Characterization of light-emitting polymers

Kevin Treacher
Heinz Goetz

Light-emitting polymer technology is set to open a complete new world of applications for a wide range of products, such as small (and eventually large) flat screen displays, warning signs, decorative lighting and illuminated advertising [1,2]. The active layer of polymer-LEDs can be prepared by simple coating methods, such as spin coating. All colors are now available for these displays which can be made as thin as one millimeter. High brightness can be achieved at low power consumption and long life times of more than 30000 hours. Light emitting polymers are organic, conjugated, macromolecules of very high molecular weight. An important example are phenyl-substituted poly(p-phenylene vinylene) (PPV). To make them soluble and to process them into thin films they are modified, for example, by introducing alkyl or alkoxy side chains. Figure 1 shows the structure of a commercially available phenyl alkoxyphenyl PPV copolymer. The compound is soluble in aromatic hydrocarbons, cyclic ethers and certain ketons.The quality of the film coating process (and thus also the resulting polymer-LED) strongly depends on the polymerization and the resulting molecular weight data/molecular weight distribution. The latter parameters can be monitored

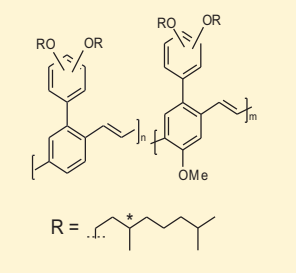

Figure 1
Structure of phenyl alkoxyphenyl PPV copolymer

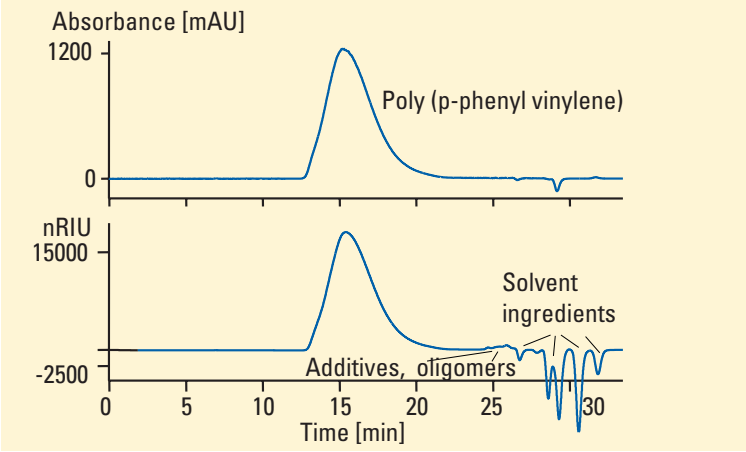

Figure 2
Overlay of chromatograms obtained simultaneously by diode-array and refractive index detection setting/evaluation

Conditions

Sample preparation
Samples were dissolved in stablized THF and filtered (concentration 0.1 %)
Column
3 × PLGel mixed C, 7.5 × 300 mm, 5 µm (Agilent p/n 79911GP-MXC)
Polymer standards
Polystyrene EasyCal vial standards (Agilent p/n 5064-8281)
Flow rate
1 ml/min
Column compartment temperature
20° C
Injection volume
100 µl

easily and precisely by GPC with Agilent Technologies PLgel columns and tetrahydrofuran as eluent. Figure 2 shows an overlay of the diode array and refractive index detector signals of a phenyl alkoxyphenyl PPV copolymer analysis. The chromatograms and the GPC report obtained with the ChemStation GPC data analysis software (figure 3) show the high quality resulting from:

- broad molecular weight distribution ranging from about 10^3 to 7×10^6 Dalton
- large polydispersity D of about 3.7
- very high molecular weight averages, e.g. M_w is larger than 800000 Dalton
- low concentration of additives and other compounds (figure 2)
- the purity of the polymer peak as proven by the overlay of UV-visible spectra acquired at various retention times (figure 4)

