Internship offered in M2
2017-2018

Responsible for internship

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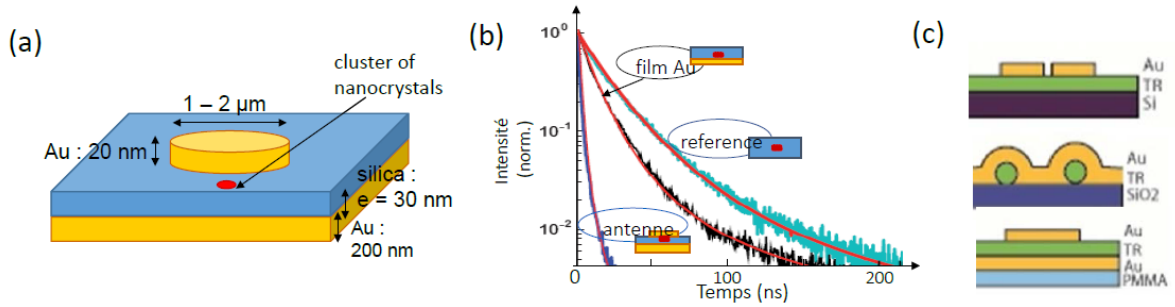
Internship topic: Coupling an optical nano-antenna to the fluorescence of rare-earth ions

The group « Nanophotonics and quantum optics » at INSP studies how light emission from a nano-emitter depends not only on the emitter itself, but also on its optical environment (as stated by Fermi's "golden rule" which relates the rate of light emission to the density of available photonic states). Various types of structures are studied (photonic crystal, nano-cavity…), among which metallic structures provide the highest electromagnetic field enhancement due to evanescent modes confined in extremely small volumes. Metallic optical nano-antennas can be fabricated to manipulate light-matter interaction and control the luminescence dynamics, direction, polarization etc.

Various antenna geometries have been demonstrated. For instance, our group has studied the coupling of fluorescent semiconductor nanocrystals to "patch" antennas (fig. a) consisting in a sandwich of a gold layer and a gold disk separated by a silica spacer where the emitter is located. We have shown that the nanocrystals decay rate (fig. b) was increased significantly by the antenna (by a factor 2 to 80 depending on the emitting dipole orientation) [1].

The purpose of the internship is to study the coupling of rare-earth (europium) ions embedded in nanocrystals or thin films (fabricated by Ph. Goldner and A. Ferrier at IRCP – Chimie Paris) to a nano-antenna. Rare-earth ions are used in various optical devices such as lighting or fibers, and their very slow dynamics and long coherence times raise interest for quantum information applications. The intership work will consist in fabricating antennas of various geometries (fig. c) and characterizing the optical properties of the obtained structures by photoluminescence microscopy.



(a) Schematic of a "patch" antenna. (b) Emission decay curves of nanocrystals clusters inside an antenna, on a gold film and in a reference homogeneous medium. (c) Proposed geometries for the insertion of rare-earth (TR)-doped nanocrystals or thin layers inside nano-antennas.

[1] C. Belacel et al., Nano Lett. 13, 1516 (2013)

Techniques involved: Photoluminescence microscopy, photon counting

Type of internship: mostly experimental
Paid internship: Yes
Can this internship be continued for a PhD? Yes/No
If yes, type of PhD funding envisaged is: No PhD funding for me this year from Ecole Doctorale but other PhD topics in the group possible

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