Tailoring the optical response of self-assembled photonic-plasmonic crystals

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Tuning the optical response of both photonic and plasmonic devices as well as their hybrid structures is a challenging issue. Recently it has been shown that colloidal self-assembled photonic crystals deposited on metallic substrates can yield large field enhancements at well defined wavelengths depending mainly on the diameter of the spheres [1]. It has also been demonstrated that such hybrid modes are strongly dependent on the morphology of the samples, or ,for example, changes on the surrounding media refractive index, as large as those of the best performing plasmon resonances based sensors[2].

In this work we present a complete theoretical and experimental study on how the filling fraction can strongly modify the modes of hybrid photonic-plasmonic crystals working in the visible-NIR range. By continuously reducing the diameter of polystyrene spheres deposited on gold substrates while keeping the lattice constant unchanged, we will show that not just the modal position, but also the field confinement can be strongly modified [3]. Evidence on this modification is carried out by mean of normal incidence reflectance measurements. As a proof of principle for application, dye doped spheres emitting in the visible range have been treated on the same way in order to strongly modify the spontaneous emission. This method allows tuning of the spontaneous emission (both angular and spectroscopic) with a very simple process.

Finally, this system is compared to well known plasmonic and photonic tunable systems showing its potential in future applications as for example solar cell, organic light emitting devices or sensing.

References

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Figures

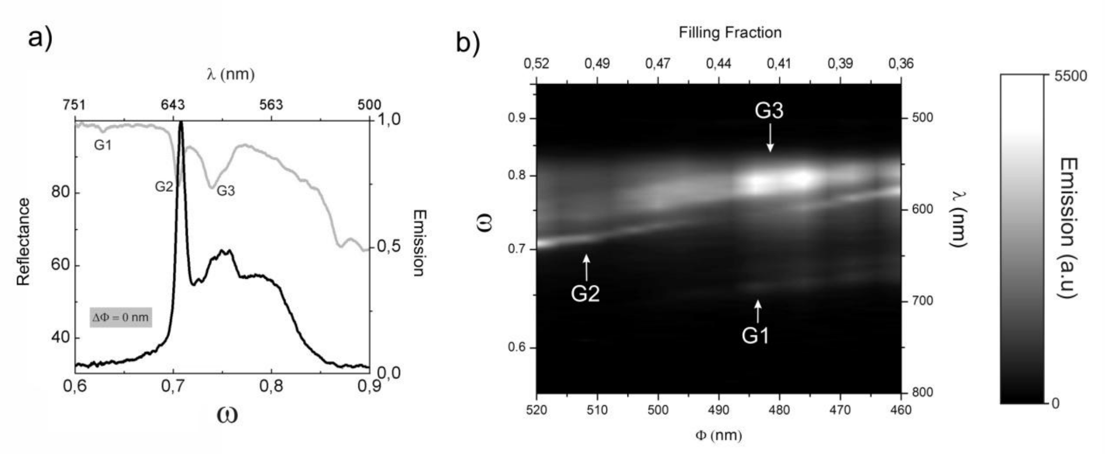

Figure 1. a) Normal incidence reflectance (grey) and emission (black) for close-packed lattice of red dye dopped PS 520 nm polystyrene spheres on gold substrate . b) Evolution of emission with filling fraction variation. G1, G2 and G3 are the best define modes shown as dips in reflectance in a).