Magneto-photonic properties of Nickel inverse opals

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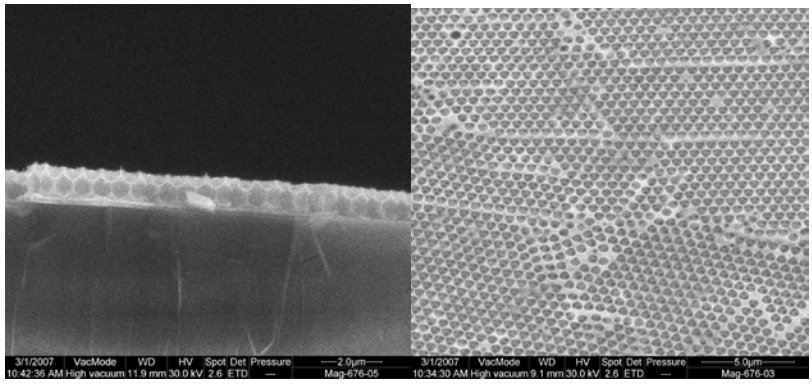
Abstract

Photonic Crystals are a new class of materials where the dielectric constant is periodically modulated. This peculiar structuration provokes the appearance of allowed and forbidden states for photons, creating where have been called photonic bands and gaps, in analogy with their electronic counterparts. Generally these materials are passive, their properties only given by the structuration. However, introducing active elements it is possible to tune their photonic properties by external stimuli. Following this idea, we have fabricated three-dimensional photonic structures based on self-assembled colloidal crystals and replicated on Nickel to actuate on their photonic properties via magnetic fields.

Thin artificial opal films with sphere diameters ranging from 200-700 nm have been infiltrated with Ni by means of electrodeposition (ED) and Atomic Layer Deposition (ALD). The former yields homogeneous infiltration that floods the inner pores of the structure while the latter provides homogeneous conformal growth (shells) around the spheres with atomic precision. The magneto-photonic properties of these two Nickel nanostructures have been studied both experimentally and theoretically, performing a thorough analysis of the Magneto-Optical Kerr Effect spectra. We have found a clear dependence of the MO response as a function of the sphere size as well as on the Ni growth method, implying thus that local properties are of great importance. This is also corroborated when comparing ordered vs. disordered structures. Our ansatz is based in the fact that, due to the metallic character of Ni, there is a plasmon-like excitation that modifies the distribution of the electromagnetic field inside the system, responsible of the MO response.



Nickel inverse opals grown by ED on 670 nm polystyrene opals.