A Pathway Toward Sub-10 nm Surface Nanostructures Utilizing Block Copolymer Crystallization Control

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Abstract

Molecular self-assembly of block copolymers offers a potential pathway for the fabrication of nanometer-sized surface nanopatterns. The use of such nanopatterns as soft templates could provide an attractive alternative to classic photolithographic methods. However, the random nature of self-assembly often results in high defect densities, and the driving forces behind the formation of vertical nanopatterns lead to a complex relationship between block lengths, film thickness, interfacial energies, temperature, and more. For potential applications, the self-assembly needs to be guided by directed self-assembly methods. This often requires the use of guiding templates, e.g., trench pattern, for macroscopic alignment of the nanopattern. In this talk, a pathway towards the fabrication of sub-10 nm surface nanostructures utilizing block copolymer crystallization is presented. The crystallization of a short-chain, double-crystalline block copolymer thin film is studied with *in situ* atomic force microscopy. A mechanism based on a crystallization-induced change of surface energies is identified, leading to the formation of vertical lamellar nanostructures. The poor order of the lamellar nanopatterns is improved significantly by using pre-patterned templates (graphoepitaxy). With the help of trench pattern fabricated via electron beam lithography, the lamellae can be aligned on a macroscopic scale. The results demonstrate how the crystallization of short-chain block copolymers offers a promising step towards the future development of functional nanodevices.

Keywords: Atomic Force Microscopy; Directed Self-Assembly; Electron Beam Lithography; Graphoepitaxy; Vertical Nanopattern