DS 37: Vibrational Spectroscopy of Nanolayers with Optical Probes

Time: Friday 13:30–15:00 Location: H 2013

Invited Talk DS 37.1 Fri 13:30 H 2013

Ambient pressure spectroscopy of catalytically active nanostructures: Mind the gap! — •Günther Rupprechter — Institute of Materials Chemistry, Vienna University of Technology, Veterinärplatz 1, A-1210 Vienna, Austria

Recent advances in model catalysis and in spectroscopic methods that can operate at ambient pressure now enable us to investigate a catalyst in its active state, i.e. while it is functioning. Polarization-modulated infrared spectroscopy, sum frequency generation, and high-pressure photoelectron spectroscopy allow monitoring the transformation of catalysts from the "as-prepared" to the "active-state", which may involve pronounced changes in catalyst structure and composition. The ultimate goal is the characterization of the active sites. A number of case studies are presented for Pd-based catalysts (single crystals, thin films, oxide supported nanoparticles), that illustrate the dynamic behavior of catalytically active surfaces, with emphasis on the activity of Pd surface oxides for CO and methanol oxidation, and on surface carbonate formation. There is clearly a need to "mind the gap" between investigations under ultrahigh vacuum and those at ambient pressure, as well as to account for the inherent differences between supported nanoparticles and extended single crystal surfaces.

Invited Talk DS 37.2 Fri 14:00 H 2013

Near-field Infrared Nanoscopy and Nanospectroscopy — •Rainer Hillenbrand — Nano-Photonics Group, Max-Planck-Institut für Biochemie, 82152 Martinsried, Germany — CIC NanoGUNE Consolider, 20009 San Sebastian, Spain

Comprehensive material analysis in thin films and nanostructures requires ultrahigh-resolution microscopy providing high sensitivity to chemical composition, structural properties and local conductivity, among others. Conventional far-field optical spectroscopy offers such sensitivity, however, diffraction limits the spatial resolution to half the illumination wavelength. Near-field optical microscopy (SNOM) can overcome this drawback. Particularly its scattering-type version (s-SNOM) allows optical imaging with nanoscale spatial resolution, independent of the wavelength. In s-SNOM, the elastically scattered light from the laser illuminated tip of an atomic force microscope is recorded, simultaneously to topography.

Besides of a short introduction to the s-SNOM technique, I will demonstrate mid-infrared microscopy and spectroscopy at 20-30 nm spatial resolution. Applications such as material-specific imaging of thin films and single nanoparticles [1-3] and free carrier mapping in semiconductor devices [4] will be demonstrated.

[1] A. Cvitkovic, et al., Phys. Rev. Lett. 97, 060801 (2006)
[2] M. Brehm, et al., Nano Lett. 6, 1307 (2006).
[3] A. Cvitkovic, N. Ocelic, R. Hillenbrand, Nano Lett. 7, 3177 (2007)
[4] A. Huber, et al., Adv. Mater. 19, 2209 (2007)

DS 37.3 Fri 14:30 H 2013

Creation of highly confined longitudinal field modes for near-field excitation — •Johannes Stadler, Catrinel Stanciu, and Alfred Meixner — Institut of Physical Chemistry, University of Tuebingen, Germany

The focusing properties of a confocal microscope are not only crucial to enhance the resolution for confocal microscopy, but also define the confinement and thus the local field strength in the focus. In particular for tip-enhanced microscopy, having a tightly focused beam is extremely important in order to avoid having a strong background overlapping the tip-enhanced signals. More important, the polarization of light in the focal area should be longitudinal to efficiently excite the metallic tips. We show here that a parabolic mirror (PM) fulfils both requirements when used as a focusing element for tip-enhanced microscopy. When using a radially-polarized beam, the PM provides the smallest diffraction-limited spot that can be created using far-field optics. Due to the different focusing properties and apodization factors of the PM, the intensity in the longitudinal mode is remarkably higher than in comparable setups using aplanar lenses. The strong longitudinal fields and the local confinement offer perfect conditions for the excitation of a near-field tip with fewer background noise. First examples of near-field optical easurements with this new arrangement will be presented.

DS 37.4 Fri 14:45 H 2013

Near-field Raman Spectroscopy utilizing scattering by noble metal particles on SiGe samples — •Peter Hermann[1], Michael Hecker[2], Sebastian Pankalla[2], Jochen Rinderknecht[2], Phillip Olk[3], Marc Tobias Wenzel[3], rené kullock[3], Yvonne Ritz[2], Ehrenfried Zschech[2], Peter Kücher[1], and Lukas Eng[3] — [1]Fraunhofer CNT, 01099 Dresden, Germany — [2]AMD Saxony LLC & Co KG, Material Analysis Department, 01099 Dresden, Germany — [3]Institut für Angewandte Photophysik TU-Dresden, 01069 Dresden, Germany

Noble metal particles show very interesting and complex optical properties. One of the most striking phenomena encountered in these particles are electromagnetic resonances due to collective oscillations of the conduction band electrons. The excitation of plasmons leads to an increased light scattering and to an enhanced electromagnetic near-field. Due to the high optical resolution which can be reached by near-field measurements, tip enhanced Raman spectroscopy (TERS) therefore became an inevitable analytical method for probing stress related phenomena in the semiconductor industry. First TERS measurements on SiGe structures indicate a much better optical resolution as compared to far-field experiments. However, the full potential of this method is not exploited yet; for instance, the observed Raman signal enhancement stemming from SiGe as investigated here, contains a composition of several contributions, such as different far-field polarization modes, scattered light, as well as near-field contributions. Careful analysis of these contributions is inevitable for local mechanical stress analysis.