Hierarchical assemblies of micro- and nano-colloids obtained by Convective Self-Assembly for multifunctional electric-optical sensors

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Current developments of nanotechnology rely on the rational design and controlled fabrication of particles, regular arrays of particles, and patterned films with at least one of their size parameters in the 1-100 nm regime. Chemically synthesized colloids have a series of advantages over nanostructures prepared by top-down lithographic techniques: they can be easily produced in large amounts, broad range of sizes, controlled shape, with a narrow size and shape dispersion, better surface quality[1]. Many interesting applications rise from interparticle coupling effects (optic, magnetic, electric), when particles are assembled on a solid substrate into structures comprising a large number of particles. A challenge remains to control the assembly of colloids into hierarchical structures of designed, desired morphology[2].

Here I present some of my results on the fabrication, properties and some applications of hierarchical assemblies of micro- and nano- colloids. The Convective Self-Assembly (CSA) technique is introduced (Fig.1-center), which is employed in two complementary approaches: 1) Metallic (or polymer) structures are fabricated by templating on regular arrays of polymer micro-colloids (i.e. colloidal crystals) obtained by CSA (some examples in Fig.1-left). Their optical properties[3] and selected sensing applications in Surface Enhanced Raman Scattering[4] and Surface Enhanced Fluorescence[5] are outlined. 2) By CSA of metallic nano-colloids a large palette of patterns (some examples in Fig.1-right) can be directly obtained by controlling several experimental parameters. Among such structures, tunable electrically conductive wire-like assemblies[6] appear promising in deformation sensing applications.

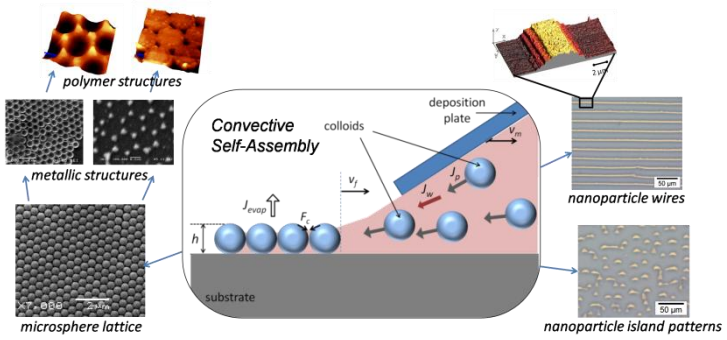

Fig.1 Scheme of Convective Self-Assembly (center). Metallic and polymeric structures by templating arrays of micro-colloids (left). Island and wire-like patterns by assembly of metallic nano-colloids.

Finally I discuss some possibilities of merging optical and electrical functionalities on a single platform consisting in arrayed metallic nano-colloids.

References

1. C. Burda, X. Chen, R. Narayanan, M. A. El-Sayed, *Chem. Rev.* 2005, *105*, 1025.
2. M. Grzelczak, J. Vermant, E. M. Furst, L. M. Liz-Marzan, *ACS Nano* 2010, *4*, 3591.
3. C. Farcau, S. Astilean, *J. Opt. A: Pure Appl. Opt.* 2007, *9*, S345.
4. C. Farcau, S. Astilean, *J. Phys. Chem. C* 2010, *114*, 11717.
5. C. Farcau, S. Astilean, *Appl. Phys. Lett.* 2009, *95*, 193110.
6. C. Farcau, H. Moreira, B. Viallet, J. Grisolia, L. Ressier, *ACS Nano* 2010, *4*, 7275.