High brightness ultrafast Transmission Electron Microscope based on a laser-driven cold field emission source: development and application to nanospectroscopy

A. Arbouet1*, G. M. Caruso1, S. Meuret1, S. Weber1, L. H. G. Tizei2, M. Kociak2 and F. Houdellier1*

1. CEMES-CNRS, 29 Rue Jeanne Marvig, 31055 Toulouse, FRANCE-EU
2. Laboratoire de Physique des Solides, Univ. Paris-Sud, Bat 510, UMR CNRS 8502, Orsay 91400, FRANCE-EU

The first Ultrafast Transmission Electron Microscopes (UTEM) have provided a unique insight into the physics of nano-objects with both sub-picosecond temporal resolution and nanometer scale spatial resolution [1,2]. We will report on the development of the first ultrafast cold-field electron source and its use for Ultrafast Transmission Electron Microscopy [3,4]. We have modified a cold field emission source to integrate laser optics in the immediate vicinity of the [310] oriented W nanotip to minimize the size of the laser focal spot on the tip apex, minimize the size of the emission region and therefore maximize the brightness of the source [4]. Light injection and collection from within the objective lens are achieved with a high numerical aperture by means of an optical set-up involving a parabolic mirror and a dedicated detection system.

The potential of this high-brightness ultrafast CFEG-TEM for ultrafast electron microscopy and holography will be illustrated. The spectro-temporal properties of this CFEG-UTEM will be characterized in electron-photon cross-correlation experiments based on the detection of energy gains. Finally, the potential of this instrument for the investigation of the optical excitations in nanoscale systems will be discussed.

References:


*arnaud.arbouet@cemes.fr, florent.houdellier@cemes.fr