Enhanced emission in self assembled photonic crystals by hybrid photonic-plasmonic modes

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Coupling between plasmonic and photonic systems has become one of the most efficient ways to obtain small scale waveguiding and emitting devices [i]. In this work, a novel structure for obtaining enhanced emission in a hybrid plasmonic-photonic structure is presented. The samples under study consist of large area close-packed ordered monolayers of dye doped polystyrene spheres grown on a thin (60nm) gold film. This system allows surface resonant plasmonic modes to couple efficiently to photonic ones leading to the formation of localized surface plasmon polariton (SPP) modes, propagating waveguide modes and hybrid ones [ii].

The dispersion relation of these modes is retrieved by means of angle and polarization resolved reflectance measurements for different crystallographic orientations. Comparison with calculated reflectance spectra as well as the spatial distribution of the electric field in the system allows us to identify different mode types. Field enhancement inside the spheres is seen to be much larger than that obtained for similar samples grown on dielectric substrates evidencing the role of the metallic layer in preventing leakage losses into the substrate [iii].

Finally we have studied the effect of such field enhancement on the emission of the dye by studying angle and polarization resolved photoluminescence (PL). We have observed that enhanced emission is obtained for those modes where the field is mainly concentrated in the region containing the emitter (i.e. polymeric spheres). A comparison with a reference system non structured thin dye doped polymer films deposited on gold, further points to the efficiency of our samples to obtain enhanced emission. The spectral tunability of the mode dispersion with sphere size makes this system a versatile one for many applications involving efficient emitting devices.

References:

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[ii] R.M. Cole, Y. Sugawara, J.J. Baumber, S. Mahajan, M. Abdelsalam and P.N. Barlett, *Phys. Rev. Lett*, **97**, 137401 (2006).

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Figures :

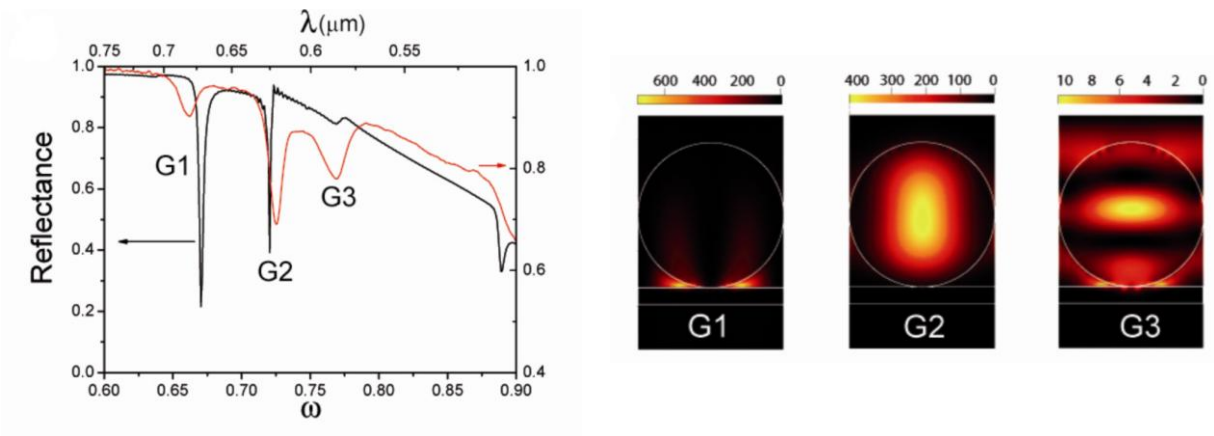

Figure 1: Left : Calculated (black curve) and measured (red curve) normal incidence reflection spectra of a ML of 520nm PS spheres grown on a gold substrate. Right: Total field intensity distribution of selected modes (as indicated in spectra.