MM 42: Electron Microscopy II - Advances in characterisation

Time: Wednesday 12:00–13:00 Location: IFW B

MM 42.1 Wed 12:00 IFW B

High-Energy Plasmons in MoS2 and graphene heterostructures — •Michael Mohn[1], Ralf Hambach[1], Philipp Wachsmuth[1], Gerd Benner[2], and Ute Kaiser[1] — [1]Electron Microscopy Group of Materials Science, Ulm University, 89081 Ulm, Germany — [2]Carl Zeiss Microscopy GmbH, 74447 Oberkochen, Germany

We investigate high-energy plasmons using momentum-resolved electron energy-loss spectroscopy and ab-initio calculations for molybdenum disulfide (MoS2) mono- and multilayers and MoS2-graphene heterostructures.

Energy-loss spectra up to 50 eV have been obtained using a Zeiss Libra 200 based low-voltage transmission electron microscope (SALVE I [1]) with an in-column energy filter. The plasmon dispersion has been studied for momentum transfers along different crystallographic axes within the Brillouin zone. Ab-initio calculations have been performed with density functional theory (DFT) and linear-response time-dependent DFT using ABINIT and the dp-code [2,3]. By direct comparison of experimental spectra and ab-initio calculations, we address the following questions:

(i) How do high-energy plasmons in MoS2 monolayers and multilayers behave for different momentum transfer? (ii) How do electron-energy loss spectra of MoS2-graphene heterostructures differ from the spectra of the bare monolayers?

[1] Kaiser et al., Ultramicroscopy 111, 1246 (2011)
[2] Gonze et al., Comp. Mat. Sci. 25, 478 (2002)
[3] Olevano, Reining, Sottile, http://www.dp-code.org (1998)

MM 42.2 Wed 12:15 IFW B

Feasibility study of using electron vortices for the measurement of electron magnetic circular dichroism (EMCD) — •Sebastian Schneider[1,2], Darius Pohl[1], Ludwig Schultz[1,2], and Bernd Rellinghaus[1] — [1]IFW Dresden, Institute for Metallic Materials, P.O. Box 270116, D-01171 Dresden, Germany — [2]TU Dresden, Institut fur Festkörperphysik, D-01062 Dresden, Germany

EMCD, which is the electron wave analogue of X-ray magnetic circular dichroism (XMCD), offers the possibility to study magnetic properties on the nanoscale in a transmission electron microscope (TEM). Recently discovered electron vortex beams, which carry an orbital angular momentum, are assumed to show comparable dichroic signals. This study is focused on the feasibility of this newly discovered method. Dichroic signals on the L_2 and L_3 edges of 3d transition metals are expected to be of the order of only 5%. In order to measure such small intensity changes in the electron energy loss (EEL) spectra, a proper microscope alignment, highly stable samples, and a high signal-to-noise-ratio of the EEL spectra are indispensable. Neglecting any of these preconditions will easily lead to artifacts showing a mime of a dichroic signal already in the raw data of the EELS spectra. Different types of magnetic samples are investigated and probed for the appearance of a dichroic signal thereby always paying highest attention to accurate measurements to avoid boosting any signals without physical relevance to EMCD. For this, thin ferromagnetic films of Fe, Fe_3C and Ni are prepared by sputtering and investigated with this novel method.

MM 42.3 Wed 12:30 IFW B

Probing atomic potentials on a sub-Angstrom scale by differential phase contrast — •Josef Zweck[1], Sorin Lazar[2], Bert Freitag[2], Knut Müller[3], Andreas Rosenauer[3], Florian Krause[3], Matthias Lohr[1], Benedikt Bauer[1], Andreas Pritschet[1], and Johannes Thalmair[1] — [1]Physics Faculty, University of Regensburg, FRG — [2]FEI Company, Eindhoven, NL — [3]Institute for Solid State Physics, University of Bremen, FRG

Differential phase contrast uses a position sensitive detector to monitor minute deflections of the electron beam in a scanning transmission microscope (STEM). With today's instruments, the electron beam can be focused into probe diameters of 80 pm, which is sufficiently small to move the probe within a unit cell of a crystal between atomic positions. The beam is influenced by the local Coulomb scattering potential of the atom. The scattering potential gradient across the electron beam diameter can in a first approximation be considered to be proportional to the local electric field caused by the nucleus and screened by the electron cloud.

Therefore, measuring the electron beam's deflection one probes a quantity related to the local field distribution. We present first results, obtained from a GaN crystal, and using a FEI Titan cubed, equipped with a high brightness gun, monochromator, an image Cs corrector and DCOR probe corrector. We can clearly show that the electron beam deflection is not radially symmetric around Ga and N atoms, which may lead to a technique capable to probe local binding structures and even electronic charge densities in sub-Angstrom resolution.

MM 42.4 Wed 12:45 IFW B

4D X-ray microscopy (XRM), In Situ imaging of practical volume samples — •Lars-Oliver Kautschor — Carl Zeiss Microscopy GmbH

In situ, 4D microscopy using X-ray microscopy is evolving as a valuable scientific technique. In order to develop this further it is important to develop the technique using realistic representative volumes in a wide range of materials. It is also important to evaluate the efficacy of the application against more traditional methods by employing correlative imaging. Conventional electron and optical microscopy techniques require the sample to be sectioned, polished or etched to expose the internal surfaces for imaging. However, such sample preparation techniques have traditionally prevented the observation of the same sample over time, under realistic three-dimensional geometries and in an environment representative of real-world operating conditions. X-ray microscopy (XRM) is a rapidly emerging technique that enables non-destructive evaluation of buried structures within hard to soft materials in 3D, requiring little to no sample preparation. Furthermore in situ and 4D quantification of microstructural evolution under controlled environment as a function of time, temperature, chemistry or stress can be performed repeatedly on the same sample, using practical specimen sizes ranging from tens of microns to several cm diameter, with achievable spatial imaging resolution from submicron to 50 nm.