector or autosampler to initiate data collection.
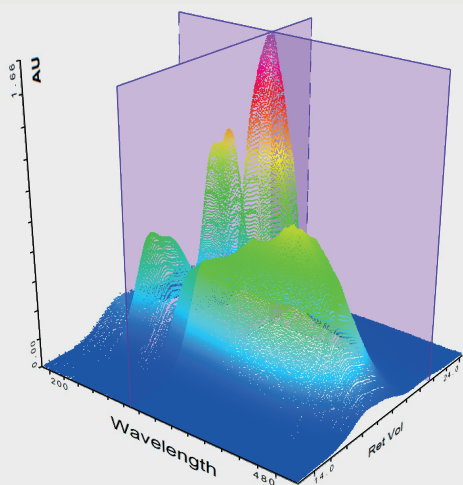
# VISCOTEK **PDA**
Concentration

The Viscotek PDA is a photodiode array detector for measuring the absorbance of ultraviolet (UV) light, covering the full UV spectrum from 190 nm – 510 nm.

A visible spectrum option is also available to measure 400 nm – 690 nm.

Fibre optic or stand-alone versions are available to allow integration into any system.

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

*Explore relationship of UV absorbance with wavelength and retention volume (or molecular weight) via powerful interactive 3D plot.*

# OMNI**SEC SOFTWARE**

Control and analysis in a single package

OmniSEC is the finest GPC/SEC software package available for both polymer and protein applications.

With its modern look and feel, and clear user interface, OmniSEC is used to control Viscotek systems, acquire data from all Viscotek detectors and perform at the very highest levels of GPC/SEC data analysis.

We are continually working to make our software packages the most usable and powerful available, and OmniSEC is no exception.
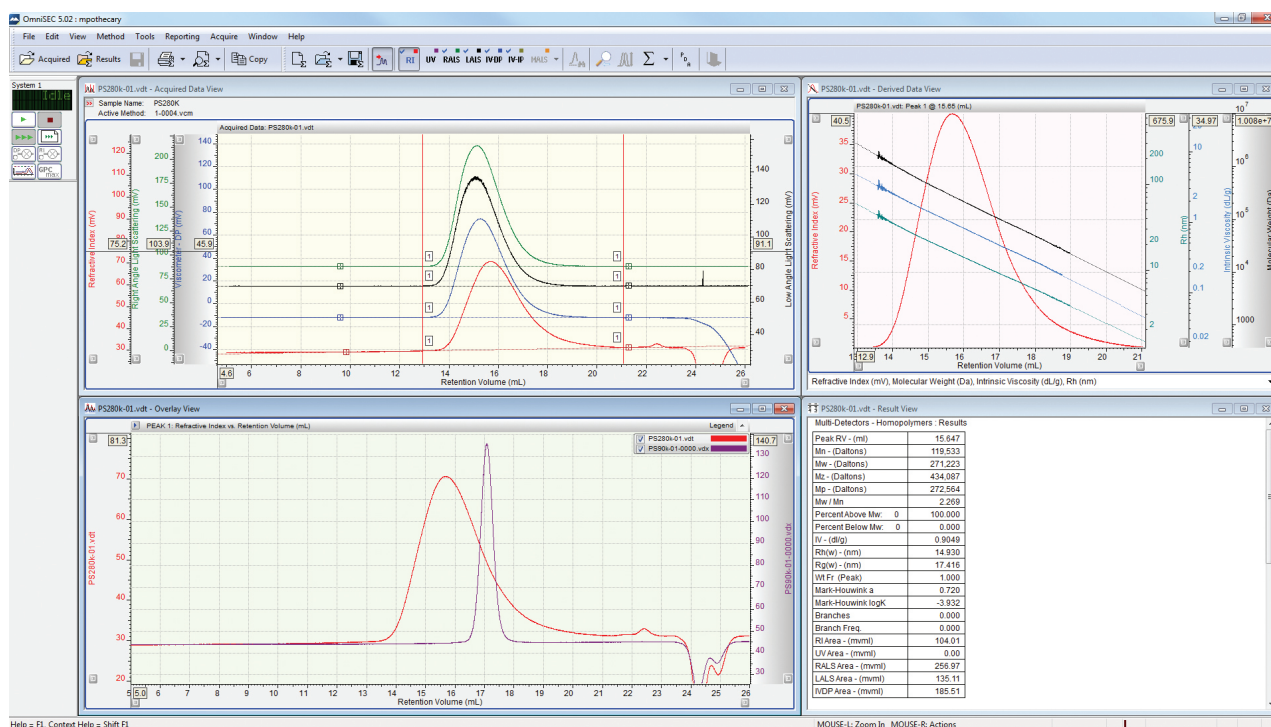


With OmniSEC you can:

- Measure molecular weight and molecular weight distribution by light scattering or by using the column calibration techniques of conventional and universal calibration

- Determine intrinsic viscosity and hydrodynamic radius, Mark-Houwink parameters and branching levels

- Be sure of the most accurate results thanks to proven band-broadening corrections

- Perform copolymer and conjugate calculations

- Overlay multiple chromatograms or results

- Reanalyze entire datasets in a few clicks using the Trend View

- Calculate dn/dc, dA/dc (extinction coefficient) and $A_2$ ($B_{22}$)

- View all the angular data from a MALS measurement in a single plot with just one click of the mouse

- Change analysis parameters and see the results update instantaneously

- Design custom reports using the easy-to-use report designer

# VISCOTEK MODULAR & INTEGRATED SYSTEMS

Complete GPC/SEC solutions

All of the Viscotek detectors in this brochure are available as individual modules to enhance your existing chromatography system, or as part of a complete Viscotek GPC/SEC system, offering exceptional flexibility.

The complete systems can be based on the integrated **TDA** platform, or on the modular **270, SEC-MALS 20** or **Zetasizer μV** detectors. Complete Viscotek systems have the advantage of being able to contain your entire application for validation and support. In addition, the entire system is controlled by one software package.

## The Viscotek system range includes:

- TDAmax - complete, temperature-controlled, triple-detector GPC/SEC system with RI, viscometer light scattering and optional PDA detector

- 270max - complete, cost-effective, modular triple-detector GPC/SEC system, with RI, viscometer and light scattering detectors

- RImax - complete, cost effective, modular, conventional calibration GPC/SEC system with RI detection

- HT-GPC – complete modular high temperature triple detector GPC/SEC system designed exclusively for the characterization of polyolefins at up to 160 °C

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