Light propagation in self-assembled hybrid metallodielectric structures

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Self assembly is a well established approach to fabricate photonic structures able to manipulate light propagation and emission at the nanoscale [1]. Beyond its use as a means to fabricate photonic crystals or resonant disordered structures such as photonic glasses, recent reports have shown how self assembly techniques can be used to fabricate hybrid photonic-plasmonic crystals [2, 3] which optical properties allow for a strong modification of the spontaneous emission of internal sources [2]. Further, the sensitivity of their optical response to their environment has been proposed as a means to use this kind of systems of optical sensors [3], and means to control their optical properties by modifying the dielectric components have been demonstrated [4].

In these hybrid structures, where periodic arrays of dielectric colloids are deposited on metallic substrates, electromagnetic fields undergo a strong spatial redistribution and strong field enhancements can be achieved. Depending on the spectral range under consideration electromagnetic fields can be localized close to the metal substrate (plasmon-like modes) or within the dielectric array (waveguided-like modes) (see Fig. 1a).

Several metallodielectric structures have been fabricated employing gold or silver substrates and their optical response has been compared to reference samples grown on dielectric substrates in order to better appreciate the effect of the metallic component. The dispersion relation of such structures has been probed by means of angle and polarization resolved reflectivity measurements (see Fig. 1b).

As in any photonic structure, losses degrade the optical response of these systems and hence its applicability; therefore knowledge is needed on how such losses can be minimized. In this work we explore the optical response of self-assembled plasmonic-photonic structures having different configurations and fabricated from different materials and explore how one can minimize intrinsic losses due to leakage and absorption. The effect of the optical constants of the metallic substrates has been explored. Further, the role of extrinsic losses originating at residual disorder generated during the growth process is discussed.

References

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Figures

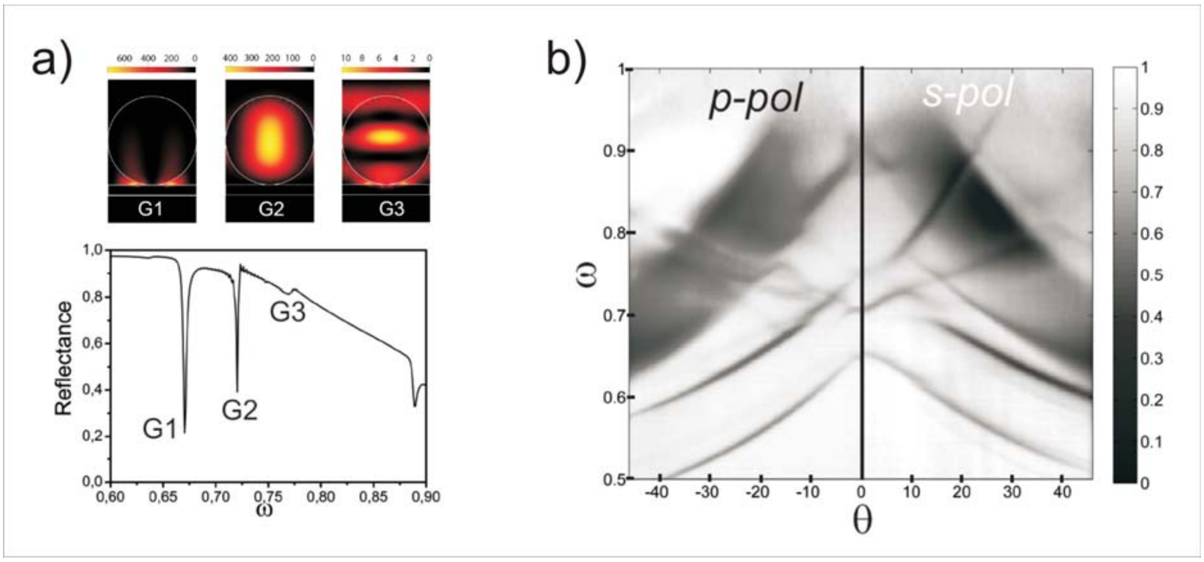

Fig. 1 *a) Normal incidence reflection spectrum for a dielectric array of 520nm diameter polystyrene spheres deposited on a gold substrate (bottom) and total field intensity profiles of the modes highlighted (top). b) Angle and polarization resolved reflection for the same sample.*