tal Sci., Ludwig-Maximilians-Universität München, 80333 München, Germany

Mapping topography and material contrast of a surface simultaneously with a scanning probe microscope is influenced by the crosstalk between the two. To avoid this, we present a new measurement technique, the so called multifrequency approach, as proposed by Rodriguez et al.[1]. In this mode of operation, a conventional AFM in non-contact tapping mode is operated with two different mechanical excitation frequencies, the first and second eigenmode of the cantilever. The first eigenmode is used to map the topography and to maintain close contact with the surface. The second eigenmode allows to determine the phase and amplitude signal with minimal topographical crosstalk. A lock-in amplifier is used to demodulate the signal with respect to the second eigenmode.

[1] T.Rodriguez et al.: Compositional mapping by excitation of the second cantilever mode, Appl.Phys.Letters 84 (3), pp.449-451 (2004).

O 17.41 Mon 17:30 Poster C

Measuring the Anisotropy of Atomic-Scale-Friction by Friction Force Microscopy — •Peter Köchling[1,2], Markus Schäfer[1,2], Jan-Erik Schmutz[1,2], and Hendrik Hölscher[1,2] — [1]Physikalisches Institut, Westfälische Wilhelms Universität Münster, Wilhelm-Klemm-Str.10, 48149 Münster, Germany — [2]CeNTech (Center for Nanotechnology), Heisenbergstr. 11, 48149 Münster, Germany

Friction anisotropy is defined as the dependence of friction on the relative orientation of two sliding surfaces. This fundamental tribological phenomenon is of high interest for the analysis of the origin of atomic scale friction [1-3].

In order to investigate the friction anisotropy between a Si-tip and different sample surfaces we included a rotation stage into a commercial Friction Force Microscope (FFM). In this way we are able to control the orientations between tip and sample without the limitation to specific samples [1,3] or sensors [2].

Using this experimental set-up we measured frictional properties like adhesion and friction coefficients in dependence of the sample orientation. We will compare these results with theoretical predictions and published experiments.

[1] Liley et al. Science 280, 273 (1998)
[2] Dienwiebel et al. Phys. Rev. Lett. 92, 126101 (2004)
[3] Park et al. Science 309, 1354 (2005)

O 17.42 Mon 17:30 Poster C

Force Interactions in Atomically Defined Tip-Sample Contacts — •D. Braun[1], J. Falter[1], A. Schirmeisen[1,3], H. Hölscher[3], U. D. Schwarz[2], and H. Fuchs[1,3] — [1]Institute of Physics, University of Münster, Münster, Germany — [2]Department of Mechanical Engineering, Yale University, New Haven, CT, USA — [3]Center for Nanotechnology (CeNTech), University of Münster, Münster, Germany

The atomic force microscope (AFM) has been established as a tool for the imaging of surfaces with atomic resolution. However, a reliable interpretation of the observed atomic-scale contrast is often difficult. Meaningful comparisons with theoretical simulations would require knowledge of the exact position and identity of all atoms at the tip apex. A determination of the position of the last atoms of the tip is possible using field ion microscopy (FIM). We build an AFM for operation at low temperatures and under ultrahigh vacuum (UHV) conditions using a tuning fork (TF) as force sensor, allowing us to choose an appropriate material such as tungsten as tip material while maintaining atomic-scale resolution capabilities in AFM mode. The combination of an AFM operated in static contact mode with a FIM allows the correlation of interatomic forces with the atomic-scale tip configuration [1]. However, the dynamic mode of operation using the TF technique is expected to greatly enhance the force sensitivity of such measurements. First results obtained with both microscopy methods are presented. Tip radii obtained with the FIM are correlated to the force distance curves measured with the same tips.

[1]G. Cross et al., Phys. Rev. Lett. 80, 4685 (1998)

O 17.43 Mon 17:30 Poster C

The influence of temperature on stick-slip friction — •Lars Jansen[1,2], André Schirmeisen[1,2], Mykhaylo Evstigneev[3], Peter Reimann[3], and Harald Fuchs[1,2] — [1]Physikalisches Institut, Universität Münster, Wilhelm-Klemm-Straße 10, 4819 Münster — [2]CeNTech, Center for NanoTechnology, Heisenbergstraße 11, 48149 Münster — [3]Fakultät für Physik, Universität Bielefeld, 33615 Bielefeld

The stick-slip phenomenon, where the sliding body performs a saw-tooth like motion over a surface, is believed to be a fundamental process in atomic friction.

