DS 36: Vibrational Spectroscopy of Nanolayers with Optical Probes

Time: Friday 10:15–12:00 Location: H 2013

Invited Talk DS 36.1 Fri 10:15 H 2013

Infrared ellipsometry on functional films at the solid-liquid-interface — •Karsten Hinrichs — ISAS - Institute for Analytical Sciences, Department Berlin, Albert-Einstein-Str. 9, 12489 Berlin, Germany

Organic/silicon hybrid systems are of high technological relevance for design of optical, electronic, biosensing and photovoltaic devices. Infrared spectroscopic ellipsometry (IRSE) was applied for in-situ monitoring of structural properties at the interface between silicon/film and liquid. Several examples with a few nm thick films at the solid-liquid interface will be discussed: 1) Etching process of anodic silicon oxide in diluted NH_4F solution; 2) The study of the switching behavior of stimuli-responsive mixed polymer brushes [1]; 3) The growth of electrochemically prepared organic films (e.g. polypyrrole, nitrobenzene).

[1] Y. Mikhaylova, L. Ionov, J. Rappich, M. Gensch, N. Esser, S. Minko, K.-J. Eichhorn, M. Stamm, K. Hinrichs, Analytical Chemistry 79 (2007) 7676.

Invited Talk DS 36.2 Fri 10:45 H 2013

Surface enhanced infrared spectroscopy — •Annemarie Pucci — Ruprecht-Karls-Universität Heidelberg, Kirchhoff-Institut für Physik, Im Neuenheimer Feld 227, 69120 Heidelberg

Surface enhanced infrared (IR) spectroscopy (SEIRS) is similar to surface enhanced Raman scattering (SERS) but its vibration signal enhancement is much less than that obtained with SERS; only up to three orders of magnitude in enhancement were achieved so far. The difference to SERS is based on the lower influence of local electromagnetic fields onto the signal enhancement. Electromagnetic field enhancement is the main enhancement effect in SEIRS and SERS and it is obtained with nano-structured metal films or with metal nanoparticles via plasmonic excitations of free electrons. Electromagnetic nearfield enhancement is strongest in nano-gaps and in proximity of sharp tips. Accordingly, metal particle systems close to percolation give a stronger effect in SEIRS of adsorbate vibrations than systems with lower or higher particle density. For single particles strong field enhancement in the IR can be obtained in case of a rod-like shape and a high aspect ratio. Such nanoantennas with length in the micrometer range behave similar to ideal antennas, which is qualitatively different to nanoparticles with resonances in the visible range. Exploiting the nearfield enhancement at the antenna resonance, SEIRS of molecules on the antenna allows extraordinary strong signal enhancement, which makes SEIRS to an interesting tool for medical and chemical sensing.

DS 36.3 Fri 11:15 H 2013

Infrared properties of ultra-thin metal films at and below the percolation threshold — •Bruno Gompf, Martin Alws, Martin Hövel, and Martin Dressel — 1.Physikalisches Institut, Universität Stuttgart

Whereas the optical properties of thicker metal films are well understood, little has been done at and below the percolation threshold especially in the infrared region. We have studied ultra-thin gold films on Si/SiO2 in the thickness range from 1 nm to 10 nm over a very broad frequency range between 500 cm^{-1} and 40.000 cm^{-1} with FTIR spectroscopy and spectroscopic ellipsometry. Thicker continuous films show a normal Drude behaviour, i.e. with increasing frequency the reflectivity decreases. Below the percolation threshold an anomaly occurs: in a certain spectral range the reflectivity becomes smaller than that of the bare substrate indicating an antireflection coating of nm thickness for infrared light. This anomaly can in principle be understood by the divergence of the dielectric function at the metal-to-insulator transition.

DS 36.4 Fri 11:30 H 2013

Resonance enhanced infrared spectroscopy using single gold nanowires — •Frank Neubrech[1], Shafqat Karim[2], Thomas Cornelius[2], Javier Aizpurua[3], and Annemarie Pucci[1] — [1]Kirchhoff-Institut für Physik, Universität Heidelberg, Germany — [2]Gesellschaft für Schwerionenforschung, Darmstadt, Germany — [3]Donostia International Physics Center, Donostia-San Sebastian, Spain

We performed enhanced vibrational spectroscopy of molecules adsorbed on individual gold nanowires using synchrotron light of the ANKA IR-beamline at the Forschungszentrum Karlsruhe. Spectroscopic IR-microscopy of nanowires with a length of a few nanometer and a diameter of about 100nm prepared by electrochemical deposition in polymeric etched ion track membranes reveals antenna like plasmon resonances in the relative transmittance spectra. For a demonstration of resonance enhanced spectroscopy we used an octadecanethiol (ODT) monolayer as adsorbate. Depending on the spectral position of the antenna-like resonance in relation to the absorption bands of ODT (2850cm^{-1} and 2919cm^{-1}) enhancement factors (enhanced absorption signal divided by not enhanced absorption signal) up to 300 000 can be achieved. Such high factors exceed the enhancement obtained by common surface enhanced infrared absorption techniques, e.g. rough films substrates, by at least 2 orders of magnitude.

DS 36.5 Fri 11:45 H 2013

IR spectroscopy for degradation studies of OLED emitter materials — •Martin Binder and Annemarie Pucci — Kirchhoff-Institut für Physik, Universität Heidelberg

We are doing Infrared Spectroscopy on new emitter materials for highly efficient organic light diodes (OLEDs). These materials are small organic molecules. In our experiments we can evaporate these molecules under UHV conditions on silicon and do IR spectroscopy *in situ*. Our special interest lies on the stability of the molecules, for example their behaviour under UV irradiation is investigated. Degradation of OLEDs is still one of the big challenges in that field and a consistent explanation is missing. During irradiation with UV light the photoluminescence is observed and, as it is well known, the luminescence is decreasing. We found a relativly strong loss in luminescence and much smaller changes in the IR spectra of the layers.