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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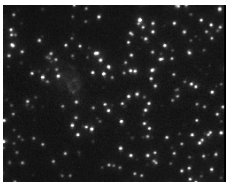
Fluorescence of a single nanocrystal in a photonic crystal

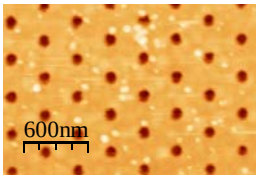
The internship will take place at the Institut des NanoSciences de Paris, in a group which studies the effect of a photonic crystal on the emission of a nano-emitter.

The nano-emitters in consideration are colloidal nanocrystals of semiconductor, typically CdSe. They are spheres of a few nanometers, chemically synthesized in solution. These are very bright and versatile structures ; their wavelength is determined by their size and tunable over the whole visible range. With a microscope, a single nanocrystal on a substrate can be observed (fig. a). It is shown then that the nanocrystal emits photons one by one, so that with a 100-ps laser pulse, one can trigger the emission of only one photon. Many studies have been devoted to these so-called single photons, which can be used as bits in quantum information.

A photonic crystal is a dielectric material with a periodic structuration at wavelength scale, so that it behaves towards photons like a crystal towards electrons, exhibiting a band structure, in particular “forbidden bands” of wavelengths that cannot propagate through the photonic crystal. Photonic crystals, besides their rich potential for fundamental optics, open great possibilities in terms of manipulating light over small volumes.

Our group studies planar photonic crystals (a dielectric layer with a network of holes obtained by e-beam lithography – fig. b) fabricated by our collaborators in Toulouse. The aim of these experiments is to observe a single nanocrystal, placed on a photonic crystal, and to use the photonic crystal to modify single-photon emission (enhancement, redirection). In this context, the internship with either deal with evidencing the nanocrystal-photonic crystal coupling itself, or with characterizing the nanocrystals and photonic crystals in collaboration with the groups that fabricate them, or, depending on the intern’s interest, with simulating these structures numerically.

a) 

b) 

a) optical-microscopy image of nanocrystals on a glass substrate (each nanocrystal is clearly distinguished as a white dot) ;

b) AFM image of a photonic crystal fabricated at the LAAS (Toulouse)

web page : http://www.insp.jussieu.fr/spip.php?article235

Techniques in use :
Time-resolved confocal microscopy, photon-counting, spectroscopy ; possibly numerical simulation

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