MASTER DE PHYSIQUE ET APPLICATIONS - 2ème année
Spécialité Sciences des Matériaux et Nano-objets
International Nanomat Master Program

Internship proposal 2009-2010

Laboratory :Institut des NanoSciences de Paris

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Modification of the fluorescence of a single nanocristal in the vicinity of a corrugated gold surface

The internship will take place at the Institut des NanoSciences de Paris, in the group « Nanostructures et optique ». This group uses confinement techniques to improve the fluorescence properties of single nano-emitters in terms of emission rate and collection efficiency.

The nano-emitters in consideration are colloidal nanocrystals of semiconductor, typically CdSe. They are spheres of a few nanometers, chemically synthesized in solution. As these nanocrystals emit single photons, they are of great interest for quantum information.

We have shown recently that a single nanocrystal in the vicinity of a plane gold film, presents an increase of its spontaneous emission rate due to the near-field coupling with surface plasmons. Moreover, as the emission diagram is modified by the proximity of the interface, the photons collection efficiency in the numerical aperture of a confocal microscope has also been improved. Eventually a 3-fold enhancement of the collected intensity (compared to the case of a reference sample made of nanocrystals spin-coated on a glass substrate and covered by PMMA) has been measured. Nevertheless, this result could widely be improved as an important part of the emission is lost in the non-radiative surface plasmons. A solution to extract a radiative field from plasmons consists in creating a periodic pattern on the metallic surface. Indeed, by choosing the period of this grating, one can phase-match the plasmonic and light momenta.

The internship will be divided in several steps.

First, the intern will realize the corrugated gold surface by methods based on auto-organization. Two alternatives will be considered: the simple outlet of polystyrene balls on a substrate and the synthesis of a silica balls monolayer by the Langmuir–Blodgett technique. The structures will then be analyzed with SEM and optical techniques to make sure that regular layers on the scale of a few μm^2 are obtained.

Then, a few 100 nm-thick gold layer will be deposited by thermal evaporation. The next step will consist in the characterization of the emission properties of single nanocrystals surrounded by silica balls of different thickness to control their distance to the gold surface. This will be done on a time-resolved confocal microscopy setup. Depending on the intern's interest, numerical simulations on these systems could be developed.

Techniques in use :
Langmuir-Blodgett technique, time-resolved confocal microscopy, photon-counting, SEM, possibility of numerical simulations

Granted internship : yes (around 400€/month)
C'nano IdF laboratory (France only) : yes
Possibility for a thesis : yes (type of grant : ministery)