

## Polymer Weight Characterisation

Smithers Rapra provides a high quality Gel Permeation Chromatography (GPC) service for molecular weight characterisation of plastics and other polymers. As one of the world leading suppliers of GPC Characterisation, considerable investment has been made in the latest technological advancements and the service now operates from a recently refurbished laboratory with vastly experienced consultants.

After polymer type, the molecular weight distribution is the next most important property of a plastic or rubber. A higher molecular weight usually gives stronger physical properties but can be harder to process. GPC is the most widely used and cost effective method of comparing the molecular weight distribution of rubber, plastics and other polymers.

### The Benefits of Utilising GPC

GPC is recognised as a useful aid in the study of polymer degradation or as part of a quality control system of polymer production or processing. The GPC process can also provide information to assist in material or product failure analysis and can establish if the polymer molecular weight was suitable to the processing and the application of the material.

Problems associated with polymer processing can occur if there is a change in the molecular weight distribution of the raw material. A "new" or "similar" material may offer a fundamental improvement but the processing conditions may need to match the change in raw material. In failure analysis, comparison of the molecular weight distribution for a "Good product" compared to a

"Failed product" and likewise "Raw material for a proven product" and "Raw material for a failed product".

A standard GPC process is usually the best approach to comparing the molecular weight distribution of polymers known to be of the same chemical type and structure (chain branching). If the samples are believed to be of a different chemical type or a comparison of chain branching is required, Triple Detection GPC or combined GPC-Viscosity may deliver greater accuracy. The best approach to your issue and the type of GPC analysis required will be discussed with you by your Smithers Rapra consultant.

A variety of approaches to GPC exist and through consultation Smithers Rapra will advise you on the method most applicable to your individual needs. The options are;

- Conventional or Triple detection GPC with solvents such as THF and Chloroform.
- Conventional or Triple detection GPC with aqueous based eluents
- High temperature GPC with a range of phenolic and polar solvents
- GPC with HFIP as the solvent



## Conventional GPC Analysis

Conventional GPC is available using all of the solvent based systems and uses the response from the refractive index (concentration) detector alone and the comparative molecular weight data is obtained via a molecular weight log versus retention time calibration. The various organic solvent systems are normally calibrated with poly(styrene) or poly(methyl methacrylate), the results are expressed as the PS/PMMA equivalent molecular weights. For some common polymer types, a mathematical correction might be applied to express the results as for a specific polymer.

GPC with HFIP as the solvent is aimed specifically at the molecular weight characterisation of polyamides and polyesters such as PET or PBT. Utilising HFIP has been found to be appropriate for other difficult and complex polymer types including PEBAX and acetals.

## Triple Detection and GPC Viscosity

Triple detection (light scattering, viscosity and refractive index) is available for near ambient GPC with tetrahydrofuran and chloroform. Other solvents suitable for use at near ambient conditions can also be considered. GPC-viscosity is available for the high temperature GPC analysis of polyolefins.

Light scattering and or viscosity detection are often used to provide the true molecular weight data of plastic and other polymer samples as opposed to expressing them as "equivalent" molecular weights or applying a possible questionable mathematical correction. These approaches are valuable in providing information on the differences in structure or composition between samples.

Triple detection GPC is not appropriate for low molecular weight polymer.

## High Temperature GPC

Conventional or combined GPC-viscosity is carried out in conditions applicable to polyolefins (1,2,4-trichlorobenzene at 160 °C) and conventional high temperature GPC is carried out using a range of polar solvents for polar polymer types or phenolic solvents for various engineering polymers. One of the most applicable applications is using phenol/trichlorobenzene at 115 °C for the analysis of PEEK.

## Data Handling

Smithers Rapra use "Cirrus" software from Polymer laboratories which provides clear and concise graphical presentation of results to support the calculated numeric molecular weight averages.



**Smithers Rapra Technology Limited**  
Shawbury, Shrewsbury  
Shropshire, SY4 4NR  
United Kingdom

**T:** +44 (0)1939 250383  
**F:** +44 (0)1939 251118  
**E:** [info@rapra.net](mailto:info@rapra.net)  
**W:** [www.rapra.net](http://www.rapra.net)

**SMITHERS**  
**rapra**