A Facile Fabrication Process for Polystyrene Nanoring Arrays

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Figure S1. SEM images of 400 nm polystyrene spheres patterns obtained by spin coating at 1,000 (a), 2,000 (b) and 3,000 rpm (c) and a digital camera image of the silicon substrate covered by nearly uniform polystyrene nanosphere monolayer (d).

Figure S2. SEM images show the etching time effect on the formation of polystyrene nanoring arrays. The samples were exposed to argon plasma for 60 (a), 90 (b), and 120 sec (c). Note that the diameter of the nanorings was not sensitive to the plasma treatment time. However, when the nanospheres were etched for 120 sec (c), in some locations the nanorings became closed. This nanoring nonuniformity could result from total polystyrene spheres modification. Therefore, for optimal results the nanospheres should be exposed to Ar etch for 60 to 90 sec; this exposure formed nanorings with diameters of about 220 nm.
Figure S3. Digital camera images (a-c) and SEM images (d-i) of ~1 cm$^2$ silicon wafer piece covered by 400 nm polystyrene spheres (a, d), and the samples after argon plasma etching for 60 sec (b, e) and 90 sec (c, f); SEM images of the polystyrene spheres after being treated by 0 sec (g), 60 sec (h), and 90 sec (i) plasma and immersed in tetrahydrofuran for 30 min.
Figure S4. SEM images show the solvent effect on the formation of polystyrene nanoring arrays. The samples were treated by tetrahydrofuran (a), toluene (b), and methanol (c) and the sonication. Note that nanorings were found after sample immersions in polystyrene good solvents including THF (a) and toluene (b), but were not apparent after immersion in non-solvents, such as methanol (c). Hexagonal close-packed pattern (c) resulted from the differential etching of the underlying silicon substrate caused by the presence of the nanospheres.

Figure S5. Outer diameters ($d_o$) of nanorings obtained from samples fabricated with (a) 400 nm spheres and THF as immersing solvent, (b) 400 nm spheres and toluene as immersing solvent, and (c) 250 nm spheres and THF as immersing solvent. The variation of the nanoring dimensions obtained from samples fabricated in three processes with identical parameters is shown in (a).
Figure S6 A digital image of round 3-in silicon disks with assembled polystyrene spheres (a) and the optical microscope image