Ultrafast electron microscopy of photo-switchable materials

DIRECTEUR DE THESE : FLORIAN BANHART
IPCMS, 23, RUE DU LOESS, 67034 STRASBOURG
TEL : 03 88 10 71 03 ; E-MAIL : FLORIAN.BANHART@IPCMS.UNISTRA.FR

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 uses extremely short electron pulses which are induced by pulsed laser beams. 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 is applied to study ultrafast transformations in nanomaterials. After excitation of the object with a laser pulse, its behaviour is studied by an electron pulse. In this pump-probe approach, electron microscopy images, diffraction patterns, or electron energy-loss spectra can be recorded.

The focus of this PhD work is on reversible light-induced transformations of nanomaterials. Length changes of solid materials under irradiation with light can be used to realize opto-electrical switches that have a high potential in optoelectronics and signal transmission technology. The candidate will study photostrictive inorganic materials and organic/inorganic hybrid hydroxide systems that expand or contract under illumination with light. The electron microscope will allow monitoring small length changes with sub-nanometer resolution. Of high importance is information about the switching speed of such systems that can now be studied with picosecond resolution.

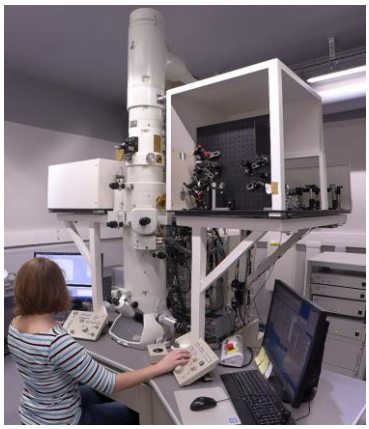

Figure 1: Ultrafast transmission electron microscope at the IPCMS. The laser optics on the optical tables is used to create ultrashort electron pulses in the vertical column.

The work will start with the synthesis and optical characterization of different materials in collaboration with other groups. A detailed structural characterization with conventional electron microscopy will follow. Experiments by stroboscopic ultrafast electron microscopy will be carried out to study the switching dynamics of the systems. The experiments will be followed by an extended analysis of the data.

The candidate should hold a Master degree in physics, chemistry, or materials science. He/she should be competent to work and collaborate in a highly demanding field of nanocharacterization. The project will be a collaboration with partners at the IPCMS. As an EQUIPEX, the infrastructure it is part of “Investissement d’avenir” and of high importance for the scientific excellence of the University and the Region.

[1] A. Zewail, *Science* **328**, 187 (2010).
[2] K. Bücker, F. Banhart et al., *Ultramicroscopy* **171**, 8 (2016).