Integration of Directed Block Copolymer Self-Assembly with Nanoimprint Lithography for Addressable Nanoarray Fabrication over Large Area

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Directed self-assembly of block copolymers (BCPs) is proved to be an effective route to create lithography-friendly nanopatterns with ultrahigh resolution. However, the area of BCP patterning with long-range order relies on the area of the prepattern, which is usually defined by e-beam lithography[1-4]. Many applications such as bit patterned media (BPM), require patterning over wafer-size area. Here, nanoimprint lithography is explored as a high-throughput and low-cost method to create high-quality prepatterns over large area. We have demonstrated addressable 1-D or 2-D PS-*b*-PDMS nanoarrays (*Fig. 1*) over several to tens of square centimeters area using this method. Factors affecting the quality of directed BCP patterns will be discussed. Extending this method to other BCP systems like PS-*b*-PMMA will also be reported.

As a benchmark of using BCP patterns for high-density nanodevice applications, pattern transfer from PS-*b*-PDMS nanotemplates with a pattern density of at least 1.3 teradot/in^2 was successfully demonstrated, into various functional materials, such as carbon, silicon, quartz, and magnetic materials. An ultrahigh density quartz template at 1.3 teradot/in^2 was fabricated to be used for the fabrication of BPM above 1 teradot/in^2 on a 2.5" disc (*Fig. 2*). A series of magnetic measurements showed excellent pattern uniformity throughout the whole patterned area.

1. R. Ruiz et al., *Science* **321**, 936 (2008).
2. I. Bita et al., *Science* **321**, 939 (2008)
3. J. Y. Cheng, C. T. Rettner, D. P. Sanders, H. C. Kim, W. D. Hinsberg, *Adv. Mater.* **20**, 3155 (2008).
4. S. Xiao, X. Yang, S. Park, D. Weller, T. P. Russell, *Adv. Mater.* **21**, 2516 (2009).

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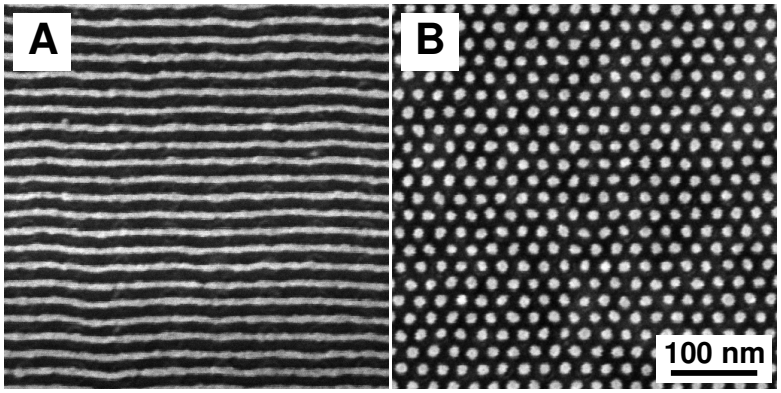

Fig. 1: 1-D and 2-D PS-*b*-PDMS nanopatterns directed by nanoimprint-defined prepatterns: (A) line array consisting of lying-down cylinders with a pitch of 21 nm; (B) hexagon dot array consisting of spheres with a pitch of 24 nm.

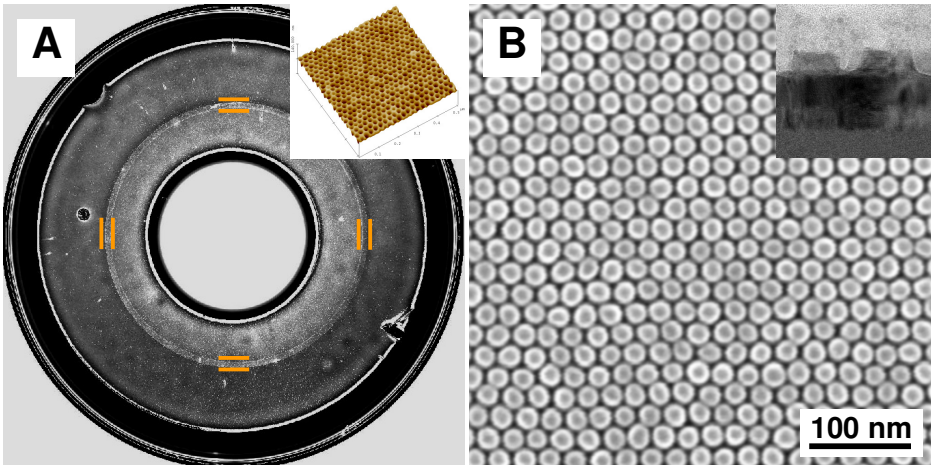

Fig. 2: Use of block copolymer nanotemplates for fabricating high-density quartz templates and bit patterned media: (A) Candela image of a 2.5" disc after imprinting using a 1.3 teradot/in^2 quartz template (patterned circumferential band as indicated by brown bars). The quartz template was fabricated using a PS-*b*-PDMS nanotemplate with the same density as the etch mask. The inset shows AFM image of imprint resist patterns; (B) SEM image of magnetic dot arrays on a disc after pattern transfer from the above imprint pattern. The inset shows cross-sectional TEM of magnetic dots.