

## O 90: Methods: Scanning Probe Techniques II

Time: Friday 10:15–12:00

Location: MA 042

O 90.1 Fri 10:15 MA 042

**Multiple distance scanning tunneling spectroscopy of organic layers** — ●CHRISTIAN WAGNER and TORSTEN FRITZ — Institut für Angewandte Photophysik, TU-Dresden, George Bähr Str. 1, 01069 Dresden

Scanning tunneling spectroscopy (STS) has been proven to be a powerful tool to investigate the energetic position of electronic states of organic molecules adsorbed on conductive surfaces. Since already the front orbitals are typically situated 1 to 2 eV below and above the substrate's Fermi energy, one inherent problem is the need to apply equivalently high voltages, which might in turn damage the rather sensitive organic layer. One technique which is able to limit the electric field strength is the multiple distance STS, where several I-V spectra are recorded subsequently at a fixed lateral position while increasing the tip sample distance and voltage range from one spectrum to the next [1]. In our contribution we want to discuss the applicability of this method to organic adsorbates on the example of unsubstituted quaterylene on Au, a molecule which has a large  $\pi$ -system and a comparably small HOMO-LUMO gap. We answer the question whether the multiple distance STS can be combined with a DOS calculation via the 1D WKB model [2]. As this method allows including the tip sample distance directly into the evaluation process, one could calculate an unambiguous sample DOS from the multiple I-V curves.

[1] R. M. Feenstra and J. A. Stroscio, *J. Vac. Sci. Technol. B* **5**, 923 (1987)

[2] C. Wagner et al., *Phys. Rev. B* **75**, 235432 (2007)

O 90.2 Fri 10:30 MA 042

**Novel design for luminescence detection in the low temperature STM** — ●KLAUS KUHNKE, ALEXANDER KABAKCHIEV, and KLAUS KERN — Max-Planck Institut für Festkörperforschung, Stuttgart

We present a novel design for the detection of luminescence from the STM tunnel junction. Three optical paths are introduced into an existing low temperature STM. We employ free optical light propagation using lenses and mirrors which fully preserve essential information carried by the light like angular distribution, polarization, and emission time. Care has been taken to minimize the thermal input through the light paths into the liquid He cryostat. Possible operation modes are discussed and demonstrated by preliminary measurements.

O 90.3 Fri 10:45 MA 042

**Alignment of molecular energy levels between two biased metal electrodes** — ●NIKOLAI SEVERIN<sup>1</sup>, HUA LIANG<sup>1</sup>, STEFAN HECHT<sup>2</sup>, RAGNAR STOLL<sup>2</sup>, KLAUS MÜLLEN<sup>3</sup>, IGOR M. SOKOLOV<sup>1</sup>, and JÜRGEN P. RABE<sup>1</sup> — <sup>1</sup>Department of Physics, Humboldt University Berlin, Newtonstr 15, D-12489, Germany — <sup>2</sup>Department of Chemistry, Humboldt University Berlin, Brook-Taylor-Str. 2, D-12489, Germany — <sup>3</sup>Max Planck Institute for Polymer Research, Ackermannweg 10, D-55128 Mainz, Germany

Understanding the alignment of molecular energy levels in a monolayer of molecules located between two biased metal electrodes in a tunneling contact is of paramount importance in the fast developing field of molecular electronics. Current rectification in such systems has been described taking into account a strong dependence of the energy levels on the relative position of the molecules between the electrodes. However, to our knowledge such dependence has not been experimentally examined yet; it is also not self-evident, since also different simple pictures of energy level alignment may be rationalized. Here we report on the dependence of the current rectification ratio on the relative position of different molecules between a highly ordered pyrolytic graphite substrate and a Pt/Ir scanning tunneling microscope tip immersed in 1-phenyloctane. The variation of the relative position of the molecules within the gap is achieved by the variation of the tip-surface distance. We find that the variation of current rectification ratio is substantially different for different molecules. We propose a simple model which rationalizes the experimental observations.

O 90.4 Fri 11:00 MA 042

**Spectroscopic THz near-field microscope** — ●HANS-GEORG VON RIBBECK<sup>4,1</sup>, MARKUS BREHM<sup>1</sup>, DANIEL VAN DER WEIDE<sup>2</sup>, MANFRED HELM<sup>3</sup>, OLEKSY DRACHENKO<sup>3</sup>, STEPHAN WINNERL<sup>3</sup>, and FRITZ KEILMANN<sup>1</sup> — <sup>1</sup>Max-Planck-Institut für Biochemie and Center of

Nanoscience, 82152 Martinsried\*Max-Planck-Institut für Biochemie and Center of Nanoscience, Martinsried, Germany — <sup>2</sup>Dept. of Electrical and Computer Engineering, University of Wisconsin, Madison, WI 53706-1691, USA — <sup>3</sup>Forschungszentrum Dresden-Rossendorf, 01314 Dresden, Germany — <sup>4</sup>Institut für Angewandte Photophysik, TU Dresden, Germany

We demonstrate operating a scanning near-field optical microscope of scattering type (s-SNOM) with broadband THz illumination. A home-made cantilevered W tip is used in a tapping-mode AFM. The direct scattering spectrum is obtained and optimized by asynchronous optical sampling (ASOPS), while near-field scattering is observed by using a space-domain delay stage and harmonic demodulation of the detector signal. True near-field interaction is manifested from the distance-dependence of gold samples. Furthermore scattering spectra of differently doped silicon are presented.

