TECHNISCHE UNIVERSITÄT CHEMNITZ

Institut für Physik
Physikalisches Kolloquium

Mittwoch, 30.05.2018, um **16:00 Uhr**

Ort: Reichenhainer Str. 90;
Zentrales Hörsaal- und Seminargebäude,
Raum 2/N013

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Magnetic imaging in transmission electron microscopy by phase retrieval

Ernst Ruska's invention of the transmission electron microscope in the year 1931 paved the way to surmount the resolution limitation in light microscopy by orders of magnitude and initiated the exploration of local structures at the nanoscale. Unavoidable aberrations of round electron lenses, however, prohibited the disposability of real atomic resolution imaging at moderate acceleration voltages until the mid-nineties of the last century. The idea of a hexapole - corrector by Harald Rose triggered a second revolution in this field resulting in routinely attainable spatial resolution below 0.1nm. In addition, the detection of the energy loss of the scattered electrons and the emitted characteristic x-ray radiation at large solid angles nowadays complete the characterization of materials atom by atom. Furthermore, monochromators and energy filters equipped with dedicated electron optical elements provide insights into optical properties of plasmonic nanostructures and permit the investigation of phonon excitations at an ultimate energy resolution of a few 10meV. The increasing availability of *insitu*-instrumentation allows exposing the object to various *stimuli*, like temperature, atmosphere, electric and magnetic fields, as well as strain, for the observation of physical and chemical processes in real time. Ultrafast processes at high spatial and temporal resolution down to femtoseconds became accessible due to the development of laser-induced thermionic or even field electron emission. Electron tomography further widens the range of observations from 2D images to 3D structures with strong applications in microbiology. Denis Gabor's invention of the holographic principle initiated the development of various techniques to retrieve the phase of the electron wave, which is normally lost by the conventional measurement of intensities. Sensitive to electric and magnetic fields, the phase of the electron wave is the key quantity for the quantitative mapping of fields in and around solids with a resolution of less than 5nm.

After an introduction to various aspects of modern transmission electron microscopy, the technique of electron holography is presented in more detail especially with respect to the quantitative mapping of weak magnetic fields in different types of magnetic thin films, like corrugated and surface modulated permalloy thin films as potential structures for future spintronic applications. In the alloy $Fe_{60}Al_{40}$, ion impact generated disorder induces local ferromagnetism, which enables direct writing of magnetic nanostructures by means of focussed ion beams. Electron holographic investigations reveal the depth and lateral distribution of the local magnetic induction and allows quantitative estimates, *e.g.*, for the effect of lateral ion scattering. Novel model-based techniques for the separation of magnetic induction and the magnetization in reconstructed phase images are necessary for the extraction of different solid state effects, like tiny deviations of the magnetic easy axis in iron-platinum nano-islands. As an outlook, the possibility for the detection of time dependent magnetic effects by phase retrieval techniques will be discussed.

Alle Zuhörer sind ab 15:45 zu Kaffee und Tee vor dem Hörsaal eingeladen.

Informationen zum Vortrag erteilt:
Prof. Dr. Olav Hellwig, Tel. 0371 531 30521

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