CONVECTIVE SELF ASSEMBLY OF MICROSPHERES FOR SUBWAVELENGTH PHOTOLITHOGRAPHY, Andrew S. Dai, Ryan Gelfand, Wei Wu, Hooman Mohseni*, Northwestern University, Department of Electrical Engineering and Computer Science, Evanston, IL, 60208, hmohseni@ece.northwestern.edu

Nanoscale structures such as nanopillars and nanoholes have very useful applications. They can be used to improve solar cells [1], increase the capacity of fuel cells [2], and enhance biosensors [3]. The traditional methods for making nanostructures, such as using focused ion beams to serially create holes, are often expensive and have low yield. Photoresist nanostructures can be made very cheaply and quickly by using silica microspheres to focus UV light sub-diffraction-limit and expose extremely small areas of the photoresist [4]. Here we present a method to produce large areas of uniform nano-hole and nano-pillar arrays for applications requiring very high throughput nano-processing. If positive tone photoresist is used, nanoholes can be formed, and if negative tone photoresist is used, nanopillars can be constructed. Metal evaporation and liftoff can then be performed, leaving the metal with an array of nanoholes or nanopillars. Wide and uniform arrays of these structures can be manufactured by assembling a large area monolayer of microspheres. To create the monolayer, a suspension of spheres in water is dropped onto the photoresist-coated substrate. A glass slide is then used to move the meniscus across the substrate. As the meniscus is dragged across, water beings to thin out and evaporate. The increased surface tension pulls the spheres towards the edge of the meniscus, thus creating a monolayer via convective self assembly [5]. Different surface treatments were used in varying concentrations to make the photoresist hydrophilic, so that the hydrophilic silica microspheres would adhere to the surface better. Other parameters such as sphere concentration, deposition speed, exposure time, and development time were also adjusted in an effort to make thin (~200nm) and tall (~500nm) pillars. The developed substrates were then analyzed using an SEM (Fig. 1). By finding the optimal parameters, large (1.5cm x 1.5cm) arrays of nanopillars were formed with high (~75%) coverage and uniformity (Fig. 2). By using microspheres and convective self assembly, pillars can be made in less time and using less expensive equipment.

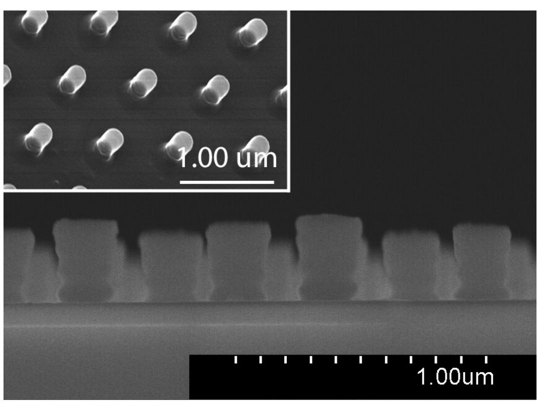

Fig. 1: SEM of nanopillars, angled and side views.

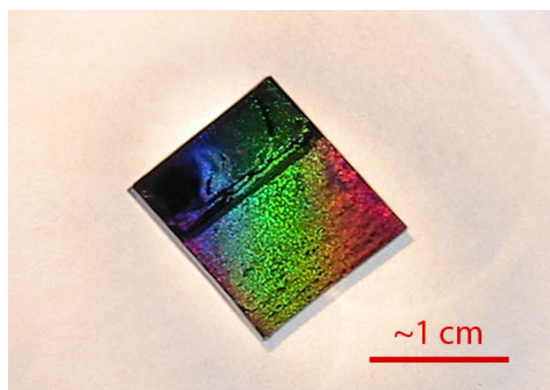

Fig. 2: Speckled region shows coverage of pillars.

References

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