We measured atomic scale stick-slip friction on a HOPG surface with an atomic force microscope under ultrahigh vacuum conditions in a temperature range from 100 K to 300 K. In this work, we present our investigations of the temperature dependence of atomic friction.

On the one hand we show a direct analysis of the influence of temperature by measuring friction vs. scan-speed curves for different temperatures and compare our results with the thermally activated Thomlinson model as described by Sang et al. [1].

On the other hand we present a direct verification of our measurements with results predicted by rate-theory, where the thermal transitions are described by Kramer's rate and show that this theory only holds for fast sliding velocities [2]. We hypothesize that the failure of rate theory in the slow velocity regime is related to multiple contact formation at the tip sample contact.

[1] Sang et al., Phys. Rev. Lett. 84, 174301 (2001)
[2] Evstigneev et al., Phys. Rev. Lett. 97, 240601 (2006)

O 17.44 Mon 17:30 Poster C

Scanning mass spectrometer setup for spatially resolved reactivity studies on model catalysts — •Matthias Roos, Christian Schirling, Stefan Kielbassa, Joachim Bansmann, and Jürgen Behm — Institut für Oberflächenchemie und Katalyse, Universität Ulm, D-89069 Ulm

A scanning mass spectrometer with micrometer-scale resolution was developed for investigations on the catalytic activity of microstructured planar model catalysts. Products of local surface reactions can be detected via a fine capillary orifice in a differentially pumped quadrupole mass spectrometer. The position of the sample with respect to the capillary is controlled by three piezo-driven translators. The surface reactivity of a resistive heated sample can be depicted in a spatially resolved topogram, taking into account the influence of the distance between sample and capillary on the magnitude of the QMS signal and the lateral resolution.

Photolithographic structured reactive patterns on top of an inactive substrate enable investigations of mesoscopic transport effects such as coupling between catalytically active areas and of (reverse) spillover phenomena on one sample by varying the size and the distances of the active areas.

O 17.45 Mon 17:30 Poster C

A scanning tunneling microscope for application at 300 mK and 14 T. — •Viktor Geringer, Stefan Becker, Torge Mashoff, Marcus Liebmann, and Markus Morgenstern — II. Physikalisches Institut B, RWTH Aachen, Otto-Blumenthal-Straße, 52074 Aachen

We present a scanning tunneling microscope (STM) for operation at 300 mK in ultra high vacuum (UHV) and at magnetic fields of up to 14 T. The STM features two linear piezo drives with slip-stick mechanism: a z-approach motor for the piezo scanner and a x-y-positioning drive for the sample stage. Furthermore an in situ tip exchange is implemented in the system. The microscope exhibits a very compact and symmetric design to increase stability and resonance frequencies. We discuss the design concept and present first measurements at room temperature.

O 17.46 Mon 17:30 Poster C

Strategies for manipulation of nanometer-scale metallic islands in ultrahigh vacuum by atomic force microscopy techniques — •T. Mönninghoff[1], D. Dietzel[1,2], A. Schirmeisen[1], H. Fuchs[1,2], and U. D. Schwarz[3] — [1]Inst. of Physics, University of Münster, Germany — [2]Forschungszentrum Karlsruhe, Germany — [3]Dept. of Mechanical Engineering, Yale University, New Haven, USA

The fundamentals of friction are still insufficiently understood, in particular the relation between friction force and contact area. Conventional friction force microscopy is unsuitable in this regard due to the ill-defined tip-sample-contact. This limitation can be circumvented by investigating evaporated metal islands with a well-defined and clean contact to the substrate. Using appropriate scanning parameters for AFM contact mode operation, it is possible to move the metallic islands on the substrate. Simultaneously, the friction can be measured by the torsion of the cantilever. In this work, we have focused on the manipulation of antimony islands on graphite samples. Two different strategies have been applied. In the 1st approach, a predefined sample area has been scanned with a normal force close to the threshold of lateral manipulation. In this case, multiple manipulations of islands orthogonal to the fast scan direction make the interpretation difficult. Therefore a 2nd strategy has been developed, where high load was applied only at a few lines, yielding well-defined displacement events. Before and after the contact-mode manipulation the area was imaged using non-contact techniques, avoiding unwanted manipulation of small islands.

