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Effect of pressure on packing regularity of hexagonal lattice for cylindrical microdomains in triblock copolymers

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Introduction

We report experimental results on the effect of pressure on the packing regularity of hexagonal lattice for cylindrical microdomains in styrene-butadiene (partially hydrogenated)-styrene (S[B/EB]S) triblock copolymers. For this purpose, we conducted in-situ measurements of the small-angle X-ray scattering (SAXS) under high pressure (up to 190MPa) at 150˚C.

Experimental

The S[B/EB]S sample has Mn of 6.07×10^4 and w_{PS} (weight fraction of PS) of 0.183. The weight fraction of the hydrogenated PB in the mid-PB block chain is 0.51.

The solution cast of the SBS triblock copolymer using a neutral solvent (toluene) was conducted at room temperature. Then, the as-cast sample was thermally annealed at 150˚C for 2 hours. The annealed sample was further subjected to a one-dimensional flow field at 150˚C for 20 sec using 1065g piston bar, as schematically shown in Figure 1. Thus obtained sample was used for the in-situ measurements of SAXS at 150˚C under high pressure up to 190MPa.

Results and Discussion

Figure 2 shows two-dimensional SAXS patterns obtained at 0.6 MPa and 190.0 MPa at 150˚C. Intensity distribution profiles as a function of the azimuthal angle μ are shown together. Here, the azimuthal angle μ is defined clock-wisely. No appreciable improvement or degradation of the hexagonal lattice of the cylindrical microdomains of PS was found upon pressurizing up to 190MPa. It might be stated that the peaks in the intensity distribution profiles as a function of the azimuthal angle were more or less sharpened, suggesting some extent of improvement of the packing manner at the high pressure. On the other hand, it was found that the Bragg peaks in the scattering profiles, which were obtained by conducting the circular average of the 2d-SAXS patterns, were more likely sharpened upon the pressurizing at 190.0 MPa, although the data were not shown here.

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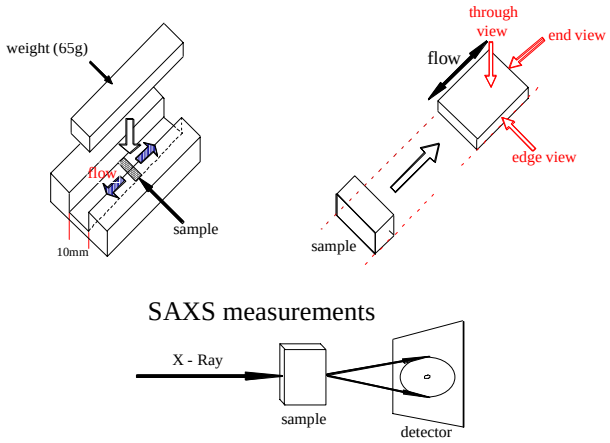

Figure 1 Schematic illustrations for application of one-dimensional flow filed on to the block copolymer sample at 150˚C using the hand-made device comprising a piston bar and a channel-cut substrate. Schematic illustrations showing the geometries of the SAXS measurement are shown together.

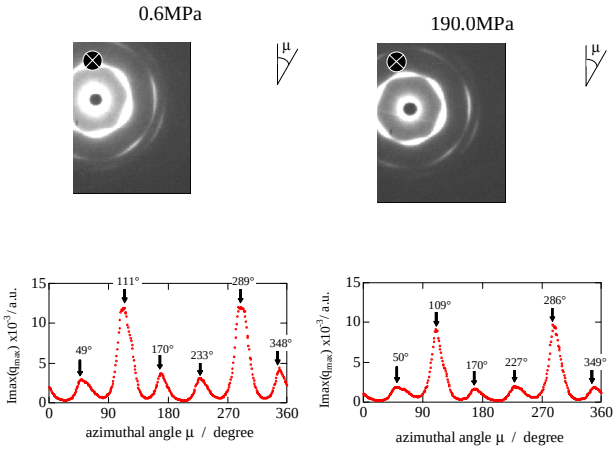

Figure 2 Two-dimensional SAXS patterns obtained at 0.6 MPa and 190.0 MPa at 150˚C. Intensity distribution profiles as a function of the azimuthal angle μ are shown together. Here, the azimuthal angle μ is defined clock-wisely.