MM 17: Topical Session TEM V

Time: Tuesday 14:00–15:30 Location: IFW A

Topical Talk MM 17.1 Tue 14:00 IFW A

New Electrostatic Phase Plate for Phase-Contrast Transmission Electron Microscopy and Its Application for Wave-Function Reconstruction — Björn Gamm[1], Katrin Schultheiss[2,4], Joachim Zach[3], Manuel Dries[1], Nicole Frindt[4], Rasmus R. Schröder[4], and •Dagmar Gerthsen[1] — [1]Laboratorium für Elektronenmikroskopie, Karlsruher Institut für Technologie (KIT), 76131 Karlsruhe, Germany — [2]InnovationLab, Speyerer Straße 4, 69115 Heidelberg, Germany — [3]CEOS GmbH, Englerstr. 28, 69126 Heidelberg, Germany — [4]Bioquant Cell Networks, Universität Heidelberg, 69120 Heidelberg, Germany

We present a promising new design of an electrostatic physical phase plate for transmission electron microscopy. The design consists of a microcoaxial cable with the exposed electrode positioned near the undiffracted beam in the back focal plane of the objective lens. The absence of an obstructing ring electrode around the central beam overcomes the major drawback of Boersch-type phase plates. The new phase plate was used to acquire phase-contrast images with different phase shifts of the undiffracted electrons. These images are used to reconstruct the complex image wave function. After correction for the objective-lens aberrations the object-wave function is obtained, which contains information as for example phase shifts due to the differences of the mean inner potential. The reconstruction algorithm is demonstrated for experimental images from platinum nanoparticles.

MM 17.2 Tue 14:30 IFW A

2D interband plasmons in free-standing graphene — •Michael Kinyanjui[1], Philipp Wachsmuth[1], Jannik Meyer[2], Christian Kramberger[2], Thomas Pichler[2], Gerd Benner[3], and Ute Kaiser[1] — [1]Central facility of electron microscopy, University of Ulm, Albert Einstein Allee 11, 89068 Ulm, Germany — [2]Faculty of physics, University of Vienna, Strudlhofgasse 4, A-1090 Vienna, Austria — [3]Carl Zeiss NTS GmbH, Carl-Zeiss-Str. 56 73447, Oberkochen, Germany

Due to its unique electronic structure 2 dimensional (2D) graphene offers a means by which many-body interactions such quasi-particle excitations (electron-hole pair interactions), collective excitations of valence electrons (plasmons) and lattice vibrations (phonons) can be studied [1]. We investigated the properties of the π-plasmon excitations in free-standing monolayer of graphene using electron energy loss spectroscopy (EELS). The investigations were conducted at a specially developed low voltage transmission electron microscope operated at 20 kV. We study the dispersion of the π Plasmon peak for momentum transfers 0 Å-1 < q < 0.5 Å-1. In this momentum transfer range we observe the π plasmon as being characterized by a quasi-linear dispersion. In addition, the π plasmon excitations are shown to lie above the single-particle excitations (SPE) in mono-layer graphene. These results are discussed and compared to results obtained from single-walled carbon nanotubes (SWCNT).

[1] A. H. Castro Neto, F. Guinea, N. M. R. Peres, K.S. Novosolev, A. K. Geim, Rev. Mod. Phys. 81, 109 (2009)

MM 17.3 Tue 14:45 IFW A

Inelastic Electron holography : First results with surface plasmons — •Roeder Falk and Lichte Hannes — Triebenberg Labor, Institute for Structure Physics, TU Dresden, 01062 Dresden, Germany

Inelastic interaction and wave optics seem to be incompatible in that inelastic processes destroy coherence, which is the fundamental requirement for holography. In special experiments it is shown that energy transfer larger than some undoubtedly destroys coherence of the inelastic electron with the elastic remainder. Consequently, the usual inelastic processes, such as phonon-, plasmon- or inner shell-excitations with energy transfer of several out to several , certainly produce incoherence with the elastic ones. However, it turned out that within the inelastic wave, *newborn* by the inelastic process, there is a sufficiently wide area of coherence for generating *inelastic holograms*. This is exploited to create holograms with electrons scattered at surface-plasmons, which opens up quantum mechanical investigation of these inelastic processes. P.L. Potapov, H. Lichte, J. Verbeeck and D. van Dyck, Ultramicroscopy 106(2006) 1012. These investigations have been performed within European Union Framework 6, Integrated Infrastructure, Reference 026019 ESTEEM.

MM 17.4 Tue 15:00 IFW A

FIB Target preparation for 20 kV T(S)EM - A method for obtaining ultra-thin lamellas — •Lorenz Lechner, Johannes Biskupek, and Ute Kaiser — Center for Electron Microscopy, Materials Science Group, Ulm University, Ulm, Germany

Recently, scientists have rediscovered the advantages of using low energies in transmission electron microscopy (TEM). It dramatically reduces knock-on damage for imaging low-Z number material and enables electron energy loss spectroscopy up to very high energy losses with exceptionally low background noise. Alas, low voltage TEM requires extremely thin specimens free of preparation artifacts. Conventional focused ion beam (FIB) preparation methods cannot be employed to create high quality specimens much thinner than 25 nm. We have developed a new method for in-situ target preparation of ultra-thin TEM lamellas by FIB milling. With this method we are able to routinely obtain large area co-planar lamellas thinner than 10 nm. The resulting specimens are suitable for low kV TEM as well as transmission scanning electron microscopy (tSEM). We have demonstrated atomic resolution using Cs-corrected TEM at 20 kV on a so prepared Si specimen only 4 nm thick.

MM 17.5 Tue 15:15 IFW A

Site and orientation specific FIB preparation technique for TEM investigation of individual nanostructures, organic thin films and sensitive materials — •Benito Fernando Vieweg and Erdmann Spiecker — CENEM, University of Erlangen-Nürnberg

Sample preparation is a crucial step for analytical and high-resolution transmission electron microscopy (TEM). While conventional techniques, like mechanical thinning followed by low-voltage Ar ion beam milling, have been optimized for preparation of high-quality samples, there are many challenges which cannot be addressed by these techniques. For instance, TEM investigation of individual anisotropic nanostructures in a predefined cross-section orientation requires site and orientation specific preparation which can only be addressed by focused ion beam (FIB) techniques. Common techniques (H-bar, lift-out) require a protective coating, which may alter the surface and degrade the observation of the nanostructure during FIB milling. Sensitive materials like organic thin films or biological materials may as well be altered by the protective coating and are furthermore sensitive to the Ga ion beam. Cross sections of such materials or devices are indispensable for chemical and microstructural analysis, however.

In this contribution an advanced FIB-preparation method is presented which does not require the deposition of a protective coating and furthermore minimizes the impact of the Ga ion beam on the material. Various applications will be presented, including the cross-sectioning of metal nanorods, organic thin film devices and scales of butterfly wings and their investigation by analytical and high-resolution TEM.