Metal Nanoparticle Arrays by Controlled Decomposition of Polymer Particles

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We report on efficient fabrication methods for ordered metal nanoparticles by exploiting the uniform geometry of polymer beads that we deposit as close-packed monolayers via convective assembly. In contrast to "colloidal lithography" that applies particles as masks, we use controlled etching of the particles to define metal structures.

Large arrays of noble metal particles arranged in hexagonal patterns (Fig 1a) on different types of substrates were produced by combining particle monolayers with standard processes such as plasma etching, wet etching, rapid thermal annealing and metal coating. For example, self-assembled core-shell particles[1] with AuNP core size of ~15 nm were converted into metal particles by rapid thermal annealing or oxygen plasma which removed the polymer shell and promoted the core-AuNP deposition on silicon substrate (Fig.1b). By adjusting the process parameters, arrays of noble metal particles with diameters ranging from several micrometers down to below 50 nm can be readily fabricated. Other routes yield combinations of different particle sizes in the array (Fig. 1a).

All processes shown here are based on the controlled decomposition of the polymer particles. We thus analyzed the etching kinetics quantitatively. Figure 2 shows how hexagonal, non-closed packed particle arrays with defined spacing can be generated by plasma treatment of monolayers.

These metal particle arrays may be used for a host of applications including Surface Enhanced Raman Spectroscopy, templates for 3D surface nanostructuring, surface biofunctionalization, sensing, data storage and many others.

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[1] *Phys. Chem. Chem. Phys., 2011, **13**, 5576–5578*

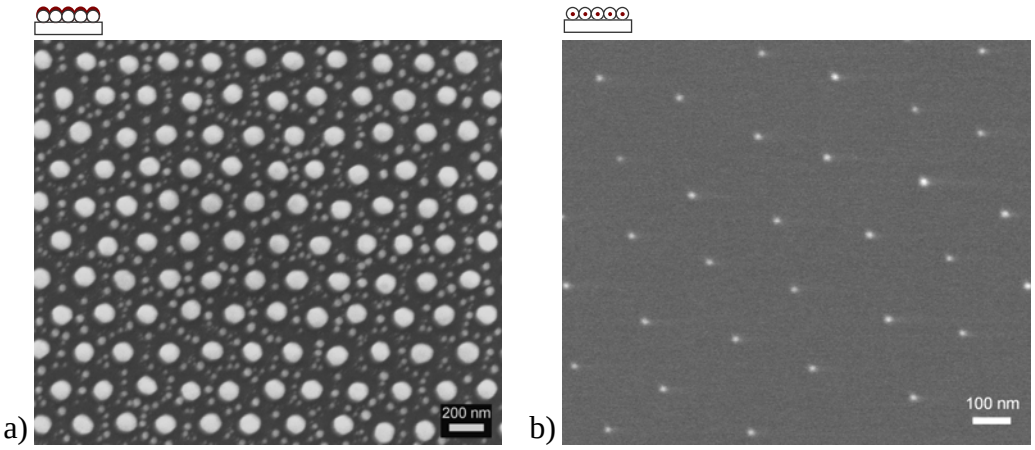

Figure 1: SEM images of typical fabricated hexagonal arrays of Au nanoparticle with sizes of ~110 nm (a) and ~15 nm (b)

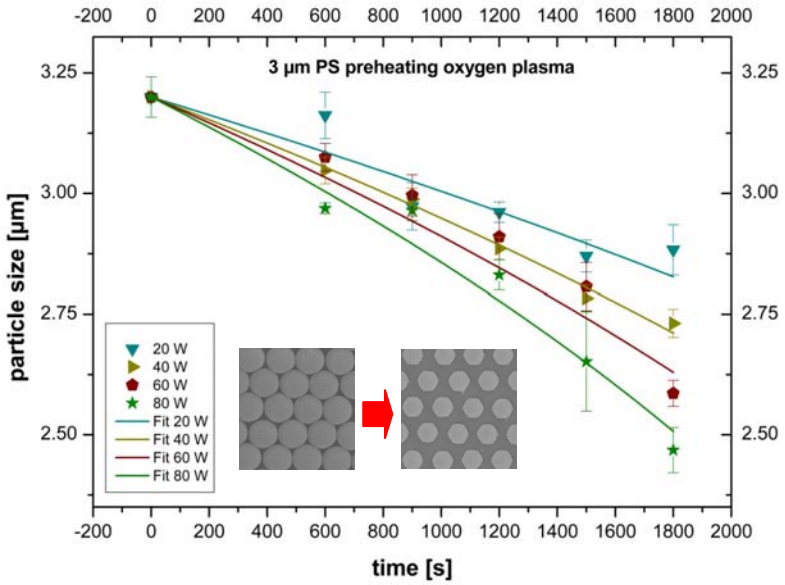

Figure 2: Polystyrene diameter dependence on oxygen plasma exposure time (inset: typical hexagonal non-closed packed monolayer produced by oxygen plasma treatment)