Application Brief

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Characterization of Polyethylene with GPC/SEC

Authors

Peter Montag and
Jasmin Preis
Agilent Technologies, Inc.

Abstract

High-temperature GPC/SEC with Agilent POLEFIN columns in 1,2,4-trichlorobenzene (TCB) was used for the characterization of polyethylenes.

Introduction

Polyolefins, especially polyethylene (PE) and polypropylene (PP), are the most common polymers on the market (representing more than 50%). Known as a packing material, the variety of polyolefin products is even broader. For example, ultrahigh molecular weight polyethylene (UHMWPE) is used for artificial hip joints.[1,2]

Recently, recycling of polyolefins has become more important. For understanding differences in materials and their macroscopic behavior, characterization with GPC/SEC is essential. In particular, the comparison between new and recycled material is a task for the future.[3]

For GPC/SEC characterization of polyolefins, high-temperature (HT)-GPC/SEC is typically used. Most polyolefins are only soluble at higher temperatures (e.g. 160 °C is used with TCB).

Starting from an investigation of molar mass distribution up to structure analysis (long-chain branching, short-chain branching, and copolymer analysis), GPC/SEC is a very powerful tool. However, the behavior of recycled material depends not only on molar mass, but also on structure (HDPE, LDPE, or LLDPE, oxidization of polymers, and much more).

Experimental

Table 1. Instrument and sample conditions.

	Conditions
Pump	Isocratic pump Flow rate: 1 mL/min Mobile phase: 1,2,4-trichlorobenzene
Injection System	Autosampler Injection volume: 200 µL
Columns	POLEFIN 20 µm precolumn, 8 × 50 mm (p/n POA080520) POLEFIN 20 µm linear XL, 8 × 300 mm (p/n POA083020LXL) POLEFIN 20 µm linear XL, 8 × 300 mm (p/n POA083020LXL) POLEFIN 20 µm linear XL, 8 × 300 mm (p/n POA083020LXL) POLEFIN 20 µm linear XL, 8 × 300 mm (p/n POA083020LXL)
Temperature	160 °C
Sample Concentration	2 to 3 mg/mL
Detectors	Infrared detector (IR) detector
Software	Agilent WinGPC

Results and discussion

Various PE samples were analyzed using high-temperature GPC/SEC in TCB with a set of four POLEFIN 20 µm linear XL columns in combination with a 20 µm POLEFIN guard column. This column set shows a good resolution over a wide separation range, starting from a couple of hundred Daltons up to ultrahigh molecular weights.

In Figure 1, an overlay of different PE samples is shown. Oligomeric PEs with a molecular weight below 1,000 Da are shown to be well separated.

The corresponding molecular weight distribution (MWD) based on conventional calibration with PE reference materials is shown in Figure 2.

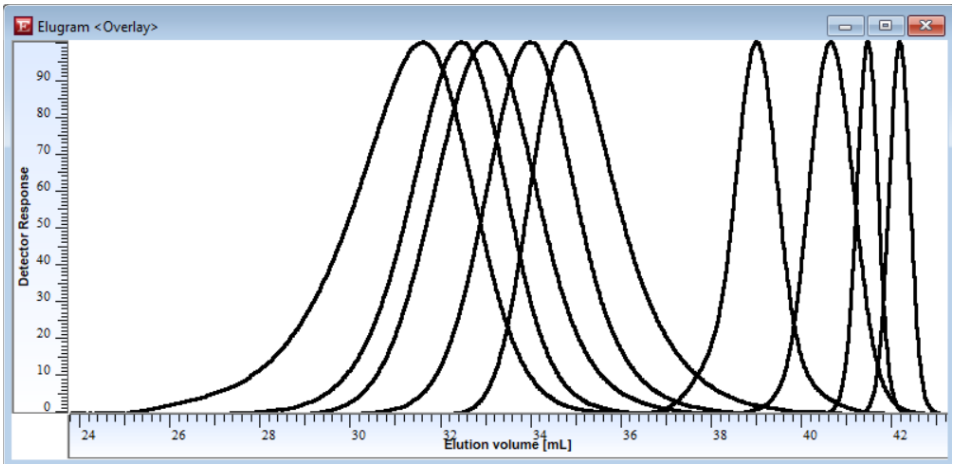

Figure 1. Overlay of nine different PE samples (IR-traces, normalized detector response).

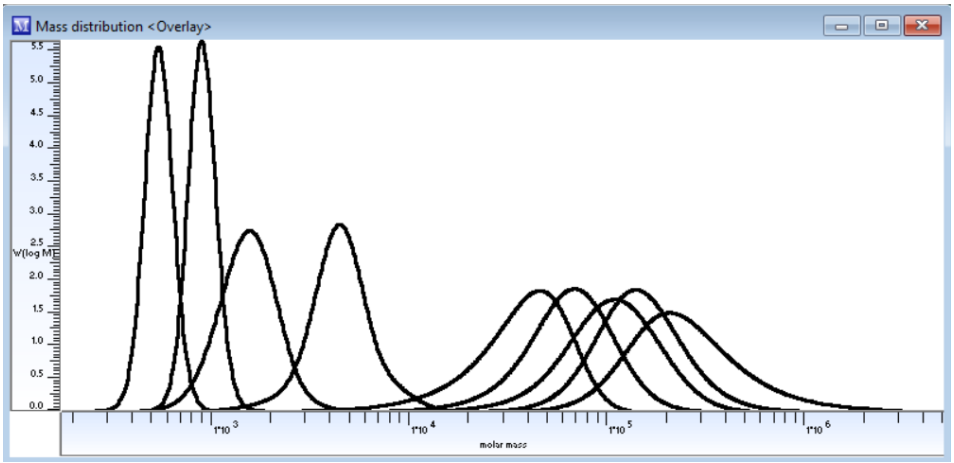

Figure 2. Overlay of the molecular weight distribution (based on calibration with PE reference materials).

Conclusion

The use of Agilent POLEFIN columns together with an HT-GPC/SEC instrument in TCB at a temperature of 160 °C allows the robust and reliable GPC/SEC analysis of polyolefins such as PEs.

References

1. Peacock, A. J. Handbook of Polyethylene, Marcel Dekker, Inc., **2000**.
2. Pezzotti, G.; Yamamoto, K. Artific ial Hip Joints: The Biomaterials Challenge. *J. Mech. Behav. Biomed. Mater*. **2014**, *31*, 3–20.
3. Schyns, Z. O. G.; Shaver, M. P. Mechanical Recycling of Packaging Plastics: A Review. *Macromolecular Rapid Communication*, **2021**, *42(3)*, 2000415.

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