Magnetic Nanostructures Made by Block Copolymer Lithography

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Fabrication of large-area periodic nanoscale structures using self-organizing systems is of great interest because of the simplicity and low cost of the process. Block copolymers consist of polymer chains made from two chemically distinct polymer materials. These can self-assemble to form small-scale domains whose size and geometry depend on the molecular weights of the two types of polymer and their interaction. The domains have a very uniform distribution of sizes and shapes. We have been using block copolymers as templates for the formation of magnetic particles, by selectively removing one type of domain and using the remaining domains as a template to pattern a magnetic film. PS/PFS 90/21 block copolymers can template hexagonally close packed arrays of magnetic dots with diameters on the order of 30 nm and periodicities of order 50 nm. The thermal stability of these magnetic dot arrays has been measured, and increases with the aspect ratio of the magnetic dots as expected.

However, the self-assembled block copolymer lacks long-range order (Figure 6). Graphoepitaxy is used here to induce orientation and positional ordering of the block copolymer through an artificial surface patterning. Block copolymers are spin-cast on silica grating substrates made by interference lithography. For PS/PFS 50/12 block copolymer, well-ordered structures form in the grooves of the gratings with all the close-packed rows aligned within the grooves (Figure 2), provided the groove width is comparable to the 'grain size' of the block copolymers. These ordered nanostructures may be useful as templates for various applications. Fabrication of ordered magnetic particle arrays is currently under study.

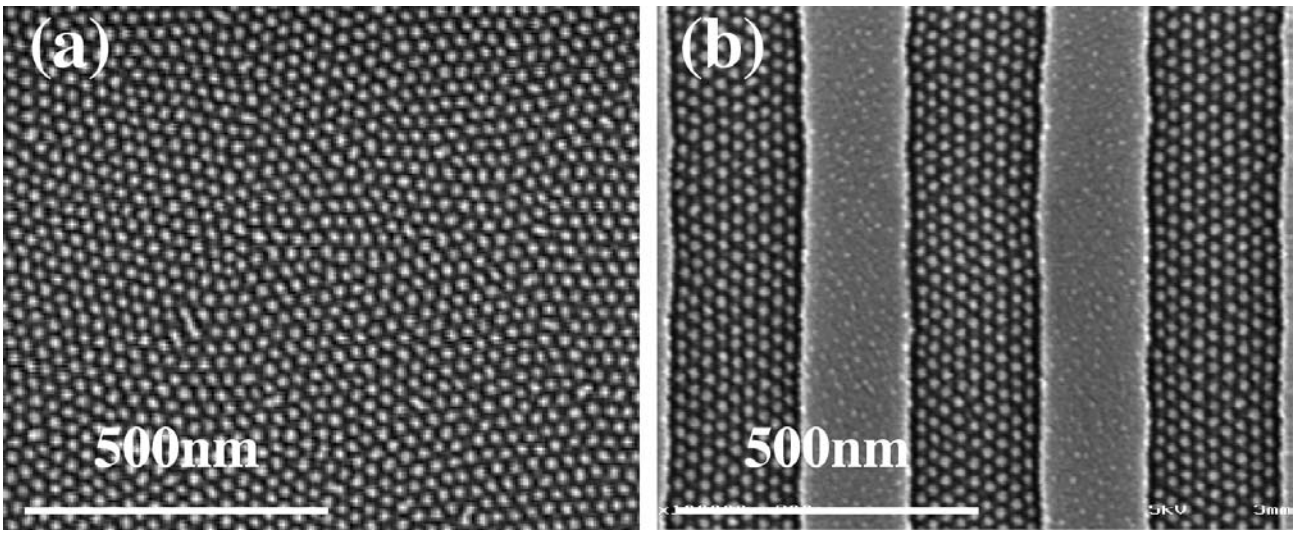

Fig. 6a: PS/PFS block copolymer 50/12 on a flat silica substrate. The pattern lacks long-range order. Fig. 1b: Ordered block copolymer PS/PFS 50/12 in 260nm wide silica grooves fabricated by interference lithography. There is long-range ordering within each groove.