

Triple Detection Characterization of Polycarbonates with the Agilent 390-MDS

Application Note

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Introduction

Polycarbonates are a class of tough, strong, high-performance engineering thermoplastics. With an amorphous structure, these materials are characterized by the presence of carbonate groups (-0-(C=0)-0-) in the polymer backbone, although the chemistry of the rest of the polymer can vary considerably.

Polycarbonates typically exhibit high transparency to visible light and have better light transmission characteristics than many kinds of glass, leading to their use in applications such as lighting and eyeglass lenses. In recent years polycarbonates have become more widely used in houseware based applications due to the high impact and temperature resistance properties.

In the manufacturing of polycarbonates used for engineering applications the final properties of the polymer must be carefully controlled to ensure the final performance. Triple detection allows the molecular weight and structural properties of different batches of polymer to be assessed and compared, and is an excellent quality control methodology. The use of light scattering gives molecular weights that are independent of the structure of the polymers, whereas the Mark-Houwink plot can be used to probe the structural properties of the materials.

This note describes the triple detection characterization of a series of four polycarbonate samples from different batches of product manufactured with slight changes to the production protocol. The intention of the analysis was to determine if the production changes caused any change to the molecular weight and structural characteristics of the materials.





Materials and Methods

Conditions

Columns: 2 x Agilent PLgel 5 µm

MIXED-C, 300 x 7.5 mm (part number PL1110-6500)

Eluent: Tetrahydrofuran
Flow Rate: 1 mL/min
Inj. Vol: 100 µL
Sample Conc: 2 mg/mL
Temp: 40 °C

Detectors: 390-MDS Multi Detector

Suite comprising differential refractive index, four capillary viscometry and dual-angle light scattering detection

Calibration Standards: Agilent Polystyrene

Individual Narrow Standard (Mp 197,300)

Results and Discussion

Figure 1 shows an example overlaid triple detection chromatogram of one of the materials.

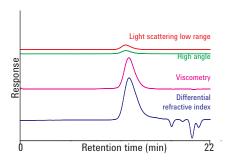


Figure 1. Overlaid triple detector raw data chromatograms for a polycarbonate sample showing the data collected from the individual detectors

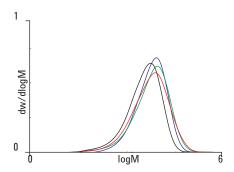


Figure 2. Overlaid molecular weight distributions calculated from triple detection analysis of all samples

The samples were all then analyzed by triple detection, employing the light scattering detector to determine molecular weights that were not dependent on a column calibration. The overlaid molecular weight distributions are shown in Figure 2.

The results showed that the changes to the production protocol had affected the molecular weight distributions of the four materials, which would result in differing characteristics in the final product. The Mark-Houwink plots for the four materials are shown in Figure ?

The Mark-Houwink relationship describes the scaling behavior of the intrinsic viscosity of polymers as a function of molecular weight. Assuming that two materials have the same molecular density, they will follow the same Mark-Houwink plot. Typically, changes in molecular density result either from differing sample chemistries or from the presence of long chain branching.

The Mark-Houwink plots of these materials show their relative structural similarities, with deviations in the relative positions of the plots indicative of structural changes. In the case of the four samples, the plots overlay, indicating that the production change has not affected the structural properties of the materials.

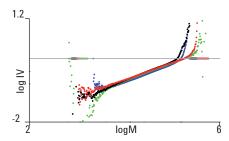


Figure 3. Overlaid Mark Houwink plots calculated from triple detection analysis of all samples

Conclusion

Triple detection GPC using the 390-MDS Multi Detector Suite is a powerful tool for investigating the molecular weight and structural properties of polymers. In this application the effect of changes to a production protocol on a series of polycarbonates could be easily observed using the 390-MDS.

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