Modifying emission by self-assembled photonic-plasmonic crystals

M. López-García[1], Ruth Oulton[1], J.F Galisteo-López[2], A.Blanco[2] and C.López[2]

[1] Bristol Centre for Nanoscience and Quantum Information (NSQI), University of Bristol, Bristol, UK.
[2]Instituto de Ciencia de Materiales de Madrid (ICMM CSIC), Madrid, Spain
Email: Martin.lopezgarcia@bristol.ac.uk

Hybrid metal-dielectric structures have recently demonstrated to support both, photonic and plasmonic modes suitable for light confinement at the nano/micro scale [1]. These systems take advantage of the large field confinement provided by plasmonic resonances to enhance light-matter interaction in reduced volumes. Moreover, the photonic character provides extraordinary control on how light propagates along the structure allowing, for example, larger propagation distances than for pure plasmonic modes. Among the different approaches to implement hybrid systems self-assembled structures have been explored due to their outstanding nanophotonic properties as well as straightfprward implementation.

Here we present our recent results on light-matter interaction enhancement in a self-assembled monolayer of organic spheres deposited on top of a metallic surface [2]. By depositing close packed arrays of polystyrene spheres on silver and gold films we have retrieved clear evidences of hybrid plasmonic/photonic modes propagating within the structure. Samples have been optically characterized obtaining experimental measurements of the dispersion relation of the modes through angle and polarization resolved reflectance spectroscopy. Moreover, we have engineered such dispersion relation to strongly enhance and direct the emission of an organic dye (Rhodamine 6G) distributed within the spheres. The comparison of the measured photonic/plasmonic bands and the emission patterns shows that emission is mainly channelled by those hybrid modes which field distribution match the position of the dye molecules.

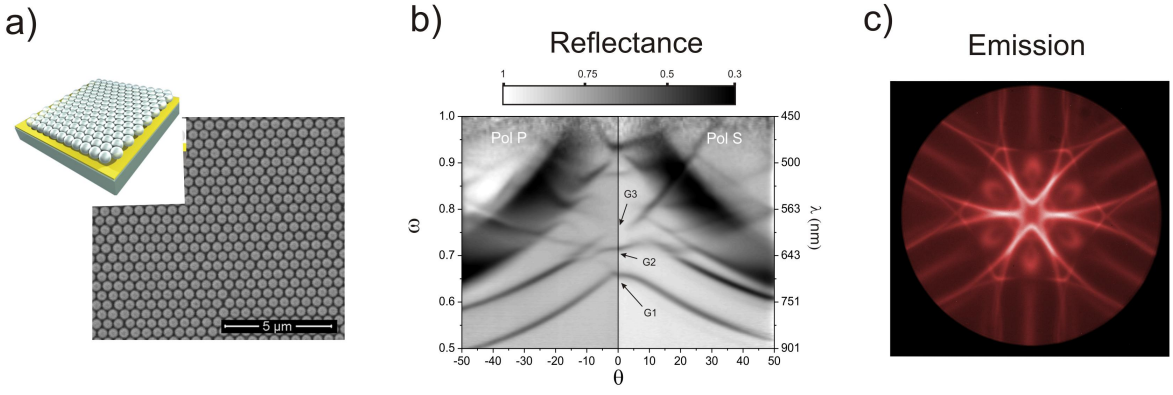

Figure 1: (a) SEM image of one of the fabricated samples. (b) Angle and polarization resolved reflectance along the K direction for polystyrene spheres deposited on silver. (c) Far field emission pattern for the sample studied in (b)

Finally we also explore the far field reflectance and emission patterns through single frequency images of the far field collected at the same area of the sample [3]. This kind of measurement can be expressed as a direct imaging of isofrequency surfaces for photons propagating within the structure. The comparison with calculated isofrecuency surfaces of the hybrid modes allows us to identify highly diffractive regions where phenomena like the superprism effect or negative refraction could take place.

References

[1] R.F. Oulton, V. J. Sorger, D. A. Genov, D. F. P. Pile and X. Zhang, A hybrid plasmonic waveguide for subwavelength confinement and long-range propagation. Nature Photonics 2, 496 - 500 (2008)

[2] M. Lopez-Garcia, J. F. Galisteo-Lopez, A. Blanco, A. Garcia-Martin and C. Lopez. "Enhancement and Directionality of Spontaneous Emission in Hybrid Self-Assembled Photonic-Plasmonic Crystals." Small, 6, 1757 (2010).

[3] J. F. Galisteo-Lopez, M. Lopez-Garcia,,A. Blanco and C. Lopez. "Studying light propagation in self-assembled hybrid photonic-plasmonic crystals by Fourier microscopy". Accepted for publication in Langmuir (2012). D.O.I: 10.1021/la300448y.