INFLUENCES OF SHAPE OF MOLECULAR WEIGHT DISTRIBUTION ON TENSILE PROPERTIES OF POLYETHYLENE SOLIDS

Takumitsu Kida[1, 2], Ryo Tanaka[3], Takeshi Shiono[3],
Masayuki Yamaguchi[1], Katsuhisa Tokumitsu[2]

[1]Japan Advanced Institute of Science and Technology, Ishikawa, Japan
[2]The University of Shiga Prefecture, Shiga, Japan
[3]Hiroshima University, Hiroshima, Japan

The molecular weight distribution (MWD) is one of the most important molecular parameters affecting the rheological and mechanical properties of polymeric materials. For the solid-state polymers, it has been reported that the strength and strain-hardening modulus of samples with broad MWD containing high-molecular-weight chains are significantly high compared with those with narrow MWD.[1] However, the mechanism of the improvement of the strength and strain-hardening modulus by adding the high-molecular-weight component has not been elucidated due to the complex morphology. In this study, we prepared a series of samples with different shapes of MWD to investigate the influences of the MWD on the mechanical properties of solid-state polymers.

We synthesized three polyethylenes (PEs) with narrow MWD ($M_w/M_n < 1/3$) and M_w of 1.2×10^5, 3.2×10^5, and 25.0×10^5. The synthesized PEs were blended with polydispersed PE ($M_w = 0.6\times10^5$ and $M_w/M_n = 5.3$) with a weight fraction of 5% in boiling xylene at 135 ºC followed by participating in cold methanol. The blend PEs were melt-pressed at 210 ºC and quenched at 0 ºC to prepare sample sheets with a thickness of approximately 0.2 mm. Figure 1 shows the stress–strain curves of all samples. The number attached in the sample code indicates the value of M_w. The stress–strain curve of PE6/PE12 was almost the same as that of PE6, suggesting that the molecular-weight component of 1.2×10^5 has almost no influence on the tensile properties. On the other hand, the strength and strain-hardening modulus were obviously increased by adding PE32 and PE250. Considering that the molecular chains with a molecular weight larger than 3.2×10^5 have a high probability for forming tie molecules connecting more than 6 lamellar crystals[2], the strength and strain-hardening modulus are dominated by the amount of the tie molecules connecting more than six lamellae.

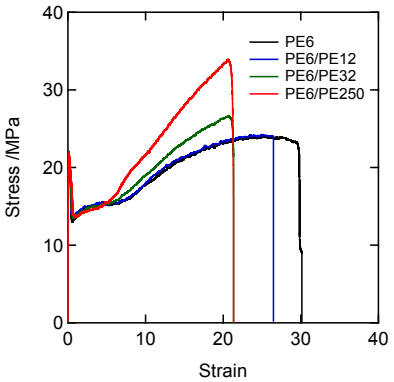

Figure 1. Stress–strain curves of all PE samples.

1. Wu, T.; Yu, L.; Cao, Y.; Yang, F.; Xiang, M., Effect of molecular weight distribution on rheological, crystallization and mechanical properties of polyethylene-100 pipe resins, *J. Polym. Res.*, **20**, 271., 2013.
2. Huang, Y.-L.; Brown, N., The effect of molecular weight on slow crack growth in linear polyethylene homopolymers, *J. Mater. Sci.*, **23**, 3648–3655., 1988.