SELF-ASSEMBLED DISORDER

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Abstract

Self-assembled nanostructures usually develop ordered patterns in three dimensions. Artificial opals are one of such possible arrangements usually forming *fcc* structures with promising photonic properties. Often, and undesirably, unwanted defects are present spoiling the optical properties of such nanostructures: e.g. in thin self-assembled photonic crystals the staking from one up to four layers of dielectric spheres may arise according to three different arrangements: face-centered cubic, hexagonal close-packed or double hexagonal close-packed (figure 1).[1] On the other hand, and contrary to intuition, the introduction of arbitrarily high amounts of disorder is, in some cases, an equally difficult task but the resulting material presents intriguing new optical properties. We have grown novel nanophotonic materials, *photonic glasses*, which are solid, disordered assembly of monodisperse dielectric spheres.[2] The novelty provided by these structures is the monodispersity of the spheres, which gives rise to a resonant behaviour of diffusion constant and transport mean free path. For the first time, we have measured these macroscopic resonances, as well as the frequency dependence of the energy velocity of the diffused light, which decreases below the group velocity when Mie resonances are excited. Diffusive modes at different frequencies, with different transport properties, appear in photonic glasses, as a result of the collective effect of the single-sphere Mie resonance.[3]

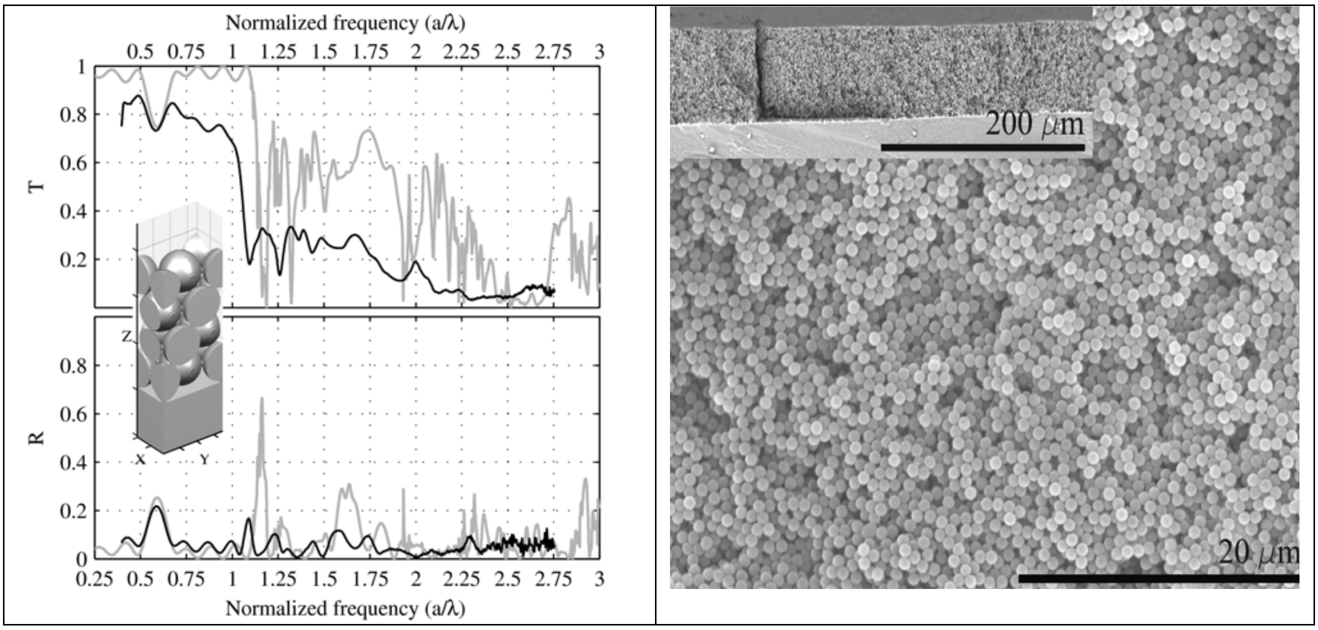

Figure 1. Left: spectra of a four-layer opal arranged in a face centered cubic structure (i.e. with a stacking of the form ABCA). Right:

[1] X. Checoury, S. Enoch, C. López, and A. Blanco, *Appl. Phys. Lett*. **90**, 161131 (2007)
[2] P. David García, Riccardo Sapienza, Alvaro Blanco, and Cefe López, *Adv. Mater.* **19**, 2597, (2007)
[3] R. Sapienza, P. D. García, J. Bertolotti, M. D. Martín, Á. Blanco, L. Viña, C. López, and D. S. Wiersma, Phys. Rev. Lett. **99**, 233902 (2007)