Doctoral Thesis Abstract

Studies on Surface Structure and Grain Coarsening in Sphere-Forming Triblock Copolymer Thin Films

The thesis focuses on the triblock copolymer forming spherical microdomains. Namely, glassy spherical microdomains embed in a rubbery matrix. Although the glass transition temperature (T_g) of the rubbery phase is much lower than room temperature, the polymeric as-cast film sometimes exhibits non-equilibrium characters. This is because the glassy spherical phase of which T_g is much higher than room temperature, results in impeding the chains in the rubbery matrix phase to freely move in the as-cast state. The thesis is divided into three chapters.

Chapter 1 investigates the surface structures of three kinds of block copolymers forming equilibrium and non-equilibrium spherical microdomains by using the atomic force microscopy, X-ray Photoelectron Spectroscopy, and Grazing-Incidence Small-Angle X-ray Scattering. Plausible model could be constructed based on that. The main finding of chapter 1 is that the layer thickness of the outermost surface is found to be very thin so that the block chains confined in this space are forced to be heavily compressed. Such an enormous chain deformation indicates that the surface coverage requirement is very strong.

Chapter 2 presents the grain coarsening on the free surface as well as in the thickness direction of sphere-forming triblock copolymer film. The main finding of chapter 2 is that the oriented layer thickness near the free surface (or facing to the substrate) has reached 9.5 μm thick, consuming almost 20 % of the total film thickness. This value is much bigger than the reported one in the literatures.

Chapter 3 addresses the ordering regularity of spherical microdomains in a dewetted triblock copolymer superthin film. The main finding of chapter 3 is that it has been found that the ordering packing inside the dewetted islands varies from a regular hexagonal to a deformed hexagonal packing, depending on the shape of the islands.