Directing Block Copolymer Assembly within Patterned Media Specifications

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As the magnetic storage industry considers the introduction of patterned media technology as a route to thermally stable magnetic recording at densities beyond 1Tbit/in^2, innovation for alternative lithographic processes to achieve patterns with full pitch below 25nm is critical to enable suitable templates for patterned media. We anticipate that fabrication specifications will require a $1\sigma < 5\%$ for both critical dimension and placement accuracy[1] making patterned media templates extremely challenging for any current lithographic technique. Directed assembly combines the uniformity of block copolymer self assembly with the long range placement accuracy of e-beam lithography as an alternative route to achieving dense patterns with tight size and placement tolerances.[2]

We compare feature size uniformity and placement accuracy for a PMMA e-beam resist pattern (Fig. 1a) and a directed block copolymer film (Fig. 1b) each with a nearly hexagonal lattice with center-to-center distance of 28nm. The white superimposed grid is a best-fit to the pattern lattice. Fig. 2a displays the dot size distribution for both samples and Fig 2b corresponds to the placement distribution around the best-fit lattice point. In both cases, the standard deviation of the block copolymer pattern is below 5% and lower than its e-beam counterpart. The statistics for the block copolymer patterns remain unchanged even when the self assembly is directed by chemical pre-patterns at lower densities than that of the block copolymer film in a scheme that improves resist resolution with reduced e-beam writing times. The feature density multiplication and pattern rectification demonstrated by directed assembly provide a method to enhance the capabilities of e-beam lithography enabling higher resolution with improved pattern quality and a reduction of writing time.

[1] M. E. Schabes, Journal of Magnetism and Magnetic Materials **320**, 2880 (2008).

[2] R. Ruiz, H. Kang, F. A. Detcheverry, E. Dobisz, D. S. Kercher, T. R. Albrecht, J. J. de Pablo, and P. F. Nealey, Science **321**, 936 (2008).

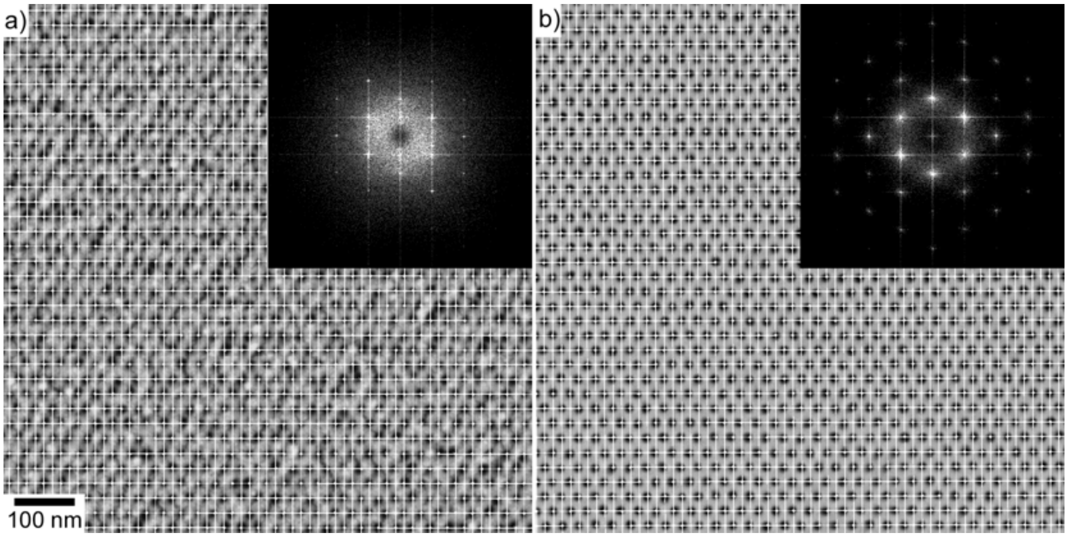

Fig. 1. Scanning electron micrographs of (a) e-beam resist and (b) directed assembly of block copolymer patterns with best fit lattice superimposed. In both cases the full pitch is 28nm. Insets show power spectra densities for both samples.

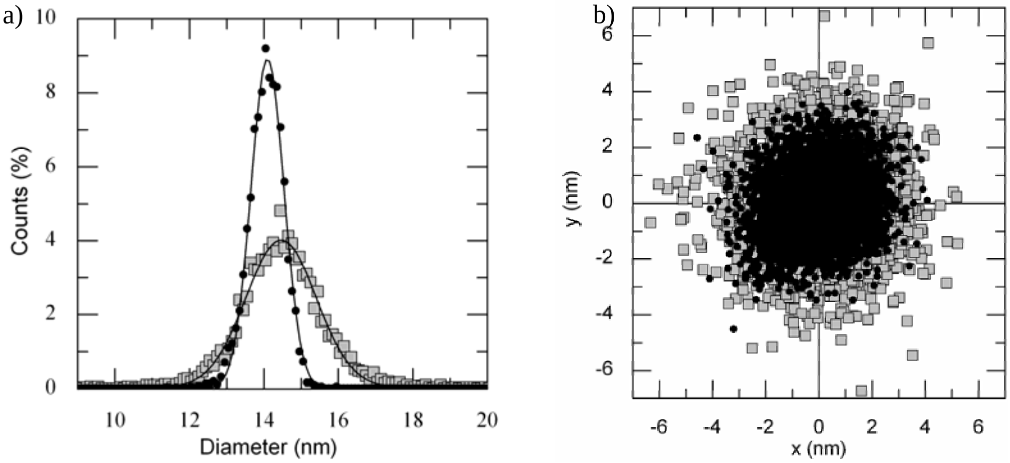

Fig. 2. (a) Feature size distribution for e-beam resist (squares, 1σ = 9.5%) and block copolymer pattern (solid circles, 1σ = 3.3%). (b) Placement distribution around the best-fit lattice point. E-beam resist patterns have a 1σ = 5.5% while the block copolymer pattern shows 1σ = 4.3%.