O 17.47 Mon 17:30 Poster C

Tunnelmikroskopie und -Spektroskopie von Terthiophen/Au(111) bei tiefen Temperaturen — •Anna Tschetschetkin[1], Berndt Koslowski[1], Christof Dietrich[1], Elena Mena-Osteritz[2], Peter Bäuerle[2] und Paul Ziemann[1] — [1]Institut für Festkörperphysik — [2]Institut für Organische ChemieII, Universität Ulm, 89069 Ulm

Wir berichten über erste Ergebnisse zur Untersuchung der elektronischen und vibronischen Eigenschaften von adsorbierten Oligothiophenen mittels Rastertunnelmikroskopie bei tiefen Temperaturen. Hierzu wurde in situ Terthiophen im Submonolagen-Bereich auf Au(111) aufgedampft. Die Moleküle adsorbieren zuerst statistisch verteilt auf der Metalloberfläche und gehen im Laufe der Zeit oder induziert durch den Tunnelstrom in eine geordnete Phase über. Die Moleküle richten sich hier an der Herringbone-Rekonstruktion der Goldoberfläche aus indem sie sich senkrecht zu den Solitonenwänden und bevorzugt in die fcc-Bereiche legen, ohne die Herringbone-Rekonstruktion erkennbar zu stören. Dies drückt sich in der elektronischen Struktur aus, indem auf den Molekülen immer noch der Shockley-artige Oberflächenzustand der Au(111)-Oberfläche gemessen werden kann. Während sich die im L-Gap des Goldes liegenden Molekülzustände bei ca. +2 eV (LUMO) einwandfrei von der Unterlage abheben, scheinen die Molekülzustände bei -2 eV (HOMO) so mit den d-Zuständen der Unterlage zu hybridisieren, dass sie mittels STS nicht von der Unterlage unterschieden werden können.

O 17.48 Mon 17:30 Poster C

Preparation and Characterization of Silicon Carbide Surfaces for Scanning Probe Microscopy Studies — •Kai Ruschmeier[1], Domenique Weiner[1], André Schirmeisen[1], Harald Fuchs[1], Nabi Aghdassi[2], Ralf Ostendorf[2], and Helmut Zacharias[2] — [1]CeNTech, Center for NanoTechnology, Heisenbergstraße 11, 48149 Münster — [2]Physikalisches Institut, Universität Münster, Wilhelm-Klemm-Straße 10, 48149 Münster

Silicon carbide (SiC) is a semiconductor that due to its unique properties is particularly well suited for electronic devices under extreme conditions, such as high temperature, high voltage and high frequency. However, the fabrication of adequate substrate surfaces, which is an important step in the production technology of high performance devices, is difficult because of its mechanical hardness and chemical inertness. We applied hydrogen etching at high temperatures to epilayer SiC substrates to reduce scratches of the polishing process and prepared different surface configurations by simultaneous annealing and evaporation of Si at different sample temperatures. We used LEED to verify several reconstructions such as (1×1), (3×3) and $(\sqrt{3}\times\sqrt{3})$. Additionally, the surface was analyzed with Auger electron spectroscopy (AES) and inverse photoemission spectroscopy (IPES). We applied scanning tunnelling microscopy (STM) in ultrahigh vacuum to analyse the surface topology at different stages of the preparation process. Our aim is to study different surface configurations with noncontact atomic force microscopy (NC-AFM) at the atomic scale.

O 17.49 Mon 17:30 Poster C

Phase-controlled Homodyne Interferometric Detection for s-SNOM — •Marcus Cebula, Susanne Schneider, and Lukas Eng — Institute of Applied Photophysics, TU Dresden, D-01062 Dresden

Apertureless or scattering-type scanning near-field optical microscopy (s-SNOM) is a versatile technique for high-resolution optical investigations of various materials. Common systems contain homodyne or heterodyne interferometric detection with lock-in demodulation to analyse the optical near-field signal. These methods are restricted in there application especially concerning their wavelengths range.

To eliminate these restrictions, a phase-controlled homodyne interferometric setup was designed. This setup can be used in the entire near-UV to far-IR spectral range. It consists of an enhanced homodyne interferometer containing a phase-modulated reference beam. By using additional lock-in demodulation and controlling techniques, a wavelength independent phase-regulation and therewith the possibility to measure both the optical amplitude and phase of the near-field signal, becomes available. The two signals can be measured simultaneously and also up to higher harmonic modes.

