Ultrafast transmission electron microscopy of irreversible transformations

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A new type of electron microscope is available at the IPCMS in Strasbourg. It is a facility that is able to obtain microscopic images with nanometer spatial resolution and microsecond to picosecond temporal resolution. This unique instrument is operated with extremely short electron pulses, induced by pulsed laser beams. Thus, it allows the imaging of dynamic processes in materials and is used to explore a variety of new fields in materials research [1, 2]. The new microscope will be applied to study ultrafast transformations in nanoparticles that cannot be studied by other techniques until now. The focus is on irreversible transformations of nanoparticles where an electron microscopy image or diffraction pattern is recorded with nanosecond exposure time after the laser excitation of the specimen.

The PhD candidate will study phase transformations in nanoparticles that occur upon heating with an intense laser pulse. The heating pulse is followed, after an adjustable time, by an electron pulse that is used for imaging. Of particular interest are phase transformations that lead first to the kinetically favoured phase which, then, relaxes to the energetically most stable phase. These step-wise relaxations occur at very short time scales and have hardly been observable with the necessary spatial resolution until now.

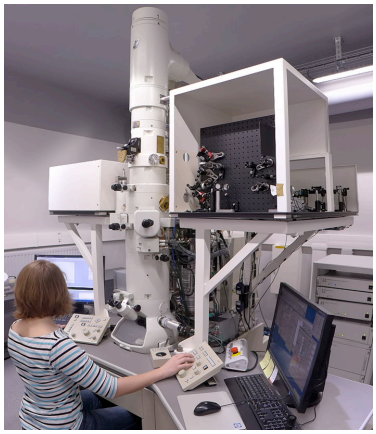

Figure 1 : New ultrafast transmission electron microscope at the IPCMS. It combines the vertical column of the electron optics with an extended periphery for the laser optics.

The work will start with the synthesis of different types of nanoparticles. A detailed structural characterization with conventional electron microscopy will follow. Experiments by ultrafast electron microscopy will be carried out to study the dynamic evolution of the nanoparticles. The experiments will be followed by an extended analysis of the data in collaboration with theory groups.

The candidate should hold a Master degree in physics, chemistry, or materials science. He/she should be competent to work in a highly demanding field of nanocharacterization. The project will be a collaboration with partners in Strasbourg, in France, and in other countries. Since it is part of “Investissement d’avenir”, it is of high importance for the scientific excellence in the Region.

[1] F. Carbone, Eur. Phys. J. Appl. Phys. **54**, 33503 (2011).
[2] A. Zewail, *La microscopie électronique fait son cinéma*, Pour la science **399**, janvier 2011.