What can be obtained using GPC except the molecular weight?
– molecular size, branch, composition distribution –

Gel Permeation Chromatography (GPC) / Size Exclusion Chromatography (SEC) is the powerful tool to obtain molecular weight distribution and estimate values of average molecular weight. Additionally, combined use of various detectors (e.g., DLS, MALS, VISCO) enables to obtain the molecular size in solution and estimate the branching ratio, analyze the composition distribution of copolymer.

Feature of the equipments

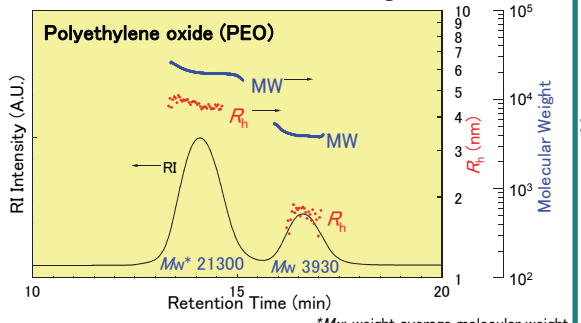
Equipment	Obtainable characteristics
GPC–MALS–DLS (**M**ulti **A**ngle **L**ight **S**cattering detector – **D**ynamic **L**ight **S**cattering detector) ※DLS equipment can be applied for batch tests.	➢Absolute molecular weight ➢R_g (radius of gyration) ➢R_h (hydrodynamic radius)
GPC/FT–IR (Infrared spectrophotometer)	➢Fractionation and identification for components of a mixture ➢Composition distribution
GPC–MALS–VISCO (**M**ulti **A**ngle **L**ight **S**cattering detector – **Visco**meter)	➢Absolute molecular weight ➢R_g、R_h ➢$[\eta]$ (Intrinsic viscosity) ➢Branching ratio

Estimation of the molecular size using DLS

✓ R_h (larger than ca.1nm) can be estimated.

Flow-type (GPC–MALS–DLS)

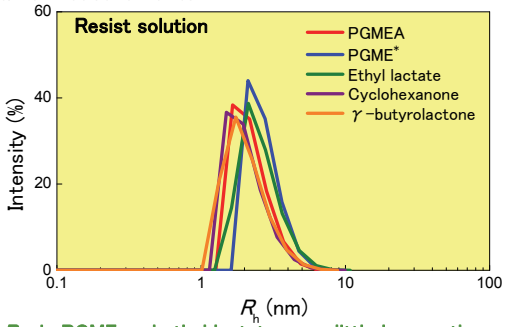
☺ R_h and weight fraction of different components can be obtained with the fractionation using GPC.



*M_w: weight average molecular weight

Batch-type DLS

☺ R_h can be estimated in various solutions (e.g., solvent, pH, concentration of a polymer, ion strength) unlike the GPC measurements.



As R_hs in PGME and ethyl lactate are a little larger , these solvents may be evaluated to be good solvents.

*PGME: 1-methoxy-2-propanol

Characterization of a branched polymer using GPC–MALS–VISCO

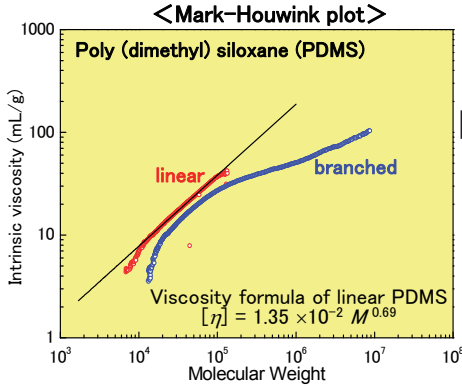
✓ Intrinsic viscosity, R_h, and the Mark–Houwink plot can be obtained.

✓ Branching analysis can be performed in comparison of a linear reference of the same polymer.

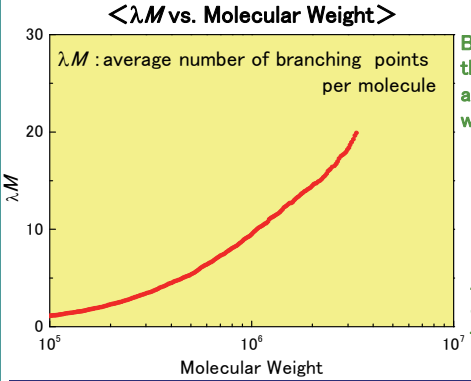
$[\eta]$ can be calculated from the specific viscosity at every fraction of molecular weight using the viscometer.

The Mark–Houwink plot showing the relationship between $[\eta]$ and M can be obtained.

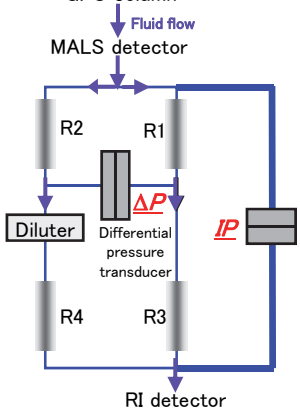
<Mark–Houwink plot>



<λM vs. Molecular Weight>



Schematic diagram of a capillary viscometer



IP: differential pressure between inlet and outlet of viscometer

Δ*P* : differential pressure across the capillaries

R1～R4 : capillary

Branching ratio g^b is expressed as the ratio of $[\eta]$ for a branched and a linear with the same molecular weight.

$$g^b = \frac{[\eta]_{br}}{[\eta]_l}$$

$[\eta]_{br}$: branched

$[\eta]_l$: linear

b = 0.5 (star)

b = 1.5 (comb, random)

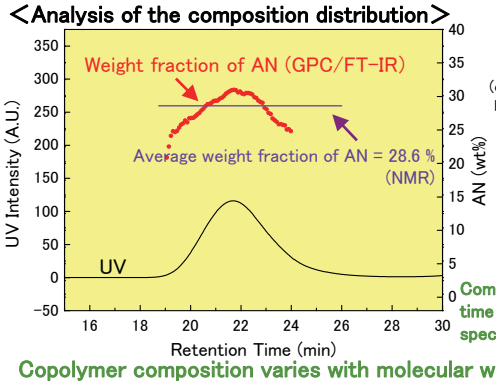
Assuming b = 1.5, λM is calculated on the random, tetra-functional polydisperse model.

Analysis of composition distribution using GPC/FT–IR

✓FT-IR spectra can be obtained at every fraction of retention time.

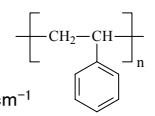
✓Each components can be identified to analyze the composition distribution.

<Analysis of the composition distribution>

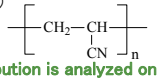


Styrene/acrylonitrile (ST/AN) copolymer
(AN = 30 % on a catalogue)

ST: 698 cm^{-1}
(out of plane deformation vibration of benzene ring)



AN: 2242 cm^{-1}
(Nitrile group)



Composition distribution is analyzed on time dependence of the particular spectral intensity of components.

Copolymer composition varies with molecular weight.