MASTER DE PHYSIQUE ET APPLICATIONS - 2ème année
Spécialité Sciences des Matériaux et Nano-objets
International Nanomat Master Program

Internship proposal 2010-2011

Laboratory : Institut des NanoSciences de Paris

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Plasmon resonance in Gold nanoparticles : application to catalysis

Scientific project :

Gold is one of the first metals discovered by humans. Its main properties were thought to be well understood: no chemical reactivity, yellow colour... However, in the last twenty years, it has been seen that it has unexpected properties at the nanometer scale.

In optics, the plasmon resonance phenomenon (collective oscillation of the conduction electrons) gives a purple colour to the gold nanoparticles. This colour depends on the size and shape of the particles (spheres, ellipsoids...).

In catalysis, gold becomes extremely active when the size of the nanoparticles is below 5 nm. For instance, gold is a good catalyst for the oxidation of the carbon oxide, even at room temperature, reaction for which catalytic exhausts are efficient only above 300 °C. This catalysis phenomenon is not well understood and is nowadays investigated by numerous laboratories in the world.

Our research group, in collaboration with a chemistry lab in the UPMC (Laboratoire de réactivité de surface), one of the world leaders in the field, is developing a multi-technique approach for understanding these catalysis phenomena by the gold nanoparticles. Methods are chemical elaboration of catalyst, catalytic activity measurements, optical spectroscopies, transmission electron microscopy (in the University and in collaboration with a group in Birmingham who holds an extreme resolution microscope), scanning tunnel microscope working in gaseous environment. The main purpose of the internship is the investigation of the optical properties of the gold nanoparticles in gas and during the chemical reactions (CO oxidation), by means of a cell specially suited for a specific optical method [1]. Indeed, the UV-visible optical spectroscopy enables us to observe plasmon resonances in the gold nanoparticles, together with molecular-like resonances in extremely small particles (less than 50 atoms), and also their modifications due to the chemical reactions and the gas adsorptions, which induce modifications of the structure and the morphology of the nanoparticles, of their electronic structure, charge transfer (oxidation, reduction). Theoretical modelling of the optical results will also be done, in the laboratory and in collaboration with groups in Mexico and in Italy.

[1] Monitoring of the Plasmon Resonance of Gold Nanoparticles in Au/TiO2 Catalyst under Oxidative and Reducing Atmospheres, Y. Borensztein, L. Delannoy, A. Djedidi, R.G. Barrera et C. Louis, J. Phys. Chem. C 114, 9008 (2010)

Techniques in use : Optical spectroscopy, catalytic reactivity, transmission electron microscopy, theoretical modelling

Granted internship : yes (417 €/month)
C'nano IdF laboratory (France only) : yes
Possibility for a thesis : yes (type of grant : Ecole Doctorale)