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Application News

High Performance Liquid Chromatograph Nexera™ GPC System

GPC Analysis of Synthetic Resin Containers Composed Mainly of Polylactic Acid

Natsuki Iwata

User Benefits

- GPC analysis of synthetic resin containers with polylactic acid (PLA) as the main component can be achieved.
- Using a mixed gel column reduces analysis time and eluent consumption.

■ Introduction

Gel permeation chromatography (GPC) analysis using a refractive index detector is widely used to measure the molecular weight distribution of synthetic polymers such as biodegradable plastics. In GPC analysis, the longer the column length, the better the separation, but the longer analysis time increases in proportion to the length, and eluent consumption is higher.

When analyzing samples with a wide range of molecular weights, multiple analytical columns covering the full molecular weight range are typically used. Mixed gel columns, on the other hand, are designed to cover a wide range of molecular weights. Using these enables analysis time and eluent consumption to be reduced.

This article describes the analysis of a cup containing PLA as its main component using a Nexera GPC system and a Shodex GPC KF-805L column with a linear calibration curve.

■ Analyses of PLA Cup

Biodegradable plastics are generally defined as plastics that have the same durability as normal plastics but that are completely decomposed into carbon dioxide and water by the action of naturally occurring microorganisms after use. Among them is PLA, a sustainable material made from plant-derived starch and sugar.

The sample was a commercially available PLA cup. Fig. 1 shows the chromatogram of the PLA cup (0.2 %, prepared with eluent), and Table 1 shows the analytical conditions. The GPC KF-805L column is shipped in tetrahydrofuran (THF) as the solvent, which was replaced with chloroform for the analysis. Refer to [Notes] on the next page for the replacement method.

Table 1 Analytical Conditions

System:	Nexera GPC
Column:	Shodex GPC KF-805L (300 mm×8.0 mm I.D.)
Flowrate:	1.0 mL/min
Mobile Phase:	Chloroform
Column Temp.:	40 °C
Sample:	0.2 % PLA solution
Injection Volume:	50 µL
Vial:	SHIMADZU LabTotal™ for LC 1.5 mL, Glass*1
Detection:	Refractive index (RID-20A) Cell temp. 40 °C

*1 P/N: 227-34001-01

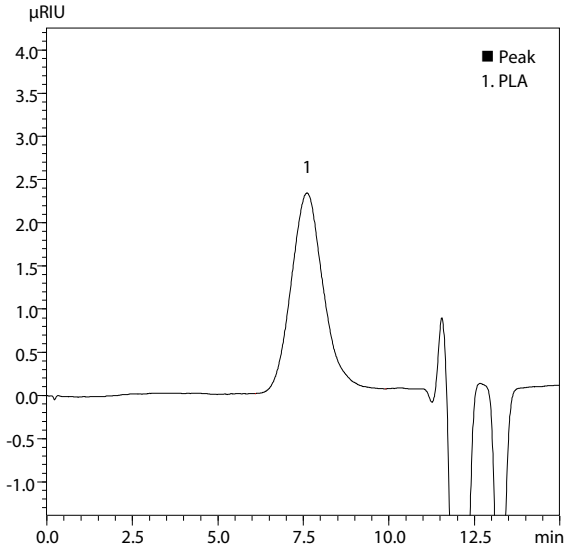

Fig. 1 Chromatogram of PLA Cup

■ Calibration Curve

Polystyrene reference markers were used to create a calibration curve for molecular weights ranging from 580 to 3,730,000. Fig. 2 shows the calibration curve. Shimadzu's LabSolutions™ GPC optional software was used for data analysis.

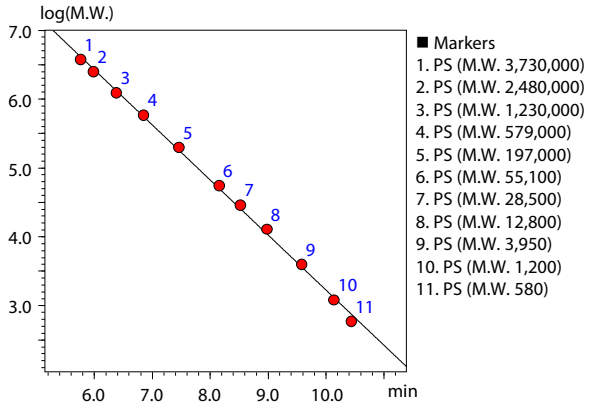

Fig. 2 Calibration Curve

■ Molecular Weight Distribution

The molecular weight distribution of the PLA cup analyzed under the analytical conditions shown in Table 1 was calculated. Table 2 shows the number average molecular weight (Mn), weight average molecular weight (Mw), and molecular weight distribution (polydispersity: Mw/Mn). These calculation results are polystyrene-equivalent molecular weights.

The sample used in this investigation has a wide molecular weight distribution, ranging from 2,000 to 2.3 million, therefore multiple analytical columns for low and high molecular weight analyses would normally be connected in series when analyzing with general-purpose GPC columns. In comparison, the GPC KF-805L column used in this investigation can cover this molecular weight range with a single column, reducing both the analysis time and eluent consumption by 50 %.

Table 2 GPC Calculation Results

Mn	Mw	Mw/Mn
81,900	179,600	2.19

■ Conclusion

GPC analysis was performed on a synthetic resin container made mainly of PLA. When analyzing samples with a wide range of molecular weights, from low to high molecular weight, a mixed gel column was able to reduce both analysis time and eluent consumption.

[Notes]

- Stainless steel parts were used for the piping and fittings downstream from the column outlet.
- An automatic rinsing kit of solvent delivery pump was not used.
- The shipping solvent for the GPC KF-805L column is THF. When replacing THF with chloroform, follow the procedure below.

1. Warm the column while flowing THF at a rate less than half the normal flowrate.
2. Flow 45-75 mL of a 1: 1 mixture of THF and chloroform.
   Flowrate: less than half of the normal flowrate
   Column temp.: warm
3. Flow 45-75 mL of chloroform.
   Flowrate: less than half of the normal flowrate
   Column temp.: warm
4. Change the flowrate and column temperature to the analytical conditions, and start the analysis when the baseline stabilizes.

- For more information, please contact SHOWA DENKO K.K, the manufacturer of the KF-805L column.

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