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Nanocomposite of silica and acrylate as a platform for nanostructuring of materials

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Abstract – This work introduces a nanostructuring procedure that allows the fabrication of ordered arrays of metallic spheres molded by a polymeric mask. The ordered composite is formed on silicon substrates by spin-coating of silica nanospheres embedded in a viscous monomer matrix which is polymerized thereafter. The ordered composite may be further processed, either by removal of the polymer matrix by oxygen plasma etching, or by selective chemical etching of the silica spheres. The latter procedure yields a microporous mold, whose interstices may be filled with metal by electrodeposition and removal of the polymeric matrix.

This work introduces a nanostructuring procedure that allows the fabrication of non-close-packed ordered arrays of metallic spheres molded by a polymeric mask. The great advantage of the technique employed is the possibility to produce, from a few procedures, three types of technologically important materials – colloidal crystal, microporous polymer and polymeric nanocomposite [1]. The three structures formed have great technological interest due of their regularity and order at the nanoscale. In particular, the periodic variation of the refractive index of nanostructure results in photonic properties (Figure 1a) that can be exploited in the manufacture of optical sensors.

Those masks are formed on silicon substrates by spin-coating of silica nanospheres embedded in a viscous and non-volatile monomer matrix, which is polymerized by UV radiation thereafter. Furthermore, the process of monodisperse silica colloidal synthesis was mastered and monodisperse spheres of varying sizes were produced [2,3] (Figure 1b). The ordered composite may be further processed, either by removal of the polymer matrix by oxygen plasma etching, or by selective chemical etching of the silica spheres (Figure 2a). The latter procedure yields a microporous mold, whose interstices may be filled with metal by electrodeposition.

Further removal of the polymeric template reveals a set of ordered metallic clusters with spacing and periodicicity resembling those of the original mask (Figure 2b). This technique enables the fabrication of nanostructured ordered arrays for applications in photonics, spintronics or catalysis, as well as sensors and devices.

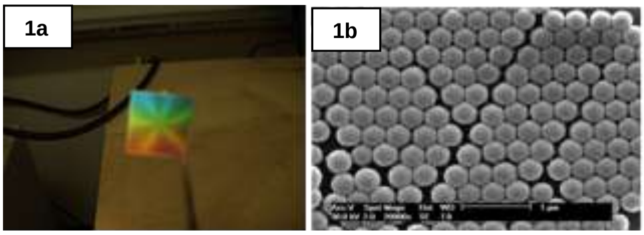

Figure 1: a) Photonic properties of the polymeric nanocomposite. **b)** SEM image of the monodisperse silica spheres used for produce of the polymeric nanocomposites.

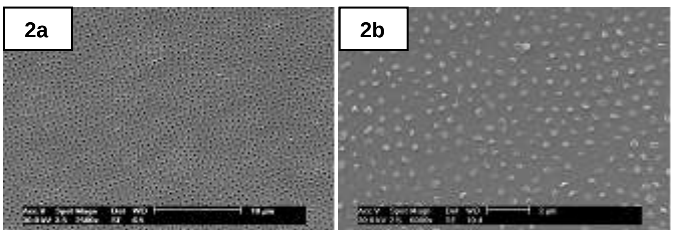

Figure 2: a) SEM image of the microporous polymer after removal of silica spheres. **b)** SEM image of the ordered metallic clusters obtained by electrodeposition in the interstices of the polymeric template.

References

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