FULL PROCESSING OF COLLOIDAL PHOTONIC CRYSTALS BY SPIN COATING

*Agustín Mihi, Manuel Ocaña, Hernán Míguez**
Instituto de Ciencia de Materiales de Sevilla, Consejo Superior de Investigaciones Científicas, Américo Vespucio s/n, 41092 Sevilla, Spain
Hernan@icmse.csic.es

Photonic crystals[1] are materials in which the periodicity of the dielectric constant in 1, 2 or 3 dimensions gives rise to forbidden photon energy intervals, the so called photonic band gaps. The properties that arise as a consequence of the band structure of the photonic crystals have potential applications in telecommunications, lasers, etc.[2]

Photonic colloidal crystals are a type of three dimensional photonic crystals composed of spherical colloids typically arranged in an FCC structure.[3] This type of structures presents high optical quality and are easily fabricated with low cost. Furthermore, they have also been used as templates to impose three dimensional order at the micron length scale to oxides,[4,5] semiconductors,[6,7] metals,[8,9] and polymers.[10,11,12], combining the properties of the infiltrated material and the photonic structure. Colloidal crystals have been used as sensors[13], in chromatography[14] and, lately, in solar cells, in which they are used to enhance the light absorption effiency of the cell.[15] Nevertheless, the main drawback of these colloidal crystals is the incompability between the current device microfabrocation techniques and the time-consuming and unclean self assembly crystallization methods commonly used to assemble the colloidal crystals. Typically, photonic colloidal crystals are grown by evaporation induced self assembly techniques which involved the immersion of the substrate in a colloidal dispersion during days. [16] In this sense, one step forward was given recently by Jiang et al.[17] developing a procedure where thin film silica – polymer composite were grown by spin coating. Such technique, although allowed the fabrication of large area films of colloidal crystals, could not be extended to polystyrene colloidal crystals and could not be used as templates since the resulting structures were already infiltrated. In this communication, we present a simple, fast and reliable method to crystallize submicrometer monodisperse silica and latex colloids using a mixture of volatile solvents as dispersion media, allowing one to attain a strongly diffracting photonic crystal structure within minutes without further processing. The use of volatile solvents as ethanol or ethylene glycol permits further infiltration of the so obtained colloidal crystals. Furthermore, during the course of our investigations we found that it was possible not only to attain planarized colloidal crystals with controlled thickness, but also to determine the crystal growth direction with respect to the substrate without the employment of any patterned substrate, as showed in figure 1.

The spin coating technique has been widely used in industry of coatings. In photonic crystals has also been used to infiltrate[18] the structure and also to fabricate nanocrystalline layers that act as dielectric dopants of the colloidal crystal.[19] All these achievements along with the abovementioned colloidal crystallization technique[20] shows the feasibility of a full processing of photonic colloidal crystals by spin coating.

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Figures:

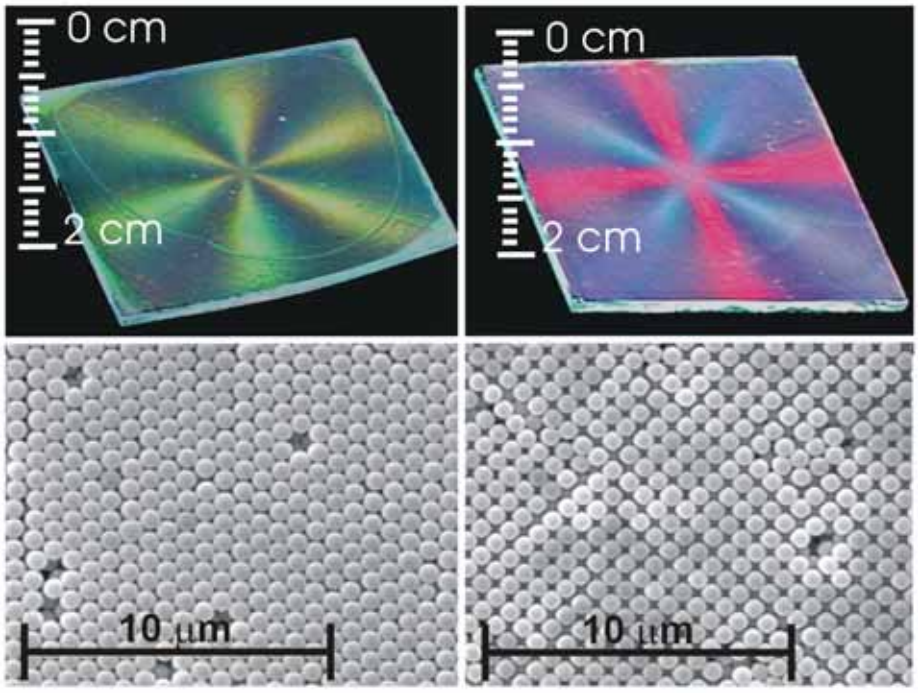

Figure 1. Optical (top) and electronic micrographs of the different colloidal lattices attained by spin coating.