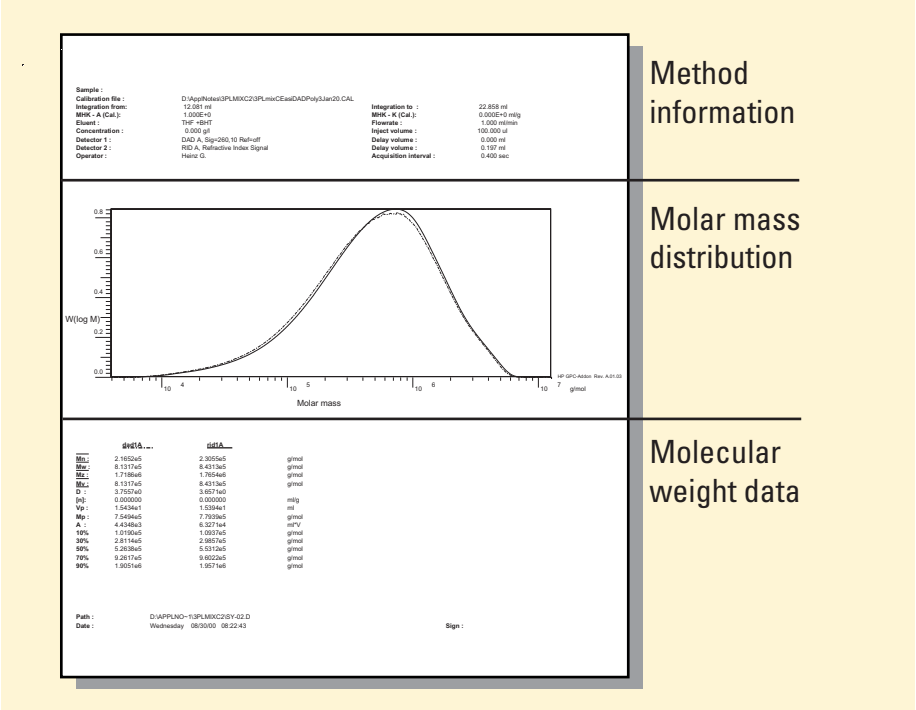

Figure 3
Single page GPC report including method parameters, molar mass distribution and molecular weight data

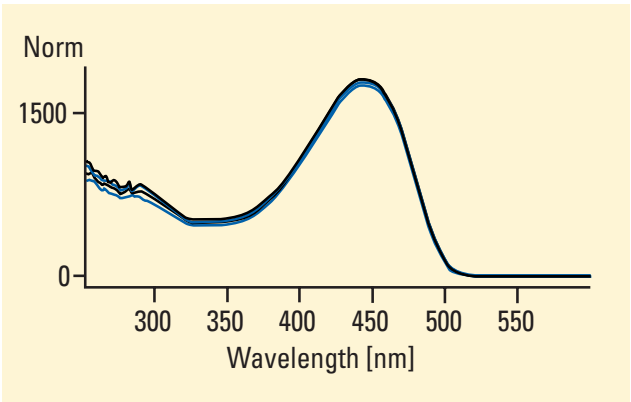

Figure 4
Proof of PPV peak purity by overlay of seven spectra acquired at different retention times

Equipment

Agilent 1100 Series GPC-SEC system
consisting of

- vacuum degasser for efficient degassing of the mobile phase
- Isocratic pump with large solvent cabinet
- Autosampler with single valve design
- Thermostatted column compartment for precise column temperatures
- Refractive index detector with automatic recycle valve
- ChemStation Plus with GPC-SEC data analysis software

References

1.
Nu Yu, H. Becker, Covion Technology Bulletin, http://www.covion.com/techsum.html
2.
H. Becker, H. Spreitzer, W. Kreuder, E. Kluge, H. Schenh, I. Parker, Y. Cao, Adv. Mater., 12(1), 42(2000)

Kevin Treacher is research chemist at Covion Organic Semiconductors GmbH, Frankfurt/Main, Germany
Heinz Goetz is an application chemist at Agilent Technologies, Waldbronn, Germany

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