Our setup is designed to allow interferometric near-field measurements by the use of a free-electron laser, available at the Forschungszentrum Rossendorf. This precisely tunable light source covers the wavelength regime from 4 to 100 micrometer, and was used up to now for near-field optical investigations of organic thin films and ferroelectric single crystals by means of a direct intensity analysis.

O 17.50 Mon 17:30 Poster C

Conductivity measurements using a beetle-type double-tip STM — Philipp Jaschinsky, Josef Myslivec̆ek, Peter Coenen, Helmut Stollwerk, Gerhard Pirug, and •Bert Voigtländer — Institut für Bio- und Nanosysteme (IBN 3) und Center for Nanoelectronic Systems for Information Technology (CNI), Forschungszentrum Jülich, 52425 Jülich, Germany

We demonstrate applications of a double-tip scanning tunnelling microscope (STM) with a scanning electron microscope (SEM) in ultrahigh vacuum (UHV) environment [P. Jaschinsky et al., Rev. Sci. Instrum. 77 (2006), 093701]. This new instruments consists of two beetle type STM's stacked into each other. The ability of this apparatus to work at the nanoscale will be shown. Since the positioning of the two tips can be controlled down to 50nm by an add-on electron column, it was possible to provide direct mechanical contact of the STM tip to nanosized GaAs/AlGaAs resonant tunnelling diodes and measure I/V curves of these diodes. Furthermore, due to the compact design, both STM's exhibit a high stability which facilitates atomically resolved imaging with each tip. The stability allows also non-destructive electrical contacts to surfaces via the tunnelling gaps. Two-point electrical measurements via tunnelling contacts on the Si(111)-7×7 surface will be presented as function of the distance of the probe tips and compared to a model for the charge transport on this surface.

O 17.51 Mon 17:30 Poster C

Automatisierte Bildanalyse von Rasterkraftmikroskopieaufnahmen — •Christian Franke[1,2], Marcus Böhme[2], Enrico Kienel[1], Sabine Scherdel[2], Nicolaus Rehse[2] und Robert Magerle[2] — [1]Graphische Datenverarbeitung und Visualisierung, TU Chemnitz, D-09107 Chemnitz — [2]Chemische Physik, TU Chemnitz, D-09107 Chemnitz

Mit Hilfe der Rasterkraftmikroskopie lässt sich die Strukturbildung von dünnen Blockcopolymerfilmen in situ beobachten. Für die Auswertung dieser Experimente ist eine umfassende Bildverarbeitung nötig, die eine quantitative Erfassung von Strukturen im Realraum erlaubt. Dabei kommen Algorithmen zur Filterung, Binarisierung und Skelettierung zur Anwendung. Da diese Art der Auswertung oft Wochen oder Monate in Anspruch nimmt, haben wir begonnen die Bildverarbeitung echtzeitfähig zu realisieren. Dazu wurden von uns einige effiziente Algorithmen implementiert, so dass schon während des Experiments charakteristische Defektstrukturen erkannt werden können. Das Ziel ist bereits während des Experiments auf Änderungen zu reagieren und so gezielt Parameter zu verändern, die die Strukturbildung beeinflussen. Weiterhin ist geplant, diese Algorithmen auch in der Nanotomographie einzusetzen, bei der ebenfalls große Mengen an Rasterkraftmikroskopiebildern anfallen.

O 17.52 Mon 17:30 Poster C

Nanotomography of polystyrene-*block*-polybutadiene block copolymer — •Christian Dietz, Eike-Christian Spitzner, Sabine Scherdel, Nicolaus Rehse, and Robert Magerle — Chemische Physik, TU Chemnitz, D-09107 Chemnitz

Thin films of polystyrene-*block*-polybutadiene block copolymer (SB) form self organized structures during solvent annealing. At the given composition of the copolymer the polystyrene phase can form different morphologies. We find cylinders lying perpendicular or parallel to the surface or perforated lamellae depending on the film thickness and the solvent concentration. Using Nanotomography, a layer by layer volume imaging technique based on scanning probe microscopy (SPM), we are able to study the volume structure of layers beneath the surface of such films. An improved in-situ etching technique is introduced, where the etching is directly executed in an SPM liquid cell connected to reservoirs of water and an etchant. Here we use a solution of potassium permanganate in sulfuric acid for stepwise eroding the surface of the polymer. The water is used for flushing the liquid cell after each etching step and for imaging the surface in water. The liquid flow is controlled with solenoid valves, which allow for an automated etching/flushing/imaging protocol which is integrated into the SPM software. We present our latest results achieved with this new method on defects of SB films.