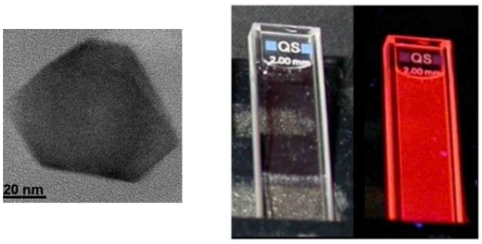
Internship/PhD proposal

Titre	***Rare earth doped nanoparticles for quantum technologies***
Lieu	Institut de Recherche de Chimie Paris, Chimie Paristech, 11, rue Pierre et Marie Curie, 75005 Paris Laboratoire PMC – Ecole Polytechnique – Route de Saclay – 91128 Palaiseau
Contact	Philippe Goldner / Thierry Gacoin
email/ telephone	philippe.goldner@chimieparistech.psl.eu, +33 1 53 73 79 30 thierry.gacoin@polytechnique.edu, +33 (0)1 69 33 46 56
website	www.cqsd.fr https://pmc.polytechnique.fr/spip.php?article623&lang=en
Starting	February or March 2020
Note	This work may be pursued in PhD as an ANR funding has been granted to the supervisors

Nanoparticles doped with rare earth ions are of great interest in the field of quantum technologies [1]. This is due to the ability to create and control optical and spin quantum states in these materials. In addition, the nanometric scale makes it possible to couple these particles to nanophotonic devices such as optical microcavities. This opens up promising prospects for the detection of single ions and hence to new applications in the field of processors and quantum communications.

Investigations by optical spectroscopy at very high resolution shows however that quantum states in nanoparticles have significantly shorter lifetimes than in massive crystals. Although classical characterization techniques attest the very high crystalline quality of the particles, residual defects produce fluctuations, similar to noise, which disturb the quantum states of the rare earth ions. These defects can for example be linked to oxygen vacancies, impurities or even extensive structural defects. The characterization, understanding and ultimately the drastic reduction of these defects are essential to fully exploit the very strong potential of these nanomaterials in quantum technologies. We propose to develop this study as part of the ANR UltraNanOSpec project which will begin in 2021.

.



Electron microscopy image of a YVO_4: Eu nanocrystal and photographs of a colloidal suspension in white and UV light showing the red luminescence characteristic of Europium Eu^{3+}.

The IRCP and LPCM teams have been developing nanoparticles doped with rare earth ions for photonics applications for several years. The 'Crystals and dynamics of quantum states' group at IRCP (http://www.cqsd.fr) specializes in materials for quantum technologies and their optical characterization. The LCMCP team has significant expertise in the synthesis of new nanomaterials by original methods and the study of their defects.

The internship project consists in developing materials obtained first by solid state synthesis and in optically characterizing a series of matrices, in order to identify materials with favorable optical properties. The selected compounds will then be synthesized in the form of nanoparticles by different techniques and an in-depth study of quantum states will be carried out. This will make it possible to identify the defects responsible for the disturbance of these states and to develop synthesis and post-processing strategies to reduce them to the lowest possible level, opening the route to applications in quantum technologies.

[1] Zhong, Tian, and Ph Goldner, Nanophotonics 8, 2019. https://doi.org/10.1515/nanoph-2019-0185.