DS 17: Optical Analysis of Thin Films III

Time: Thursday 16:15–17:45 Location: SCH A 316

Invited Talk DS 17.1 Thu 16:15 SCH A 316
In-situ optical spectroscopy on electrochemical interfaces: From OER electrocatalysts to "smart" electro-switchable interfaces — •Martin Rabe — Department of Interface Chemistry and Surface Engineering, Max-Planck-Institut für Eisenforschung GmbH, Max-Planck-Str. 1, 40237 Düsseldorf

We employ electrochemical in-situ optical spectroscopies, namely IR- and Raman-spectroscopy as well as UV/vis-spectroscopic ellipsometry to understand fundamental processes at electrolyte/solid interfaces. Here, different examples from our research will be presented and discussed. 1: Electrocatalytically active manganese and nickel oxides during the anodic oxygen evolution reaction (OER) were studied. The formation, phase transitions and dissolution processes in these metal oxides is shown to govern their activity and stabilities on metallic electrodes. These material properties play a major role for the improvement of electrocatalysts for the sluggish OER in hydrogen production by the electrochemical water splitting. 2: The impact of the electrochemical Ge-OH to Ge-H surface termination on germanium interfaces was studied, which is accompanied by a switching of the interface hydrophobicity. The formation of a hydrophobic gap at semiconductor/electrolyte interface gives access to study fundamental properties of the water solvation layers. Furthermore, it is shown how the macroscopic change of the hydrophobicity can be employed as a "smart" electro-switchable surface that allows to reversibly control the adsorption and orientation of bio-macromolecules, a process that is potentially useful for novel bio sensing applications.

Invited Talk DS 17.2 Thu 16:45 SCH A 316
The physics of low symmetry semiconductors: Gallium oxide for the future of green energy as example — •Mathias Schubert — Department of Electrical and Computer Engineering, University of Nebraska-Lincoln, Lincoln, Nebraska 68588, USA — NanoLund and Solid State Physics, Lund University, 22100 Lund, Sweden

The physics of Gallium arsenide (zincblende structure) and Gallium nitride (wurtzite structure) led to disruptive technologies driven by extreme properties such as small effective mass, large direct bandgap, and piezoelectric polarization. Gallium reappears in a monoclinic crystal structure Oxide with enormous prospects for applications in power electronics for the future of green energy. Numerous new phenomena hitherto unknown for traditional semiconductors occur in monoclinic symmetry semiconductors such as non-parallel phonon-plasmon scattering, hyperbolic shear polaritons, splitting of associated transverse and longitudinal phonon modes, non-degenerate highly anisotropic fundamental excitonic band-to-band transitions, directional band offsets, and complex defect spin interactions within the highly anisotropic host lattice. The influences of composition, strain, doping, and defects are discussed for Gallium oxide and related alloys, and special emphasis is given to new semiconductor physics, and consequences for thin film growth and device designs are pointed out. Methods such as generalized ellipsometry, the optical Hall effect, Terahertz electron paramagnetic resonance ellipsometry, and density functional perturbation theory computations are employed for characterization and analysis.

Invited Talk DS 17.3 Thu 17:15 SCH A 316
Spectroscopic ellipsometry studies of optical constants in highly excited semiconductors — •Stefan Zollner — New Mexico State University, Las Cruces, NM, USA

Spectroscopic ellipsometry is an optical reflection technique with polarized light. Most commonly, it is used to measure the thicknesses of thin-film layers, such as SiO_2 on Si. But it can also be used to study the energies and broadenings of elementary excitations in solids, such as electrons (band gaps, transport), infrared active phonons, and their interactions. We previously reported precision measurements of the complex refractive index of germanium near the direct band gap, which allowed us to compare our results quantitatively with theoretical predictions from Fermi's Golden Rule, based on k.p theory and including the excitonic interaction between electrons and holes. Going further, we can investigate how many-body effects impact the properties of electrons in highly excited semiconductors. Large carrier concentrations can be achieved through doping, thermal excitation of electron-hole pairs in small band-gap semiconductors, or optical excitation with ultrafast lasers. In this talk, I will report recent ellipsometry results for the temperature-dependent dielectric function of InSb near the direct band gap and the transient dielectric function of Ge near the E_1 and $E_1 + \Delta_1$ transitions from femtosecond pump-probe ellipsometry. I will also point out the theoretical approach needed to explain these data sets.