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Equibiaxial drawing behavior of isotactic polypropylene film by time-resolved WAXS/SAXS measurements

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Introduction

Considerable work has been reported to investigate the structural deformation of isotactic polypropylene (iPP) over a wide range of strain and temperature. However, most of the research about deformation reported in the literature is uniaxial. In real industrial processes such as blow molding and film stretching, iPP is often deformed under much more complex strain fields than simple uniaxial drawing. It is therefore of significant importance to investigate how the microstructure of iPP subjected to the complex strain field evolves, in particular, in biaxial drawing processes [1].

Recently, we have developed newly designed biaxial film drawing machine and have successfully applied for *in-situ* time-resolved measurements of wide- and small-angle X-ray scattering (WAXS and SAXS, respectively) in order to trace the structural evolution of iPP during equibiaxial drawing.

Experimental

As a typical example, we used here a commercially available Zieglar-Natta iPP with *M*w of 4.5 × 10^5 g/mol, *M*w/*M*n of 5.1, melt flow rate index of 2 g/10min, and a melting temperature of 163 °C.

The specimen (20mm×20mm×0.5mmt) was prepared by pressing at 230 °C followed by cooling to room temperature. In Figure 1, we briefly present the set up of newly designed biaxial film drawing machine. Equibiaxial drawing tests were carried out at temperature close to melting point (160 °C) and draw rate of 1mm/sec.

The WAXS and SAXS measurements were conducted at the BL-15A beam line. For tracing the structural change in the specimen during drawing, time-resolved two-dimensional (2D) WAXS and SAXS patterns were measured with 0.5 sec time slices by using a CCD X-ray detector [2].

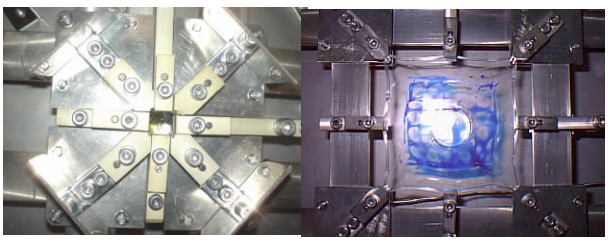

Figure 1 Newly designed biaxial film drawing machine

Results and Discussion

Figure 2 shows the time dependence of WAXS and SAXS profiles on the horizontal line. The WAXS intensity became gradually weaker and finally not detective. The peak position was constant during drawing. The peak position of SAXS shifted to lower scattering angle, being accompanied with the decrease in peak intensity. No anisotropy was observed for 2D WAXS and SAXS patterns, respectively. These results suggest that the chain axes of crystalline chains orient into each direction of drawing.

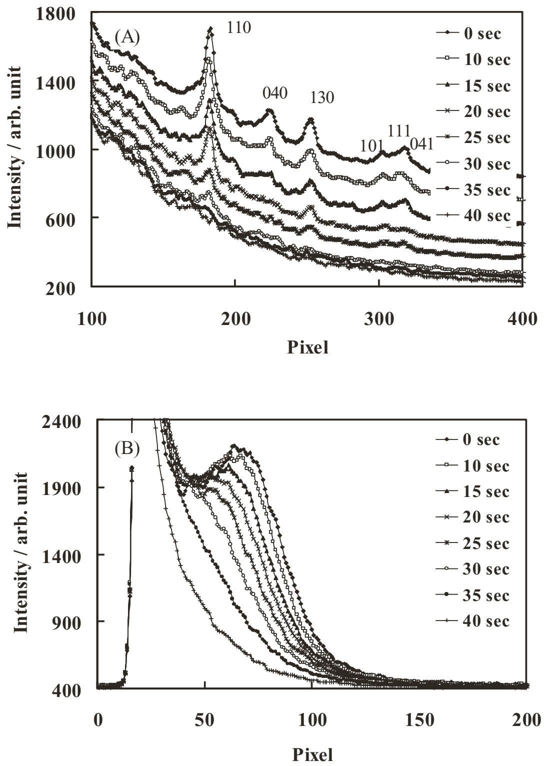

Figure 2 The time dependence of (A) WAXS and (B) SAXS profiles on the horizontal line obtained from WAXS and SAXS patterns

References

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