

Influences of Temperature on Uniaxial Deformation Behavior of Polyethylene Solids Evaluated by SANS Measurement

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Molecular weight distribution (MWD) is one of the most important molecular parameters affecting the mechanical properties of polymeric materials. For example, the broader MWD samples show higher drawability than the narrower MWD samples. However, the mechanism of the influences of MWD on the mechanical properties is still under discussion because of the complicated morphology composed of the lamellar crystalline structure. The direct observation of each molecular weight component during deformation is very important to elucidate the relationship between MWD and mechanical properties. The deuterium isotope method using small-angle neutron scattering (SANS) is a powerful method for the direct observation of deformation of a specific molecular weight component. In particular, we focused on the influences of temperature on the deformation behavior of each molecular weight chain because the mechanical properties strongly depend on temperature.¹⁾ However, in most previous studies, temperature dependences of the deformation behavior of different molecular weight components have not been discussed in detail.

In this study, deuterated PEs (dPEs) with narrow MWD ($M_w/M_n < 1.3$) and different molecular weights ($M_w = 4.0 \times 10^4$ and 44×10^4) were synthesized using a phenoxy-imine catalyst, and partially deuterated PE in which only specific molecular-weight component is deuterated was prepared by blending dPE and two hydrogenated PE (hPE) with broad MWD and different molecular weights ($M_w = 8.0 \times 10^4$ and 18.0×10^4). The blend samples were melt pressed at 210 °C and 20 MPa, followed by quenching in iced water to prepare sample sheets with 200 μm thickness. A two-dimensional SANS pattern was obtained with a wavelength of 7 Å, camera lengths of 1 m and 8 m, and an exposure time of 2 h.

Figure 1 shows the one-dimensional SANS profiles of blends of hPE and dPE with different molecular weights. Here, the number attached in the sample code represents the weight-average molecular weight of 10,000 units. The intensity of scattering in the low-angle region increased drastically by stretching at 80 °C for hPE/dPE44, suggesting that the molecular orientation of high-molecular-weight chains was enhanced by increasing the deformation temperature. On the other hand, the scattering intensity of hPE/dPE4 was almost independent of the deformation temperature. Therefore, the low-molecular-weight chains were inactive to the mechanical response under tensile deformation.

- 1) Z. Wang *et al.*, *Polymer*, **160**, 170–180 (2019).

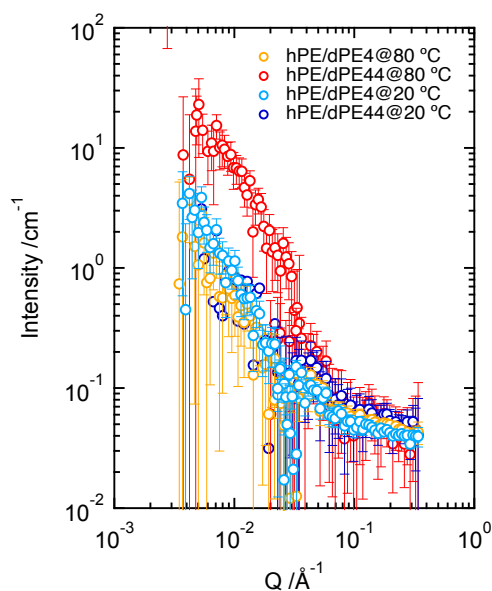


Fig. 1. One-dimensional small-angle neutron scattering profile all blend samples.