Application Brief

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Characterization of Polysulfone and Polyethersulfone with GPC/SEC

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Abstract

This application brief shows the determination of the molar mass distribution of two technically important polymers, polysulfone (PSU) and polyethersulfone (PES). GPC/SEC is a well-known technique for assessing the molecular weight distribution of polymers, a property that influences many physical characteristics of the polymeric materials.

Introduction

Polysulfone (PSU) is an amorphous aromatic polymer and belongs to a class of high-performance polymers, showing extraordinary properties such as temperature stability, high distortion-temperature stiffness, chemical resistance, electrical performance, flame retardancy, and toughness. The properties of step-growth-polymerization-made polymers strongly depend on the molar mass and the molar mass distribution.[1,2]

Due to its outstanding properties, PSU belongs to a family of biomaterials used for production of mechanical- and temperature-stable membranes. Its superior fire retardant (low smoke and thermal emissions) properties enable PSU to be used in aircraft, for example. For some applications, PSU needs to be more meltable. In these cases, artificial softening is introduced based on an ether linkage group. These polymers are a subclass of PSU and are called polyethersulfones (PES). The superior PSU properties remain constant, but the PES are less stiff, and show a lower glass transition temperature (Tg) and melting viscosity.

Experimental

Table 1. Instrument and sample conditions.

	Conditions
Pump	Isocratic pump Flow rate: 1 mL/min Mobile phase: dimethylacetamide, lithium bromide 5 g/L
Injection System	Autosampler Injection volume: 50 µL
Columns	GRAM high MW combination: GRAM 10 µm precolumn, 8 × 50 mm (p/n AMA080510) GRAM 10 µm 100 Å, 8 × 300 mm (p/n AMA0830101e2) 2 × GRAM 10 µm 3,000 Å, 8 × 300 mm (p/n AMA0830103e3)
Temperature	70 °C
Sample Concentration	2 to 3 mg/mL
Calibration	Agilent ReadyCal-Kit polymethylmethacrylate (p/n PSS-MMKITR1)
Detectors	Refractive index (RI) detector
Software	Agilent WinGPC

Results and discussion

The differential molar mass distribution information offers a deep insight into the polymer production process as well as the correlation of polymer performance and the molar mass properties of the polymeric material. It is important to offer a well-balanced column-solvent-polymer system to get reliable and robust GPC/SEC results.

Figure 1 shows an overlay of a PSU and PES sample measured in dimethylacetamide (DMAc) with 0.5% lithium bromide as mobile phase at 70 °C with a set of GRAM columns as stationary phase.

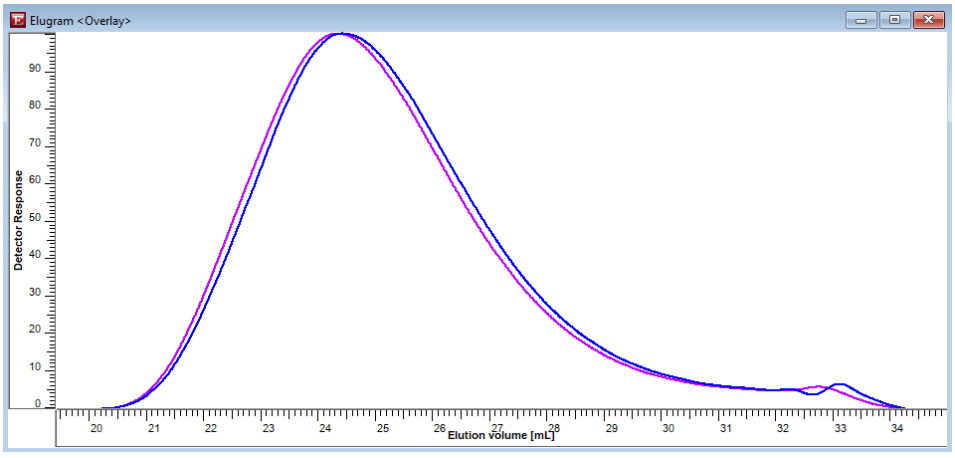

Figure 1. Overlay of a PSU (blue line) and PES (purple line) sample (RI traces, normalized detector response).

The GRAM high MW combination was composed of a GRAM 10 µm guard column in combination with one 100 Å and two 3,000 Å columns. This assembly provided reasonable resolution in the low molar mass region. In Figure 2, the corresponding molecular weight distributions (MWD) are shown. Both samples have a comparable MWD and show broad distributions starting in the low molar mass range.

Conclusion

GPC/SEC is a powerful tool to determine the overall molar mass distribution of PSU and PES. GRAM column is a recommended stationary phase to be used for hydrophobic polar organic solvents such as dimethylacetamide.

References

1. Mark, J. E. Polymer Data Handbook; Oxford University Press, Inc. **2011**.
2. Ehrenstein, G. W. Polymere Werkstoffe; Carl Hanser Verlag, **2011**, p 325.

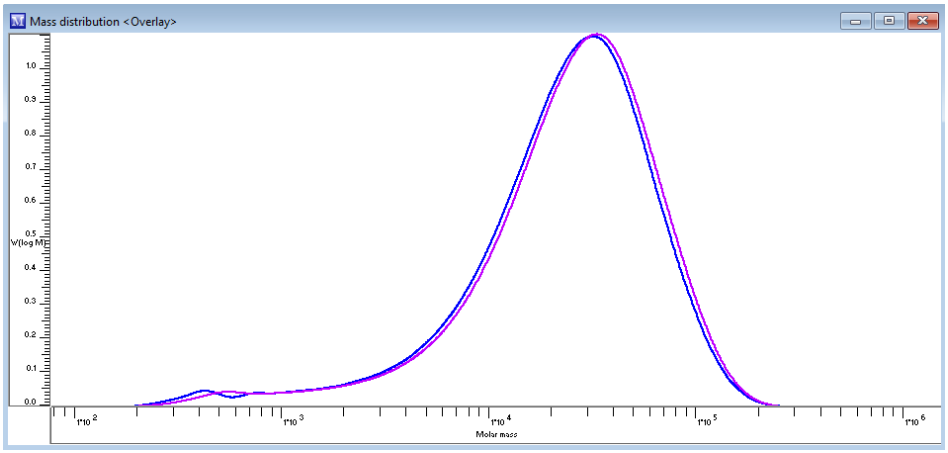

Figure 2. Overlay of the molecular weight distribution of a PSU (blue line) and PES (purple line) sample (based on calibration with PMMA reference materials, ReadyCal-Kit PMMA, p/n PSS-MMKITR1).

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