MI 2: Topical Session: Using Transmission Electron Microscopy to Unravel the Mysteries of Materials II - Joint Session with MM

Time: Monday 11:45–13:15 Location: H4

Invited Talk MI 2.1 Mon 11:45 H4

Prospects for mapping spins with atomic resolution in TEM — •Johan Verbeeck — EMAT, University of Antwerp, Groenenborgerlaan 171, 2020 Antwerp, Belgium

In this talk, the prospects for mapping spins with atomic resolution in a TEM will be outlined. The proposed method is based on the use of electron vortex STEM probes. Such probes contain a helical phase of the type $\psi(r,\phi) = f(r)e^{im\phi}$ with m the so-called topological charge. This topological charge is responsible for an orbital angular momentum of $m\hbar$ and a magnetic moment of $m\mu_B$ carried by the electron probe. The phase symmetry affects the dipole selection rules in inelastic scattering which allows us to measure the change in magnetic quantum number upon excitation. As vortex electron probes can now be made to atomic size, we also expect to get magnetic information from individual atom columns in atomic resolution STEM-EELS experiment. Indeed, simulations show that even for thicker samples where multiple scattering can become important, an atomic resolution signal remains that contains information on the spin and orbital magnetic moment of a targeted atom with atomic resolution. Preliminary experiments are shown and the different experimental obstacles will be discussed.

Invited Talk MI 2.2 Mon 12:15 H4

Structural Characterization of nc-Si / SiO_x based quantum superstructures for the solar cell application by aberration-corrected high resolution electron microscopy — •Maryam Beig Mohamadi[1], Birger Berghoff[2], and Joachim Mayer[1,3] — [1]Central Facility for Electron Microscopy, RWTH Aachen, Ahornstrasse 55, 52074 Aachen, Germany — [2]Institute of Semiconductor Electronics, RWTH Aachen University, Sommerfeldstr.24, 52074 Aachen, Germany — [3]Peter Gruenberg Institute and Ernst Ruska Center for Microscopy and Spectroscopy with Electrons, Research Centre Jülich, D-52425 Jülich, Germany

In the frame of SINOVA project, two nano-structured systems were investigated, a-Si/SiO_x and SiO_x/SiO_2 multilayer systems. After annealing the sample, Si nano-crystals formed within an amorphous SiO_2 matrix. The morphology and distribution of the nc-Si precipitates within the amorphous layer, their nucleation and growth kinetics, the thickness of conducting layers and the diffusion of O or Si through interfaces were analyzed by high resolution transmission electron microscopy, energy filtered transmission electron microscopy and electron energy loss spectroscopy. We employed aberration-corrected TEM microscopes to reveal the crystalline structure and the chemical distribution of Si on the atomic scale. It is observed that the mean size of the QDs and their distribution in the dielectric matrix changes by the initial thickness of the SiO_x layer. The kinetics of the formation of nc-Si precipitates in Si-rich layers sandwiched between barrier layers was studied as a function of stacking period and oxygen content in the system.

MI 2.3 Mon 12:45 H4

Aktuelle Ergebnisse mit den HRTEM JEOL JEM-ARM 200F — •Jürgen Heindl — JEOL (Germany) GmbH; Oskar-von-Miller-Str. 1a; 85386 Eching; Germany

Das JEOL JEM-ARM 200F ist das erste Transmissions-Elektronen-Mikroskop das von Grund auf ausschließlich für den Betrieb mit Korrektoren für die Aberration der Linsen entwickelt wurde. Es können sowohl die limitierenden Aberrationen im STEM (Scanning Transmission Electron Microscopy) Betrieb (CESCOR) als auch die des Objektivs in der hochauflösenden Transmissionselektronenmikroskopie (HREM, CETCOR) bzw. beide ausgeglichen werden. Ergänzend kann das System an Stelle der Schottky-Feldemissionskathode mit einer völlig neuartigen kalten Feldemissionsquelle (ColdFEG) mit sehr geringer Energiebreite mit hoher Intensität ausgerüstet werden. Im STEM-Betrieb zeigt die ColdFEG deutlich verbesserte Abbildungsleistungen gegenüber einer Schottky-Quelle, was bei der direkten Abbildung der H-Atome in Yttriumhydrid gezeigt wird. Im HREM-Betrieb ist die ColdFEG anderen Lösungen überlegen, weil die geringe Energiebreite der Primärelektronen unmittelbar auf die Auflösung verbessert. Der Nachteil einer polychromen Beleuchtung entfällt; die Bildergebnisse sind vollumfänglich simulierbar. Ein vollanalytisches JEM-ARM200F zeichnet sich durch den neuen JEOL Centurio-EDX- Detektor aus. Der Centurio-Detektor erreicht seine sehr hohe Empfindlichkeit durch eine aktive Fläche von 100 mm2 und einen Raumwinkel von 1 sr. Mit der neuen ColdFEG wird ein Echtzeit-EDX-Mapping an SrTi03 und GaAs gezeigt.

MI 2.4 Mon 13:00 H4

Investigation of innovative capacitors for energy storage based on 0-3 composites — •Jens Glenneberg, Gerald Wagner, Alexandra Buchsteiner, Mandy Zenkner, Thomas Grossmann, Claudia Ehrhardt, Stefan G. Ebbinghaus, Martin Diestelhorst, Sebastian Lemm, Wolfram Münchgesang, Horst Beige, and Hartmut S. Leipner — Martin-Luther-Universität, Halle-Wittenberg, 06099 Halle

Currently energy storage is an interesting and important topic. Next to accumulators, thin film capacitors with high energy densities are feasible. The aim of our work is to develop novel capacitors exhibiting several advantages like very quick charging and discharging times, long lifetimes and high robustness as well as low manufacturing costs.

For this purpose, ceramic nanoparticles with perovskite structure and high permittivities ($BaTiO_3$, $Ba(Ti,Ge)O_3$, $CaCu_3Ti_4O_{12}$) are embedded in either an organic polymer or an inorganic glass matrix. In order to achieve a uniform dispersion, the nanoparticles are coated with a specific surfactant depending on the matrix. Size and distribution of the embedded particles have a strong effect on the electrical properties of the capacitor dielectrics. Therefore, accurate knowledge of the microstructure is necessary. The single composites are imaged via environmental scanning electron microscopy (ESEM) in secondary electron (SE) and backscattered electron contrast (BSE). Additionally, transmission electron microscopy (TEM) investigations are carried out and energy-dispersive X-ray spectroscopy is conducted in order to get compositional information.