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# Magnetic Orientation of Lamellar Microdomains in All-Amorphous Block Copolymer Solutions

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Block copolymers have been widely used in many applications of nanotechnology because of nanostructures spontaneously formed as a consequence of strong segregation between constituent block chains comprising different chemical species. Recently, the significance of control of the nanostructure orientation is more and more recognized in correlation with a property control and creation of novel specialty materials. Very recently, we have shown efficiency of the magnetic field to the nanostructure orientation in a thin film of an all-amorphous block copolymer. It has been a challenging project for the all-amorphous block copolymers which do not include liquid-crystalline or semi-crystalline moieties, which are sensitive to the magnetic field. Our basic idea of the magnetic orientation is schematically illustrated in Figure 1. In our previous study, we have experimentally confirmed the magnetic orientation of cylinders upon the morphological transformation from well-oriented lamellae to cylinders in the presence of the 12T magnetic field, for which the concept is illustrated in Figure 1 (a) from lamella to cylinder. As far as the difference in the magnetic susceptibility between A and B components is sufficient, undulation of the microdomain interface determines the orientation of the resulted cylinders. Since the free energy is increased when the interface is not parallel to the magnetic field direction, orientation of cylinders finally achieved is parallel to the field direction.

Then, it is considered that the concept can be applied to the magnetic orientation of lamellae, via a reversed process from cylinder to lamella, as shown in Figure 1(a). From well-oriented cylinders, it will be possible to obtain lamellar orientation via the magnetic control of the coalescence direction of the microdomain interface. For this purpose, block copolymer solutions (SEBS/ dibutylphthalate), which undergo morphological transformation from cylinders to lamellae upon cooling from 155$^{o}$C to room temperature, were examined. Due to low viscosity, the solution may give us chance to attain magnetic orientation of lamellae. As matter of fact, the magnetic orientation of lamellae has been successfully achieved as shown in Figure 2.

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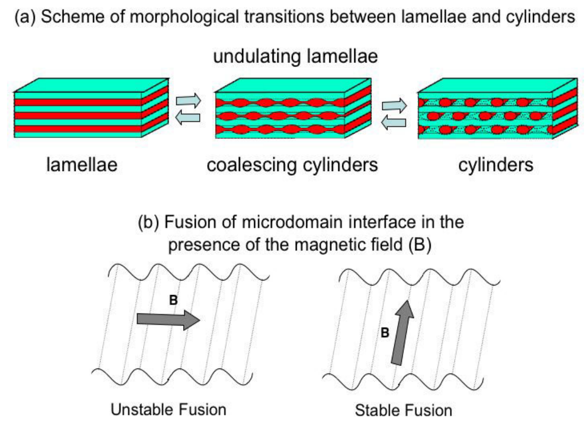


**Figure 1** Schematic illustrations of the concept for the magnetic orientation of cylinders or lamellae by the application of the magnetic field B during the morphological transformation between these morphologies, where the magnetic control of undulation direction or coalescence direction of the interface induces microdomain orientation.

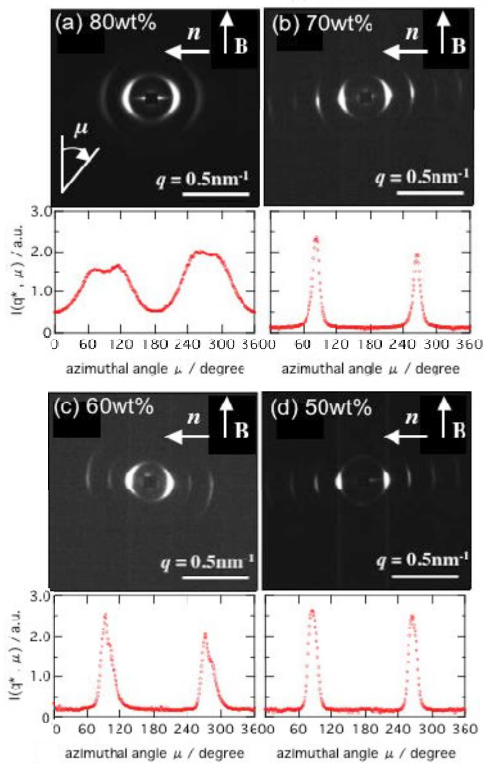


**Figure 2** 2d-SAXS patterns with plots of the first-order peak intensity as a function of the azimuthal angle $\mu$ for the SEBS/DBP solutions which were subjected to the 12T parallel magnetic field during slow cooling process from 155$^{o}$C to RT.