

DS 1: Optical Analysis of Thin Films I (Reflection, Ellipsometry, Raman, IR-DUV Spectroscopy, ...)

Time: Monday 9:30–11:45

Location: H32

Invited Talk

DS 1.1 Mon 9:30 H32

Charge and ion exchange at electrochemical interfaces: atomistic insights by means of in-situ ellipsometry — ●CHRISTOPH COBET — Johannes Kepler University, Altenbergerstr 69, 4040, Linz, Austria

Recently, solid-liquid interfaces and electrochemical surface reactions received more and more attention. The motivation may arise by applications e.g. to solve energy harvesting problems or to develop novel (bio-)sensing techniques. The functionality, however, depends on the adjacent atomic layers near the interface and the development of respective surface sensitive methods allow nowadays a more detailed study. In general we have to deal with alternating charges and chemical compounds perpendicular to the interfaces. In the presented work we use polarization optical methods in the spectral range of transparency of the electrolytes. It is an advantage and at the same time a challenge that all boundaries in the light pass contribute to a polarization change. We show in comparison to conventional cyclic voltammetry, impedance spectroscopy, and electrochemical STM that spectroscopic ellipsometry and reflection anisotropy spectroscopy (RAS) can nevertheless provide quantitative information. At metal single crystal surface it was e.g. possible to determine the amount of surface adsorbates and the amount of interface charges. Thus, we could determine also the so called potential of zero total charge (PZTC). Furthermore, we got evidences for an increased density of the water film near the interface. Time resolved measurements gave supplementary insights in the dynamics of electrochemical absorption processes.

15 min. break

DS 1.2 Mon 10:15 H32

Sensing and structure analysis by in situ IR spectroscopy: From ml flow cells to microfluidic applications — ●KARSTEN HINRICH, LUCJAN GRZEGORZEWSKI, ANDREAS FURCHNER, and CHRISTOPH KRATZ — ISAS - e.V., Schwarzschildstr. 8, 12489 Berlin, Germany

The low penetration depths of IR radiation in aqueous solutions poses a challenge for utilizing IR spectroscopy in investigations with macro- and microfluidic flow cells. Probing the solid liquid interface through an IR transparent substrate can be advantageous in such experiments. In situ IR ellipsometry in combination with optical modeling can be applied for detailed analysis of molecular interactions and hydration states of ultrathin functional polymer films. The development of an optofluidic platform incorporating metal-island film substrates for signal enhancement translates this technique to the world of microfluidics. Time-resolved measurements of monolayer formation of organic molecules show that the developed concept can be employed to monitor dynamic processes under in situ conditions in nL volumes.

DS 1.3 Mon 10:30 H32

Reflectance Anisotropy Spectroscopy as an analytical tool for phase transformation studies: order reactions in Cu-Au Thin Films — ●MARCO VOLPI, ALLA SOLOGUBENKO, PHILIPP OKLE, and RALPH SPOLENAK — ETHZ, Zürich, Switzerland

Increasing interest of materials science in thin films is driven by a vast range of applications in many fields like mechanics, electronics and optics. Outstanding physical and mechanical properties originate from their morphology and microstructure, which are processing conditions dependent. Therefore, monitoring of film phase stabilities during their production is fundamental. In this work, we study thermally induced phase transformations of Cu-x at.% Au (x=15, 25, 50, 75) thin films produced with Plasma Assisted Physical Vapor Deposition (PA-PVD) by combining transmission electron microscopy (TEM) and X-Ray diffraction (XRD). Information gained on the order reactions were used to validate the phase state sensitivity in Reflectance Anisotropy Spectroscopy (RAS) [1]. As-deposited Cu-Au thin films show a solid solution state that disagrees with the equilibrium phase configurations expected from the bulk phase diagram. However, thermal treatment triggers order reactions that lead to equilibrium. Both TEM and RAS revealed the formation of intermetallic phases in Cu-25 at.% Au and Cu-50 at.% Au upon annealing. Yet, only RAS could reveal a two-

phase state that coexisted in the annealed Cu-25 at.% Au and Cu-50 at.% Au films. To conclude, RAS proves to be a very sensitive alternative to TEM that allows prompt and non-destructive phase analyses in films. [1] Cole R.J. et al., J Phys. D Appl. Phys., (2003), 36.

DS 1.4 Mon 10:45 H32

Direct band gap of alpha-tin investigated by infrared ellipsometry — RIGO A. CARRASCO¹, CESY M. ZAMARRIPA¹, ●STEFAN ZOLLNER¹, and JOSE MENENDEZ² — ¹New Mexico State University, Las Cruces, NM — ²Arizona State University, Tempe, AZ

Interest in gray tin has been revived because it is the endpoint constituent of Ge_{1-x}Sn_x alloys, which have potential applications as mid-infrared detectors and lasers. α -tin also becomes a topological insulator or Dirac semimetal under stress. The band structure for gray tin is similar to Ge, but the Γ_7^- s-antibonding band, which is the conduction band in Ge, moves downward in gray tin and appears between Γ_8^+ and Γ_7^+ with a negative energy \bar{E}_0 if we conventionally choose Γ_8^+ as the zero energy level.

