Research Topic for the ParisTech/CSC PhD Program

Field:	2.Chemistry, Physical Chemistry and Chemical Engineering
Subfield:	8. Materials Science, Mechanics, Fluids
Title:	**Paramagnetic analysis inside diamagnetic nanoparticles by NMR relaxation**
ParisTech School:	École polytechnique
Advisor(s) Name:	MARON Sébastien; GACOIN Thierry
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(Lab, website):	Laboratoire de Physique de la Matière Condensée https://pmc.polytechnique.fr/spip.php?article623

Short description of possible research topics for a PhD:
A vast majority of functional materials have physical properties (optical, magnetic or transport) whose origin comes from the presence of doping elements. Often present in small quantities, their precise characterization in terms of distribution, oxidation state or other, is a major difficulty in materials science and the development of adapted experimental techniques is an important subject. On this theme, the laboratory has been working for some years on the use of solid-state nuclear magnetic resonance (NMR), notably by seeking to use paramagnetic dopant induced relaxation effects. Beyond the methodological aspect, this subject is treated in connection with our activities in the field of luminescent nanoparticles, whose properties result from the insertion of rare earths into the crystalline matrix. These particles are of great interest in the field of probes for biology, in microfluidics, or for lighting or display devices...

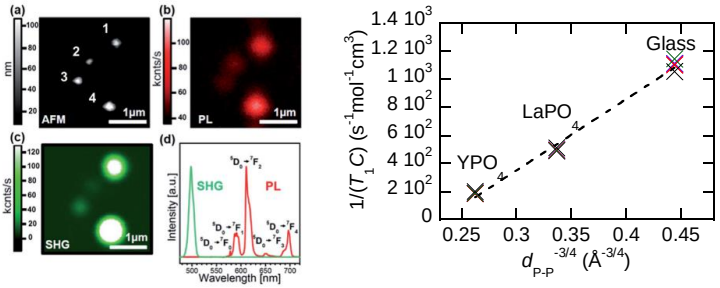

Figure 1: LEFT – Application of a kind of nanoparticle (here: KTP@$LaPO_4$:Eu). For more details, see Mayer et. al DOI: 10.1039/c4tc01227e. RIGHT - Determination of Nd^{3+} concentration *C* in different phosphorus materials.

Previously, we have shown that, whatever the massive material, crystalline or not, the longitudinal relaxation rate $1 / T_1$ being linear with the doping rate, there exists a law connecting the concentration in dopant C, T_1 and the average distance between each nucleus probed by the NMR experiment (^{31}P here), $d_{P\text{-}P}$. After having developed this law on massive materials, we now want to implement it on nanoparticles which we control the synthesis, especially $LaPO_4$ monazite phase. This monoclinic phase of lanthanum phosphate is of interest, unlike the hexagonal phase, to have no proton.

Required background of the student: Solid-State Chemistry; Solid-State NMR

A list of 5(max.) representative publications of the group:
Maron, S. *et al*. DOI: 10.1039/C4CP02628D
Maron, S. *et al*. DOI: 10.1039/C7CP00451F