O 90.5 Fri 11:15 MA 042

**Studying the spatial distribution of reactant gases above catalytically active microstructures by means of scanning mass spectrometry** — ●MATTHIAS ROOS, STEFAN KIELBASSA, JOACHIM BANSMANN, and ROLF JUERGEN BEHM — Institute of Surface Chemistry and Catalysis, Ulm University, D-89069 Ulm, Germany

We present an apparatus for spatially resolving scanning mass spectrometry for measuring the 3D gas composition above planar catalytically active surfaces, which enables us to quantitatively determine local reaction rates, e.g., on individual fields of microstructured model catalysts. A piezo-electrically driven positioning substage allows control of the lateral and vertical positioning of the sample under a stationary capillary probe with micrometer-scale resolution. The diameter of the capillary orifice, connecting the reaction chamber with a differentially pumped quadrupole mass spectrometer, varies from 50 to 150  $\mu\text{m}$ , depending on the used capillary. Measurements can be performed at pressures in the range of  $10^{-3}$  –  $10$  mbar and temperatures between room temperature and 450°C. The CO oxidation reaction on planar Pt microstructures was used as a test reaction for determining the lateral resolution of the setup and the spatial distribution of reactant gases. The CO<sub>2</sub> formation and CO consumption above the microstructures was evaluated as function of lateral displacement and distance between sample and probe to study the effects of gas transport in the regime between sample and probe. Furthermore, the feasibility of determining absolute reaction rates on individual microstructures is demonstrated.

O 90.6 Fri 11:30 MA 042

**Smoothing of surfaces by deposition of amorphous PSZ** — ●JOHANNA RÖDER and HANS-ULRICH KREBS — Institut für Materialphysik, Universität Göttingen, Friedrich-Hund-Platz 1, D-37077 Göttingen, Germany

Nowadays the investigation of growth characteristics is of great interest, as for many thin film technologies the surface morphology plays an important role. Especially for optical, electrical or mechanical properties it is important to control features like surface and interface roughnesses during the deposition of thin films. Up to now a lot of experimental and theoretical work has been done to investigate the roughness evolution during film growth on a smooth substrate. In this contribution another approach is chosen and the growth of films deposited on an already rough surface is investigated. Here smoothing phenomena may occur depending on the materials used. As rough substrates thin Ag-films on Si were used, which show distinct island growth and thus exhibit statistic roughness (rms of 0.9 nm). Smoothing is done by deposition of an additional amorphous layer of partially stabilized zirconium oxide (PSZ) with an rms-roughness of 0.1 nm on Si and the results were discussed with respect to the dominating smoothing mechanisms that occur during deposition. Therefore stochastic differential equations were consulted and the scaling behaviour of the roughness evolution was investigated. All samples were deposited by pulsed laser deposition and investigated via atomic force microscopy. Power spectral densities as well as autocorrelation functions were calculated.

O 90.7 Fri 11:45 MA 042

**Experimental Observation of Amontonian und Superlubric Sliding in Extended Nanocontacts** — ●DIRK DIETZEL<sup>1,2</sup>, TRISTAN MÖNNINGHOFF<sup>1</sup>, U. D. SCHWARZ<sup>3</sup>, CLAUDIA RITTER<sup>3</sup>, HARALD

---

FUCHS<sup>1,2</sup>, and ANDRE SCHIRMEISEN<sup>1</sup> — <sup>1</sup>Institute of Physics, University of Münster, Münster, Germany — <sup>2</sup>INT, Forschungszentrum Karlsruhe (FZK), Karlsruhe, Germany — <sup>3</sup>Department of Mechanical Engineering, Yale University, New Haven, CT, USA

One of the most fundamental questions in nanotribology is the contact area dependence of frictional forces on the nanometer scale. Unfortunately, conventional friction force microscopy techniques are limited for analyzing this problem due to the unknown and ill-defined tip-sample contact. This limitation can be circumvented by measuring the lateral force signal during the manipulation of nanoscale particles with a

well-defined, clean contact to the substrate. In our study, the samples under investigation were metallic islands with diameters between 50-500 nm grown by thermal evaporation of antimony on highly oriented pyrolytic graphite (HOPG). Experiments that included the controlled manipulation of a large number of nanoparticles in ultrahigh vacuum show two distinct frictional states during particle sliding: While some particles show finite friction increasing linearly with interface area, thus reinforcing Amonton's law at the nanoscale, other particles assume a state of frictionless or 'superlubric' sliding. This unexpected duality of friction states can be explained by contamination effects of the interface that alter the frictional properties.