Using Fourier-transform infrared ellipsometry, we provide spectroscopic evidence about the valence band structure of α -tin. The mid-infrared dielectric function of α -tin grown pseudomorphically on InSb or CdTe by molecular beam epitaxy shows a strong \bar{E}_0 peak near 0.41 eV. The peak can be attributed to allowed intra-valence band transitions from the Γ_7^- (electron-like) to the Γ_8^{+v} heavy hole valence band and/or interband transitions from the Γ_7^- band to the Γ_8^{+c} light "hole" conduction band. Possible sources for the strength of the peak, and its temperature dependence will be discussed. We would like to thank Dr. Arnold M. Kiefer and Stephanie Chastang for providing us the strained α -tin samples.

DS 1.5 Mon 11:00 H32

Temperature induced changes in monolayers observed by sum frequency generation spectroscopy — ●DAMIAN FIRLA, ROBERT RAMEKER, JOSHUA MULTHAUP, and ECKART HASSELBRINK — Universität Duisburg-Essen, Universitätsstr. 5, 45141 Essen, Germany

A major component in cell membranes are phospholipids which form bilayers. The amphiphilic character of phospholipids was exploited to spread a solution on water in a Langmuir trough. This monolayer was compressed, transferred on a substrate and studied by sum frequency generation spectroscopy. The main goal was to observe changes upon raising the temperature. Typically conformational changes of alkyl chains from *all-trans* to a conformation with *gauche* defects were observed as recognized by the change of the intensities of the CH₃ and CH₂ vibrational modes. Different types of phospholipids and mixtures of phospholipids with varying chain lengths were studied. Investigations of single phospholipid species showed that the intensity of CH₃ vibrational modes decreased with rising the temperature whereas the intensity of the CH₂ symmetrical stretching mode was not increasing. This was attributed to the high density of such monolayers, in which conformational changes were not possible because of strong van der Waals interactions. Further on mixtures of phospholipids with different chain lengths were used. In these studies the symmetrical stretching mode of CH₂ was observed as well, consistent with the larger space for conformational changes. The thermal stability of phospholipid monolayers was also probed. Results showed that monolayers of single phospholipid species were more stable than monolayers of phospholipid mixtures.

DS 1.6 Mon 11:15 H32

Raman spectroscopy characterization of silicon nanoribbons on Ag(110) — ●DMYTRO SOLONENKO, ALEXANDER EHM, DIETRICH R. T. ZAHN, and PATRICK VOGT — Semiconductor Physics, Chemnitz University of Technology, D-09107 Chemnitz, Germany

Silicon nanoribbons, which can be grown epitaxially on the Ag(110) surface [1], have an unexpected chain-like structure of Si pentagons, originating from the missing row arrangement of the Ag surface and the adlayer-substrate interaction [2]. Such interplay has consequences for the Si-Si bond lengths and force constants, which can be probed by Raman spectroscopy. Our Raman results reveal the mode symmetries, which are necessary to properly assign the modes of these highly anisotropic quasi-1D crystals. Furthermore, the results allow the differ-

entiation between the two structural phases of the ribbons, *i.e.*, single- and double-strand ribbons, and the identification of structures, which appear at the super-monolayer growth regime. The spectroscopic signatures of Si nanoribbons are compared to those of epitaxial silicene, formed on Ag(111) [3], in order to understand the fundamental principles of the Si-Ag interaction and the hybridization states of the Si atoms. The functionalization of the nanoribbons and their application are also discussed. [1] P. De Padova, *et al.*, *Nano Lett.* 8, 271 (2008). [2] J. I. Cerdá, *et al.*, *Nat. Comm.* 7, 13076 (2016). [3] D. Solonenko, *et al.*, *2D Mater.* 4, 015008 (2017).

DS 1.7 Mon 11:30 H32

Revealing the distinct structural and plasmonic properties of gold nanosponges through FIB nanotomographical reconstruction — •PETER SCHAAF, LARS HAUKE HONIG, and DONG WANG — TU Ilmenau, Institute of Materials Science and Engineering and Institute of Micro and Nanotechnologies MacroNano(R), Gustav-Kirchhoff-Str. 5, 98693 Ilmenau, Germany

Individual gold nanosponges (nanoporous gold nanoparticles) which were fabricated by solid state dewetting of Ag/Au bilayers and subsequent dealloying, are reconstructed from SEM images captured by FIB nanotomography. The investigated particles have diameters in the range of a few hundred nanometers and ligament diameters around 12 nm. The optical and plasmonic properties of the gold nanosponges are clearly different from that of the solid nanoparticles, and are more complex and fascinating due to unique structural features. In this work, the 3D reconstructed models of gold nanosponges, which correspond precisely to the real structures, have been used for the simulation. The results show that the plasmon peak shifts red and multiple resonance behavior appears with increasing porosity. [1] D. Wang et al., *J. Mater. Chem.*, 2012, 22, 5344. [2] Fujita, T. et al., *Applied Physics Letters*, 2008, 92, 251902. [3] Vidal C. et al., *ACS Photonics* 2015, 2, 1436. [4] Rao W. et al., *ACS Appl. Mater. Interfaces* 2017, 9, 6273. [5] Vidal, C. et al., *Nano Lett* 2018, 18, (2), 1269. [6] Hergert, G. et al., *Light Sci. Appl.* 2017, 6, e17075.