Cambridge Polymer Group

Molar Mass Measurements

Characterize Molecular Weight

Molar mass, otherwise known as the molecular weight, of a polymeric or biological material usually has a direct effect on its mechanical properties, thermal behavior, and viscosity characteristics. There are a variety of analytical techniques used to characterize molecular weight in polymers, each providing essential information about the influence of molar mass on the measured properties.

Why CPG for Your Molecular Weight?

CPG offers molecular weight analysis using GPC, Dilute Solution Viscometry, Melt Flow Index and Static Light Scattering. We will recommend the method most suited to your application. If you need to test a custom-synthesized or engineered polymer, we develop a method to characterize your material's molecular weight.

Materials Characterized for Molar Mass

Dextran	Hyaluronic Acid
Polyglycolic-co-Lactic Acid	Silicones
Polyurethanes	Acrylics
Polyols	Proteins
Polysaccharides	Polyolefins

Relevant Standards

ASTM D6474 Standard Test Method for Determining Molecular Weight Distribution and Molecular Weight Averages of Polyolefins by High Temperature Gel Permeation Chromatography

ASTM D5296 Standard Test Method for Molecular Weight Averages and Molecular Weight Distribution of Polystyrene by High Performance Size-Exclusion Chromatography

ASTM D445 Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

USP Monograph for Dextran 40/70

ASTM D1243 Standard Test Method for Dilute Solution Viscosity of Vinyl Chloride Polymers

ASTM D2857 Standard Practice for Dilute Solution Viscosity of Polymers

ASTM D4020 Standard Specification for Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials

ASTM D1238 Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer

Applications

- Lot-to-lot Comparison
- Degradation Analysis
- Quality Release
- Root Cause Analysis

Gel Permeation Chromatography

Gel Permeation Chromatography (GPC) is a commonly used technique for determination of molar mass. In GPC, a dilute solution of the analyte in question is prepared, using a solvent to ensure good dissolution of the analyte and expansion of the polymer chains in solution. The solution is injected into a packed column containing a distribution of pore sizes which separate the polymer chains by size. Exiting the column, the size-separated chains are effectively 'counted' by a detector according to their elution time from the column. This analysis allows the calculation of a molar mass distribution, along with molar mass moments (number-, weight-, and z-averaged molar masses). CPG can perform conventional organic analysis, aqueous analysis, room temperature, and elevated temperature GPC, using multiple detectors for triple detection analysis as well as universal calibration. We test a variety of polymers and biological materials.

Static Light Scattering

If suitable GPC conditions cannot be found (e.g., preventing column packing interaction), absolute Mw can be measured by SLS. SLS does not separate a polymer by size; instead, SLS measures Mw of the bulk polymer (no distribution, just a single value). How a dilute polymer scatters light is directly proportional to the molar mass. Since the scattering intensity is sensitive to mean size (i.e., radius of gyration) of the polymer, the SLS measurement provides the mass-average molar mass, Mw. Classic polymer characterization used SLS for Mw, osmometry for Mn, and capillary viscometry for Mv, so combining these single value measurements gives a sense of the distribution, e.g., Mw/Mn which is the dispersity—a measure of distribution broadness.

Melt Flow Index

MFI is perhaps the most commonly reported parameter relating to molar mass for thermoplastics, as it requires no solvents, and is directly relatable to melt processing behavior. The solid resin is placed into a heated capillary and extruded through the die at the end of the capillary under the influence of a specific weight on the plunger pushing the molten resin through the capillary. The mass of material extruded in a given amount of time is measured and reported as the MFI under those test conditions (temperature and mass). The MFI can be correlated to the viscosity-averaged molar mass.

Dilute Solution Viscometry

In viscometry, a dilute polymer solution is allowed to flow through a fine capillary in a viscometer, and the flow time is measured relative to the flow time of the neat solvent. The results are normally reported in terms of relative or inherent viscosity. If a series of concentrations are measured, the intrinsic viscosity can be calculated (the viscosity extrapolated to zero concentration), which can then be used to determine a viscosity-averaged molecular weight using Mark-Houwink parameters for the polymer-solvent system used.

Cambridge Polymer Group, Inc. is a contract research laboratory specializing in materials. We partner with our clients to solve the world's toughest polymer problems utilizing our multi-disciplinary research team and full service laboratory.

We work with clients throughout the product life cycle to:

- Develop new materials
- Design prototypes for proof-of-concept studies
- Create and execute experimental design
- Validate and verify manufacturing processes
- Perform root-cause analysis in product failures

Cambridge Polymer Group, Inc. was founded in 1996 to provide a cost-effective resource for testing, research and development to clients who need periodic access to Ph.D.-level scientists and their support structure. We have developed a host of testing methods and materials for our clients, which number more than 1,000.

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