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Spatial Inhomogeneity in Injection-molded Polypropylene Investigated with Microcbeam Wide-angle X-ray Diffraction

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Introduction

Injection molding is one of the most common processes to shape polymeric materials. Injection molded materials show spatially inhomogeneous structure: a core-shell structure in micron scale, a size distribution of spherullites, and differences in polymorph, crystallinity and orientations. These spatially inhomogeneous structures influence the mechanical properties of injection molding, thus understandings of the relationship between structure and mechanical properties are important from both academic and industrial points of view.

Microbeam wide-angle X-ray diffraction (WAXD) offers us informations about the micron-scale distribution of nano-structures [1]. In this report, we present the results of scanning microbeam WAXD measurement of injecion-molded PP.

Experiment

Microbeam WAXD experiment was performed at BL-4A. The sample used was typical injection-molded PP. A schematic illustration of sample is shown in Fig. 1. The X-ray beam was focused to 5 μm × 5 μm (FWHM) at a sample position with Kirkpatric-Baez mirrors. The microbeam scanned the sample along the depth direction with a normal direction with a 10 μm step. WAXS images were measured with an X-ray CCD detector coupled with an X-ray Image Intensifier. The distance between the sample and the detector was around 170 mm. The X-ray wavelength was 1.13 Å. The position of X-ray microbeam on the sample was monitored by using a polarized optical microscope.

Results and Discussion

Figure 2 shows a polarized optical micrograph of the sample, WAXD images at different irradiation points and their one-dimensional diffraction intensity profiles. The diffraction images showed highly oriented patterns at skin region, while the diffraction at the central part showed rather isotropic pattern. Furthermore, peaks originating from a polymorph being different from the dominant one were observed. From the observation, it is found that spatial distribution of crystal sizes and polymorph is a key to improve the mechanical properties [3].

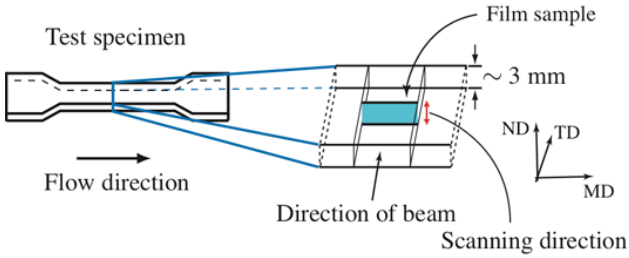

Fig. 1: Schematic illustration of injection-molded sample. The flow direction and the direction of X-rays are shown in the figure. MD: machine direction, ND: normal direction, and TD: transverse direction

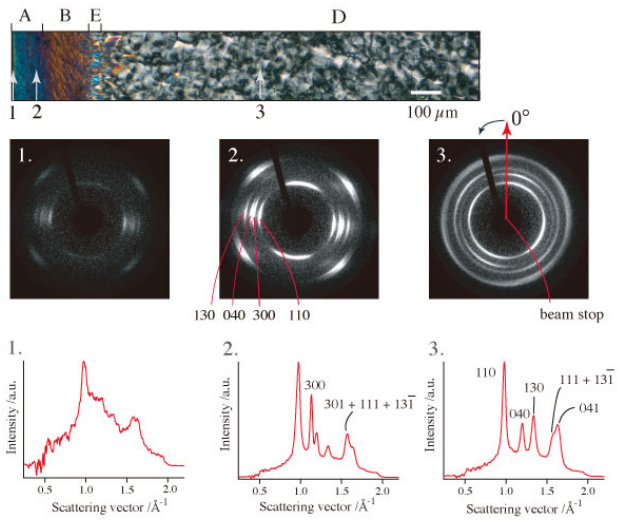

Fig. 2: Polarized optical micrograph of injection-molded PP with the white arrows marking the positions where the WAXS patterns are taken. (1) Outermost region of skin layer, (2) the central part of the skin layer, and (3) the core layers. Both two-dimensional diffraction patterns (center) and one-dimensional intensity profiles (bottom) are shown.

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References

[1] Y. Nozue et al., Polymer J. **39**, 1221-1237 (2007).
[2] Y. Amemiya et al., Rev. Sci. Instrum. **66**, 2290 (1995).
[3] K. Yamazoe et al., in preparation.