Study of Lattice Defects and Grain Boundaries in Microphase-Separated Structures of Block Copolymers by Three-Dimensional Electron Tomography

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【Outline of survey】

Block copolymers obtained by connecting two or more different polymers, in which the same kind of polymer molecules segregate to form fine domains (microphase-separated structures), form highly periodic structures where spherical, cylindrical, lamellar or bicontinuous microphases are arranged in regular arrays. By using such structures as the templates, we can make a variety of nanotechnology materials. However, since the microphase-separated structures and the material properties are closely related, how we control the microphase-separated structures determines the quality of the materials. Thanks to the researches to date, we can control the shapes and the sizes of the microphase-separated structures, but the researches to develop the techniques to control the orientation and the size of the regular area (grain) of the microphase-separated structures and to reduce their defects have just started. It has been difficult to analyze the three-dimensional local nano-sized structures such as defects. In this study, we utilize the electron tomography technique, in which we apply the computed tomography (CT) technique to transmission electron micrpscopy (TEM), to observe the defect in the microphase-separated structures in three dimension. To do so, we can clarify the mechanisms how the defects appear and disappear, which will leads us to the complete control of the defects in the microphase-separated structures. By clarifying the grain-boundary structures, which are a kind of defects, we will be able to get a big hint to increase the grain size.

【Expected results】

Since block copolymers self-assemble to form highly regular periodic structures of nanometer sizes, they are the materials friendly to the environments. By utilizing the microphase-separated structures of block copolymers as the templates for nano-technology materials, we can produce highly functional materials such as electrical and optical devices, sensors, materials for medical use, membranes for separation, etc. However, it is a big problem how to the microphase-separated structures with a large grain size and without defects. This study will shed lights on the mechanism of formation and vanishing of the defects by 3D electron tomography. By knowing the mechanism, we will be able to establish a technique to control the defects and contribute to accelerate the development of the nano-technology materials.

【References by the principal researcher】

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【Homepage address】 http://alloy.polym.kyoto-u.ac.jp