Process Simulation of Block Copolymer Nanofabrication

S.-K. Kim
Department of Applied Physics, Hanyang University, Ansan, South Korea
sangkon.kim@catholic.ac.kr

As a promising high-resolution lithographic tool, the self-assembly of block copolymer is a lithography technology for the creation of next-generation information storage and electronic devices. The self-assembly of block copolymer thin films can apply for regular arrays of quantum or magnetic dots, membranes with tailored nanoscale porosity, and dense assemblies of nanowires. Block copolymer lithography (BCL) has been recently attracting considerable attention as a potential candidate for sub-20 or 10-nm lithography. The bottom-up self-assembly makes it easy to exceed the resolution limit of current state-of-the-art top-down lithography because only the molecular size of block copolymers governs the resolution and, in this case, the repetition period of microphase-separated domains of block copolymers. This technique is advantageous in that it yields microphase-separated domains with almost uniform sizes in large quantities at a low cost.

Figure 1 shows patterns of block copolymer due to one-molecular weight and nano-patterns to apply those patterns of block copolymer. BCL apply to nanodevice fabrication, which was limited by the use of the top-down technology. For the fabrication techniques, graphoepitaxy technique, which involves the use of a resist pattern as the alignment guide, is a very effective technique for strictly controlling the alignment direction of microphase-separated domains. The combination of the neutralization of the substrate surface and the use of hydrogen silsesquioxane (HSQ) resist patterns with a hydrophilic surface as an alignment guide enables the graphoepitaxy of the vertical lamellar domains of the symmetric diblock copolymer PS-b-PMMA in the specially designed confinement between the alignment guides. Understanding of the mechanism of BCL and the modeling of BCL in mesoscale and molecular scale are useful for the predicting of self-assembled structures. For a schematic diagram of the alignment process, a hydrophilic guiding pattern is formed on a Si substrate by optical lithography. The block copolymer film is deposited over the resist pattern guide. The film is annealed on a hot plate under air atmosphere in order to induce lateral alignment of the vertical cylindrical domain as well as microphase separation. Figure 2 shows two fabrication processes which are template process and self-assembly process. The simulation results in the self-assembly of block copolymer will be presented in the conference.

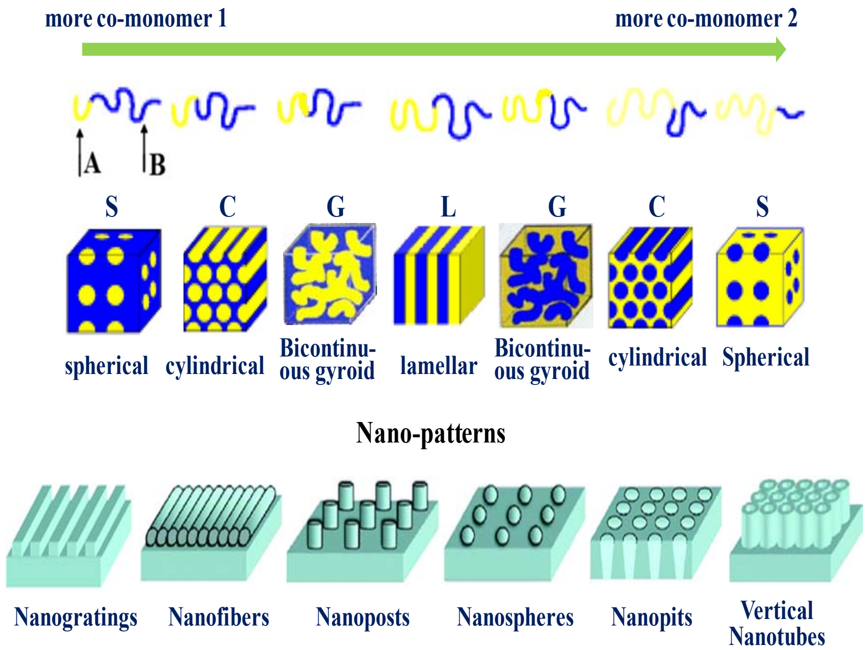

Figure 1: Patterns of block copolymer due to one–molecular weight and application of those patterns.

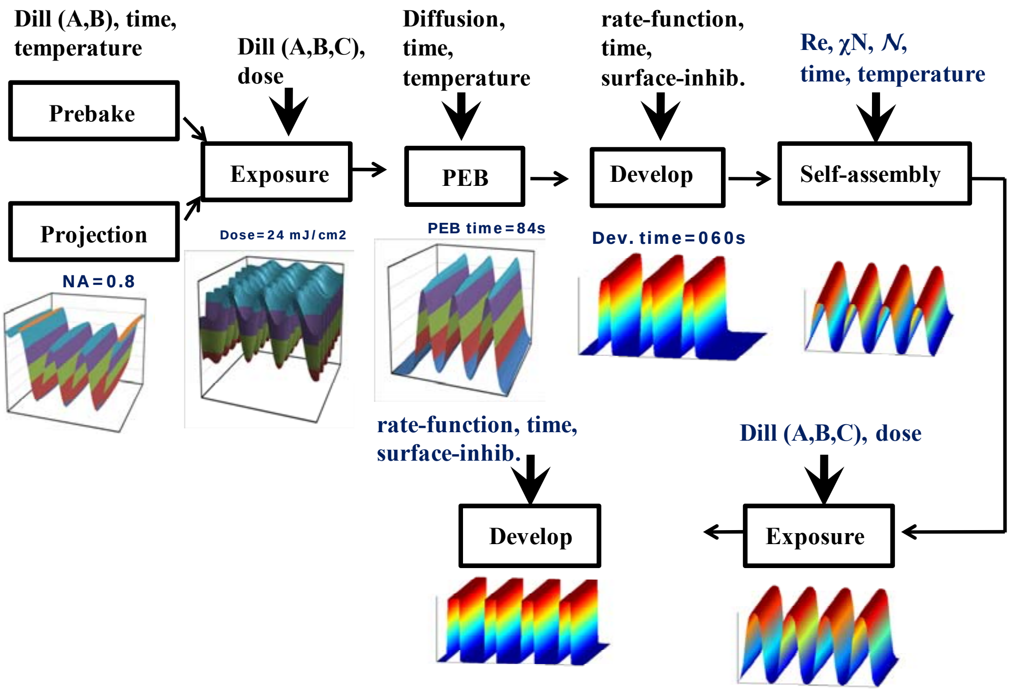

Figure 2: Modeling of self-assembly block copolymer