


**Internship proposal 2011-2012**

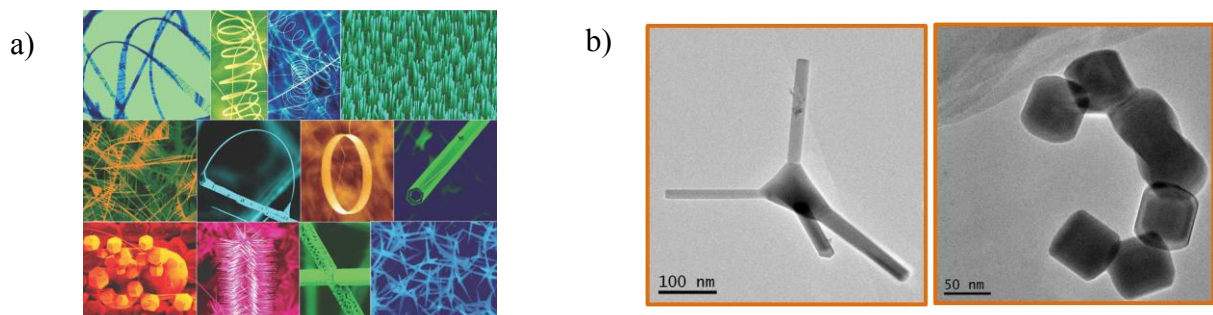
<p><b>Laboratory : INSP (Oxydes en basses dimensions)</b></p> <p><b>Address : 4, place Jussieu, tour 22, 22-12, Et. 5</b></p> <p><b>Laboratory director : Bernard Perrin</b></p>	
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**H<sub>2</sub>-doping of ZnO nanoparticles**

ZnO represents one of the richest families of nanostructures among all materials, both in structures (see Figure a)) and properties. It exhibits, therefore, an amazing spectrum of applications in optoelectronics, sensors and transducers, catalysis, as well as in biomedical science because it is bio-safe. With a direct band gap of 3,4 eV, ZnO reveals absorption in the near UV range ( $\lambda < 360$  nm) and luminescence emission in the visible ranging from green to red light. High exciton-binding energy (60 meV) allows efficient excitonic emission even at room temperature whereas two emission processes were usually attributed to the bulk.

Surface phenomena responsible for catalytic activity and gas sensing capability of ZnO are poorly understood, despite a large number of relevant studies. Regarding the surface reactivity of ZnO nanocrystals, a pivotal issue is the chemisorption of molecular hydrogen since hydrogen not only adsorbs on the surface of ZnO but also diffuses into the bulk. This was already shown for perfect single crystal surface and, just recently, Wöll and co-workers [*ChemPhysChem* 11 (2010) 3604] have provided direct and quantitative evidence for subsurface and bulk diffusion of H-atoms after exposure of ZnO nanopowders to hydrogen.

In this internship, we propose a comparative study of hydrogen interaction with ZnO nanoparticles by combining Infrared (IR) with UV/Vis and Photoluminescence (PL) spectroscopies. ZnO nanoparticles will be produced by means of metal combustion technique and their morphology (see Figure b)) will be analyzed by Transmission Electron Microscopy. Our goal is to establish to which extent the one (adsorption at the surface) or another (diffusion through the bulk) process is favored when ZnO nanoparticles are considered. IR spectroscopy will provide insights into both processes since it monitors the occupation of hydrogen interstitial sites as well as the evolution of OH and Zn-H bands at the surface. Presence of hydrogen in the bulk affects electronic properties of ZnO which must be reflected in optical properties of ZnO and traced back by UV/Vis and PL spectroscopy.



**Figure:** a) Variety of ZnO nanoshapes and b) ZnO tetrapods and hexagonal prisms synthesized in our lab.

**Techniques in use:** Infrared (IR), Photoluminescence (PL) and UV/Vis spectroscopy.

**Applicant skills:** skills in IR, PL and UV/Vis would be appreciated

**Granted internship:** yes (~400€/month) / no

**C'nano IdF laboratory (France only):** yes

**Possibility for a thesis:** yes (type of grant: Scholarship by French ministry)