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

Internship proposal 2011-2012

Laboratory: Synchrotron SOLEIL
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Synchrotron radiation based inner-shell electron spectroscopy of isolated nanoparticles: a probe for nanoparticle's chemical composition and size

Scientific project:
Our research group investigates the behavior of isolated species following their exposure to high-energy radiation, namely to soft x-rays. At these energies, inner-shell ionization and excitation processes are abundant and lead to the formation of very excited species, including multiply charged ions (following the Auger decay) that are very unstable and usually undergo fragmentation. The situation is particularly interesting for the species made of light elements, for which the natural lifetimes of their inner-shell excited states are of the same order of magnitude as the time scale of nuclear motion, i.e. a few to a few tenths of femtoseconds. Understanding these complex processes requires control and simultaneous measurement of many physical parameters: photon energy, energy and angular distribution of electrons, mass, energy and angular distribution of the fragment ions [1].

Based on the aerosols generation technique, we have developed a new source allowing to flow into vacuum isolated nanoparticles of controlled size as a focused beam. Preliminary electron spectroscopy experiments allowed revealing a strong anisotropy (forward / backward) in the angular distribution of electrons emitted from SiO_2 nanoparticles. The purpose of this internship is to continue these studies using an electron spectrometer developed in the group and perfectly suited for the simultaneous measurement of the kinetic energies and ejection angles of the emitted electrons [2]. The expected result is developing a new methodology allowing to characterize nano-objects based on spectroscopic measurements. This methodology will be deeper explored and applied to a series of nano-objects of different sizes, shapes and chemical compositions in the framework of a PhD thesis.

[1] C. Miron and P. Morin "High-resolution inner-shell coincidence spectroscopy." NIM A 601 (1-2), 66-77 (2009).
[2] C. Miron, M. Simon, N. Leclercq, P. Morin, « A new high luminosity double toroidal electron spectrometer », Rev. Sci. Instrum. 68, 3728 (1997).

Techniques in use: synchrotron radiation, inner-shell ionization, x-ray absorption spectroscopy (XAS), electron spectroscopy, aerosol generation, aerodynamic lens, position sensitive detection (PSD), numerical modeling, and programming

Applicant skills: motivation, tenacity, curiosity, knowledge of fundamental radiation-matter interaction processes and of the foundations of quantum mechanics, notions of spectroscopy

Granted internship: yes (600-900_€ net/month depending on duration)
C'nano IdF laboratory (France only): yes
Possibility for a thesis : yes (type of grant : doctoral school EDOM/E2MC or SOLEIL PhD grant)