Solvent Annealing Conbined with Surface Resconstruction towards the Fabrication of Silicon Nanodots with Areal Density beyond 1 Teradots/Inch^2

Ji Xu, Thomas P. Russell

University of Massachusetts, Amherst, MA 01003

jixu@mail.pse.umass.edu

Shuaigang Xiao, Kim Y. Lee, David Kuo

Seagate Technology, 47010 Kato Road, Fremont, CA 94538

Pattern transfer is one of the key steps to fabricate functional nanostructures for microelectronic applications, like high density data storage. Here we use a surface reconstruction technique with polystyrene-*b*-poly(ethylene oxide) (PS-*b*-PEO) and polystyrene-b-polyvinylpyridine (PS-*b*-PVP) to address this issue with an areal density beyond 1 Teradots/inch^2. We applied solvent annealing method to block copolymer systems to obtain good lateral ordering, and then use surface reconstruction to produce nanopores at each microdomain site. The nanopores were then converted to silicon oxide nanoposts through a tone reversal process utilizing spin-on glass. We found that the overall depth of nanopores and thin film's surface roughness played a critical role in obtaining silicon oxide nanoposts with good quality. An areal density beyond 2 teradots/inch^2 was achieved by adding salts to PS-*b*-PEO with lower molecular weight. We successfully fabricated silicon nanodots with 1.3 Teradots/inch^2 system but had difficulty in getting satisfactory results from surface reconstruction when dealing with >2 Teradots/inch^2 system, due, more than likely, to the energy penalty associated with stretching short polymer chains during the surface reconstruction process. Feature density multiplication of addressable dot arrays was realized using solvent annealing on chemically patterned surfaces fabricated by electron-beam lithography.

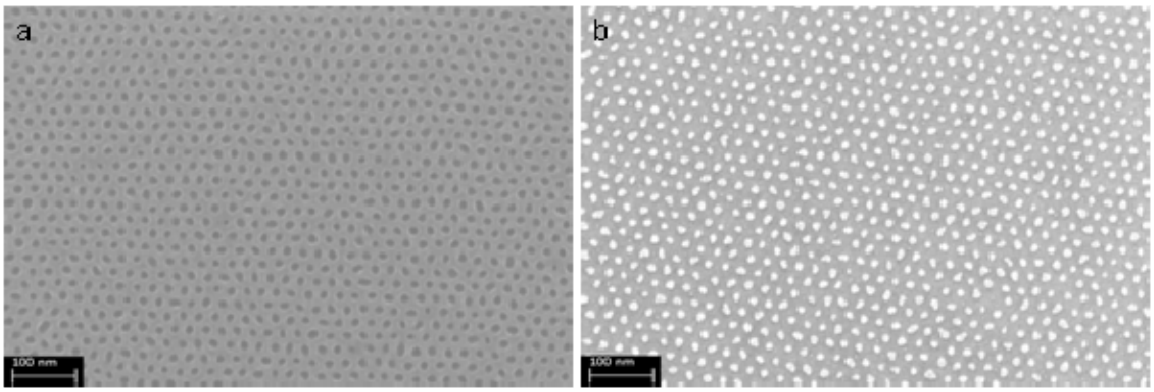

Figure 1. SEM images: (a) a thin film of PS-*b*-PEO (16k-5k) after surface reconstruction with diluted acetic acid (90%) and (b) silicon oxide nanoposts obtained from the tone reversal process.

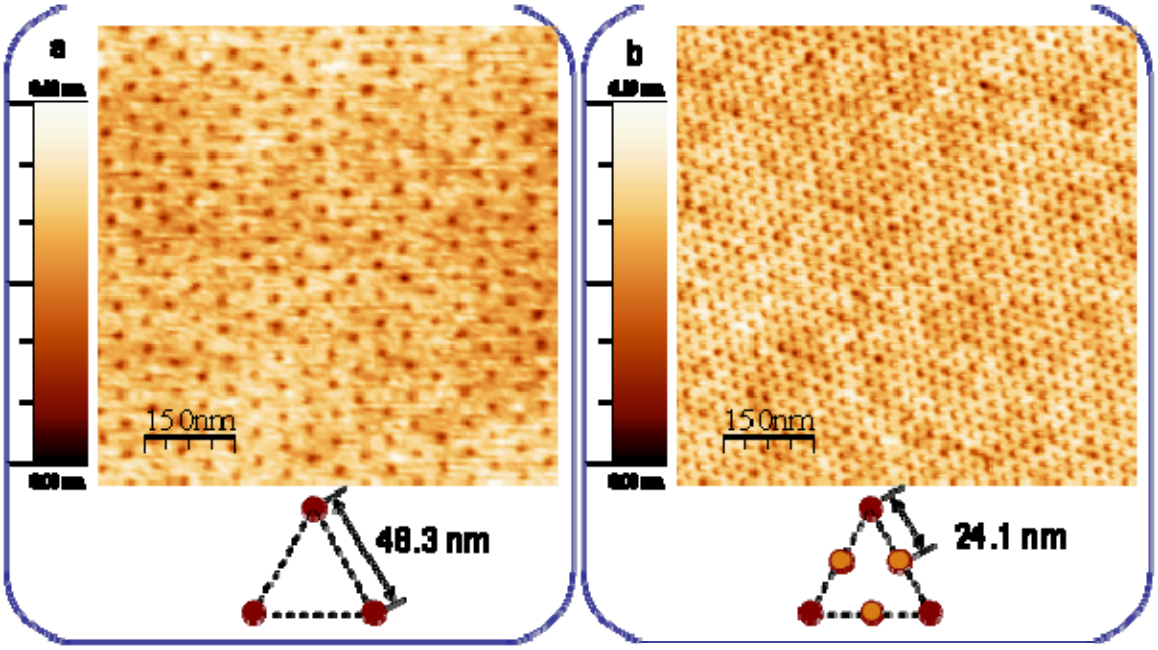

Figure 2. Tapping mode AFM height images: (a) chemical dot pattern fabricated by e-beam lithography and (b) PS-*b*-PEO thin film annealed with solvent vapor on the prepatterned surface. The scheme underneath each image illustrates the approach of density multiplication.