

Structural deformation behavior of ethylene- α -olefin copolymer

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Introduction

In polyolefin's materials, molecular structure is one of the key factors governing the mechanical properties. As for the ethylene- α -olefin random copolymers, the kinds and amounts of comonomer greatly affect tensile mechanical properties, which are very different from ethylene/butene-1 and ethylene/higher α -olefin (hexene-1 etc.). From the point of academic and industrial view, it is significant to investigate the effects of comonomer on the tensile behavior. In this study the structural evolution during deformation process was examined.

Experimental

The samples used here are copolymer of polyethylene with butene-1 (EB) or hexene-1 (EH). The molecular characteristics of the samples are listed in Table 1.

The sample specimens of 0.4 mm in thickness were set in a tensile tester installed in the pass of X-ray beam. The specimens were uniaxially stretched with strain rate of 0.5mm/sec at 323 K.

The WAXD and SAXS measurements were conducted at the BL-15A beam line. Time-resolved two-dimensional (2D) WAXD and SAXS patterns were measured with 1 sec time slices by using CCD X-ray detector [1].

Table 1. The molecular characteristics of samples

sample	EB	EH
Comonomer	Butene-1	Hexene-1
Comonomer content ^a (mol%)	2.1	1.8
$M_w/104$	140	140
M_w/M_n	2.0	1.9
Crystallinity ^b (wt%)	49.6	44.6
Density (g/cm ³)	0.920	0.917
Tm (°C)	112.5	111.8

^a Determined by C¹³ NMR. ^b Determined by WAXD.

Results and Discussion

The stress-strain curves, 2D WAXD and SAXS patterns during drawing are shown in Figure 1. The 2D WAXD pattern before drawing exhibited the Debye-Scherrer rings. These rings were changed into the arcs with the onset of yielding and necking. Beyond necking, the

azimuthal spread of the reflections became narrow, indicating that the crystal orientation increased with draw ratio.

The 2D SAXS pattern before stretching showed rings. It transformed to the elliptical pattern in the yielding necking regions. In the draw region beyond the necking, the 2D SAXS pattern showed a two-bar pattern with the scattering maximum on the horizontal direction. The significant diffuse scattering at the small scattering angle was recognized for 2D SAXS pattern of EB, indicating the formation of microvoids during drawing is different among the EB and EH samples.

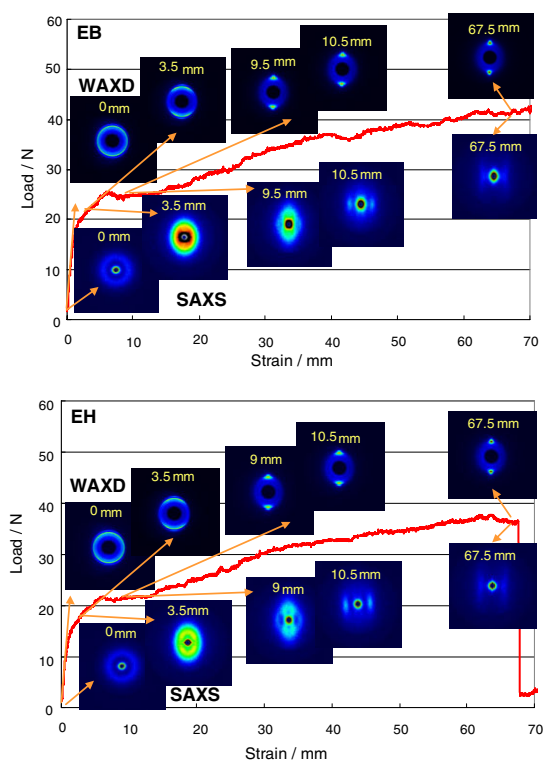


Fig 1. 2D WAXD and SAXS patterns observed in the drawing process (EB:upper, EH:bottom). The drawing direction is horizontal.

Reference

- [1] Y. Amemiya et al., *Rev. Sci. Instrum.* 66, 2290 (1995).
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