

Simultaneous SAXS/WAXS/Hv-SALS Studies on Crystallization and Spherulite Growth of Poly(ethylene) in Phase-Separated Polymer Blends

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Introduction

Crystalline polymer has structural hierarchy, which affects its mechanical property. Especially, it is significant to study and control spherulite growth because spherulite stays at the top of the structural hierarchy. It has been reported in our previous study that spherulite can grow bigger than phase-separated domains in rapid cooling process. For blends of LLDPE (linear low density polyethylene) with rubbery polymers, effects of phase-separated domains on spherulite growth and crystallization of LLDPE were studied by focusing the radius of spherulite and the long period of crystalline lamellae in isothermal crystallization process. The former was evaluated from small-angle light scattering (Hv-SALS) measurements and the latter was examined by the small-angle X-ray scattering technique (SAXS). The crystallinity was evaluated as well by the wide-angle X-ray scattering technique (WAXD).

Experimental

Simultaneous SAXS/WAXS/Hv-SALS measurements were conducted at the BL-9C and 15A beamlines. Figure 1 shows the schematic diagram for the simultaneous SAXS/WAXS/Hv-SALS equipment at the BL-9C beamline. Simultaneous SAXS/WAXS measurements were also conducted at the BL-15A beamline. The wavelength of X-ray was tuned at 0.154 nm. A set of position-sensitive proportional counters were used.

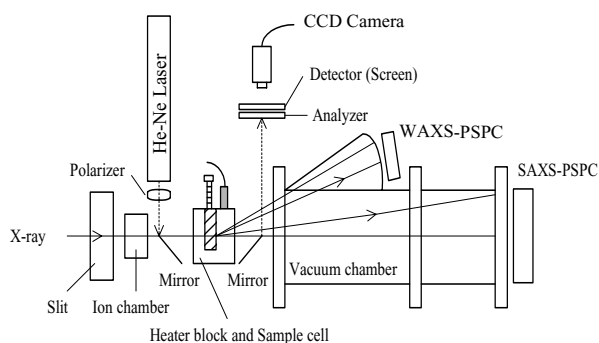


Fig. 1 Simultaneous synchrotron SAXS/WAXS/Hv-SALS equipment (PF BL-9C).

Results and Discussion

It was found, in some particular cases, that the spherulites were 10 times larger than the phase-separated domains, which was analyzed by the transmission electron microscopy. It was also found that the rate of spherulite growth in a neat LLDPE is faster than in the phase-separated blend of LLDPE with a rubber polymer. Based on these results of the simultaneous SAXS/WAXS/Hv-SALS measurements, the mechanism of spherulite growth is considered. As shown in Figure 2, spherulites can grow well bigger than phase-separated domains through percolating growth of crystalline-lamellar fibrils in a channel of crystalline LLDPE phase without altering the domain structures.

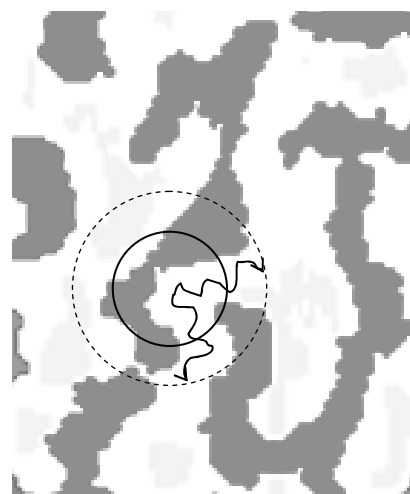


Fig. 2 A possible mechanism of spherulite growth in a channel of crystalline LLDPE phase without altering the domain structures.

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