Template fabrication for bit-patterned media using graphoepitaxial block copolymer cylindrical nanodomains

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Bit-patterned media (BPM) is attracting tremendous research efforts, as a promising next-generation magnetic recording technology. Various precise and expensive lithographic methods, such as electron beam lithography and interference lithography, are investigated to produce BPM templates and thus fabricate densely packed magnetic dots by additive or subtractive pattern transfer. To shorten the patterning process time and lower the cost, some non-conventional lithographic methods, such as block copolymer self-assembly, have also been explored to create well-registered magnetic dots.

In the fabrication of a BPM template using block copolymers, one major advantage is that the stringent lithography requirement, put forward by the ultra-high patterning density (i.e. 39 nm dot pitch for 500 Gbit/in^2 in a hexagon array), can be lowered by applying a relatively large-pitch surface pattern to guide the self-assembly of small-pitch block copolymer patterns. To be a viable template for BPM fabrication, two key parameters of the block copolymer nanodomains need to be addressed: (a) size uniformity, and (b) registration to the substrate. Here, the registration of domain structures to the substrate is achieved by graphoepitaxy of cylindrical block copolymer domains to a surface topographic trench pattern.[1,2] The block copolymer cylindrical domains orient perpendicular to the substrate due to balanced interfacial interactions between the two components in the copolymer and the substrate surface. All of the domains are aligned well along the sidewall of the trench pattern. The size distributions of cylindrical domains on both flat surface and topographically patterned surface are analyzed, and the correlation between the size distribution and the long-range order is discussed, as illustrated in Fig. 1. The distributions of some domain position-related parameters, such as the interaxis distance and interspot distance along the axis parallel to the trench sidewall, are investigated as a function of the number of domain rows in the trench. Some factors affecting the quality of block copolymer templates are also studied. Finally as shown in Fig. 2, the pattern transfer from well-ordered block copolymer templates to patterned magnetic dots is performed and the change of magnetic properties before and after magnetic dot patterning is demonstrated.

[1] X-M. Yang, S. Xiao, C. Liu, K. Pelhos, K. Minor, J. Vac. Sci. Technol. B **22**, 3331 (2004).
[2] S. Xiao, X-M. Yang, E. W. Edwards, Y. H. La, P. F. Nealey, Nanotechnology, **16**, s324 (2005).

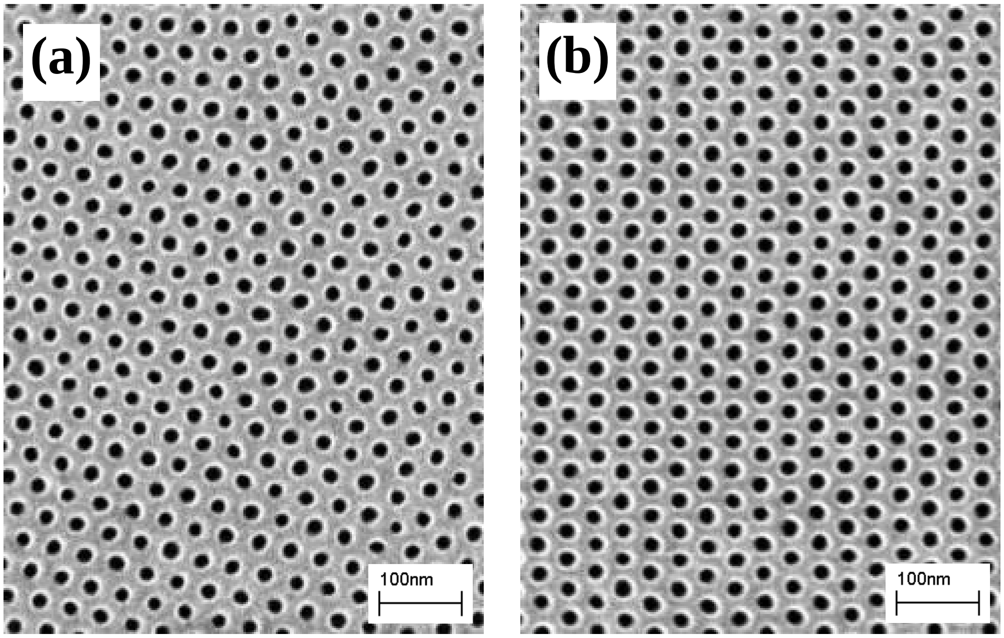

Fig 1: Top-down SEM images of perpendicularly oriented cylindrical PS-*b*-PMMA domains, with size distributions (1σ) of (a) 6.0% in multiple grains, and (b) 4.6% in a single grain.

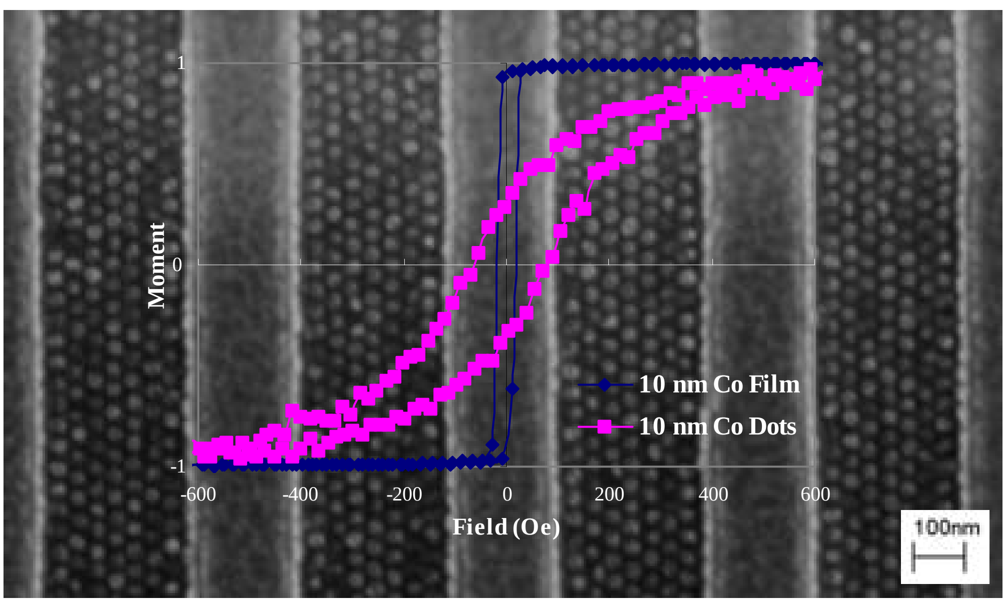

Fig 2: SEM image of well-aligned magnetic dots after pattern transfer from a block copolymer template confined in trenches and magnetic loops of Co dots and a continuous Co film (inset).