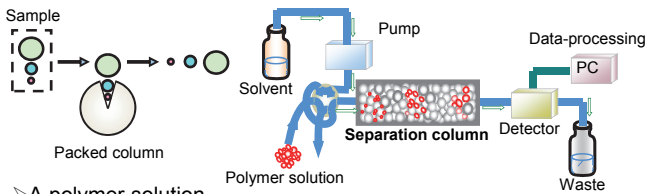


The technical progress of measurement of molecular weight distribution of polymers

Using Gel Permeation Chromatography (GPC), the average molecular weight (MW) and the molecular weight distribution (MWD) of polymers can be obtained. Multi-detector GPC enables us to obtain not only MW but also chemical composition, molecular size, intrinsic viscosity.

Principle and feature of GPC



- A polymer solution sample injected into a packed column is separated according to the hydrodynamic volume of polymers.
- Larger polymers are eluted faster.
- One of the HPLC
- Only soluble polymer can be measured
- Multi detector enables to obtain various information.
- Measurable under high temperature (max. 210° C)

Technical progress of GPC

-Detectors (hyphenation technology)

...UV, LS, VISCO, IR

-Measurement of poorly-soluble polymer

...Development of high-temperature GPC, dissolution by specialty solvent or pretreatment

-Column

...Improvement of resolution, downsizing, applicable range of MW

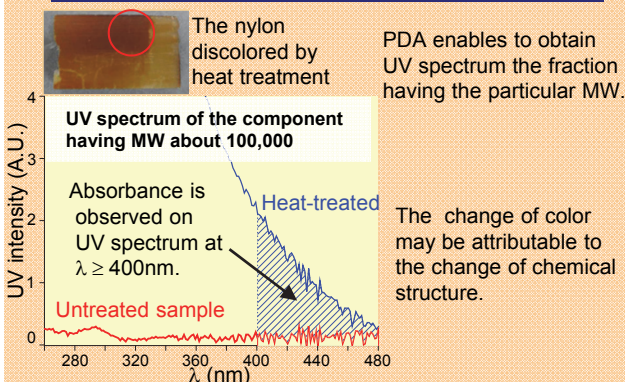
Representative detectors applied to GPC

Detector	Aspects	Obtainable characteristic Values
Differential Refractive Index (RI)	<ul style="list-style-type: none"> ☉ Detectable if refractive index is different between solvent and samples ☉ Relatively accurate concentration ☹ Lower sensitivity than other detectors 	Relative MW, MWD
Evaporative Light Scattering (ELS)	<ul style="list-style-type: none"> ☉ Higher sensitivity than RI ☉ Detectable if samples have no UV absorbance ☉ Sensitivity depends on MW 	Relative MW, MWD
Photo Diode Array (PDA)	<ul style="list-style-type: none"> ☉ Higher sensitivity than RI ☉ Applicable to only samples with UV absorbance 	UV spectrum, relative MW, MWD
Multi-Angle Laser Light Scattering (MALS)	<ul style="list-style-type: none"> • Mainly used with RI ☉ more sensitive to higher MW sample 	Absolute MW, MWD, molecular size
Differential Viscometry (VISCO)	<ul style="list-style-type: none"> • Mainly used with RI ☉ More informative by coupling with MALS (molecular size, Mark-Houwink plot, etc.) 	Intrinsic viscosity $[\eta]$

Application to poorly-soluble polymers

Engineering plastic (i.e. PPS, PEEK, LCP), polyolefin (PE, PP), biomass (α -cellulose, lignin), fluorinated electrolyte membrane

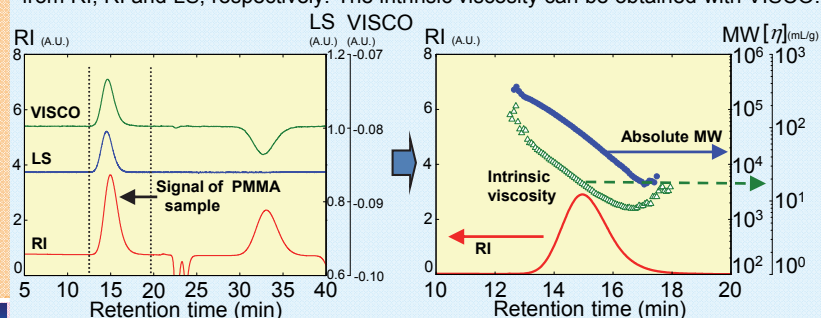
Degradation Analysis of Polymer —GPC-UV-RI of discolored nylon—



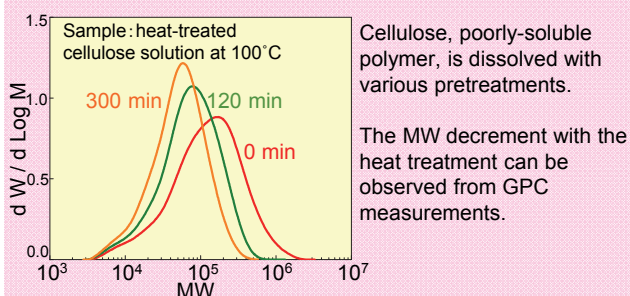
GPC-MALS-VISCO

GPC-MALS-VISCO measurement for PMMA

The concentration, the MW of the fraction separated in column can be determined from RI, RI and LS, respectively. The intrinsic viscosity can be obtained with VISCO.

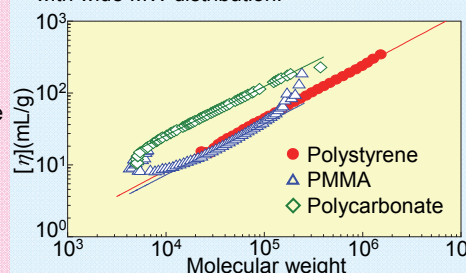


GPC of poorly-soluble polymer —Change of MW of cellulose by heat-treatment—



Mark-Houwink plot

The Mark-Houwink plot can be obtained using GPC-MALS-VISCO for a polymer with wide MW distribution.



The Mark-Houwink plot showing the relationship between MW and $[\eta]$ is specific for a polymer.

The flexibility of a polymer chain, the affinity between a polymer and a solvent, the branching ratio, and etc. can be estimated from the MW dependence of $[\eta]$.