Large-Area Nanofabrication by Colloidal Lithography

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In the recent years regular nanostructured arrays have been attracted great interest because of their potential applications in many devices such as photonic crystals, surface plasmonics, solar cells and magnetic memories. To develop such nanostructured systems, fabrication techniques like electron beam lithography and focused ion beam lithography are generally involved for their capability to realize array of nanofeatures with precise size, shape and distribution control. However, these complex processes present some critical drawbacks like high-cost and low speed. The negative aspects of conventional nanolithographic techniques have encouraged the development of an innovative method for parallel nanofabrication called colloidal lithography.

Colloidal lithography is a promising fabrication tool that provides a much faster, cheaper and simpler approach than conventional methods for the realization of nanoscale patterns such as nanodisks, nanoholes, nanodots.

Generally, in this technique, an array of polystyrene spheres is deposited on the substrate and used as a lithographic mask (positively, using the particles or negatively, using the interstitial spaces). The colloidal crystal array can be assembled by means of several approaches such as spin coating, controlled evaporation, Lagmiur-Blodgett coating, electrophoretic deposition.

The aim of our work was the fabrication of a gold nanodisk distribution for application in surface plasmonics. Among various methods for colloidal mask fabrication, we focused our efforts on the use of an electrostatic self-assembly strategy capable to produce large uniform area [1]. In our method, functionalization of substrates was applied to aid in the attraction and assembly of particles. Specifically, we applied a simple procedure in which negatively charged polystyrene nanospheres adsorb randomly onto positively charged surface and self-organize through

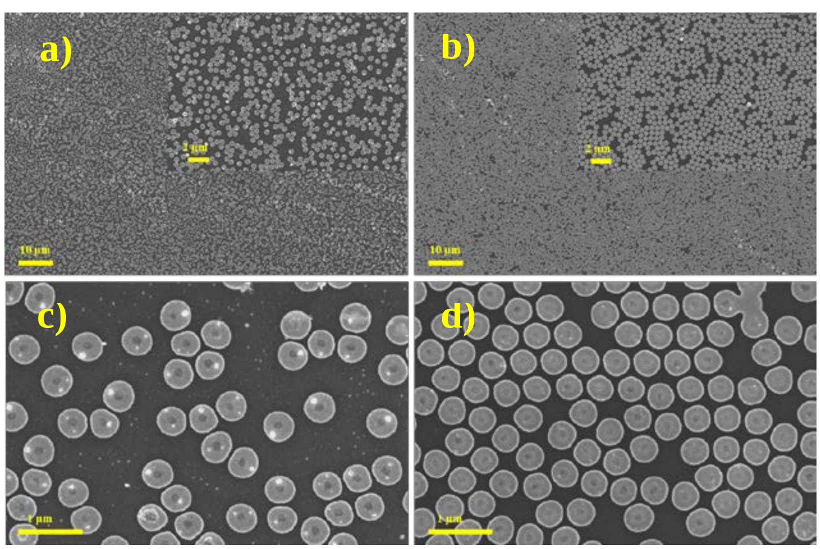

Figure 1 *SEM plan-view at low* ***(a,b)*** *and high magnification* ***(c.d)*** *of two sample with different condition of nanosphere mask preparation.*

electrostatic interaction.

In particular, for the realization of gold nanodisk distribution, a thin layer of gold (40 nm) was deposited by thermal evaporation on glass substrate. Then the gold surface was positively charged by dip coating the substrate in three different suspensions of polymers with alternating charge polarity. Later, a monolayer of polystyrene nanospheres was adsorbed onto the gold surface and used as an etch mask. For this reason, Reactive Ion Etching was employed to selectively remove the portion of the gold film that was not protected by the nanospheres. Finally, the removal of the nanosphere residues reveals the fabricated nanostructures on the substrates. The size of nanodisks can be directly controlled by changing the diameter of the polystyrene spheres, while the coverage can be varied by controlling the salt concentration of the nanosphere solution (**Figure 1**).

In conclusion, we realized a large-area (cm^2) nanostructured system using an inexpensive and simple method as colloidal lithography.

References

[1] P. Hanarp, M. Käll, and D. S. Sutherland, J. Phys. Chem. B, 107, 5768–5772, (2003).