MAR09-2008-001047

Abstract for an Invited Paper
for the MAR09 Meeting of
the American Physical Society

Long range ordering in block copolymer thin films

CAROLINE ROSS, MIT

Thin films of microphase separated block copolymers, which can form patterns consisting of dense arrays of lines or dots, are attractive materials for self-assembled nanoscale lithography. The long range order of the block copolymer microdomains can be controlled by the use of chemical or topographical patterns. In this work, we discuss how Si-containing block copolymers, polystyrene-b-polyferrocenyldimethylsilane (PS-PFS) and polystyrene-b-polydimethylsiloxane (PS-PDMS), can be templated on substrates patterned with posts or steps. In the case of 40 nm period spherical morphology PS-PDMS, <20 nm diameter posts, which are coated with a grafted layer of PDMS homopolymer, define the locations of surrounding PDMS microdomains. The lattice spacing and orientation of the templated PDMS microdomain array can be predicted from the ratio between the post spacing and the equilibrium microdomain spacing. PFS spheres, formed from spherical-morphology PS-PFS, can be aligned within shallow trenches to form a close-packed array with row spacing determined by the trench width. We also show how 32 nm period cylindrical morphology PS-PDMS can be templated using topographical features. Templating using posts or linear substrate features gives arrays of straight parallel cylinders with controllable period and orientation, while templating in circular pits creates sharply curved, concentric toroidal structures. The overall morphology and period of the block copolymer microdomain arrays can be varied by solvent annealing in mixed solvent vapors, for example cylindrical-morphology PS-PDMS can form perforated lamellae by annealing in toluene plus heptane. These results will be discussed in the context of nanolithography, including examples of pattern transfer to form metal, oxide and polymer functional nanostructures. Bita et al, Science 321 939 (2008); Jung et al, Nano Letts. 7 2046 (2007); 8 2975 (2008).