corrugation maxima and minima. We find good agreement between our measurements and simulations for the K^+-terminated tip for both sample positions confirming a previous analysis [2].

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[2] K. Ruschmeier *et al.*, Phys. Rev. Lett. **101**, 156102 (2008).

O 27.7 Tue 18:30 P2

Indium microsoldering of graphene on silicon dioxide substrate — •Ann-Katrin Michel[1], Viktor Geringer[1], Tim Echtermeyer[2], Marcus Liebmann[1], and Markus Morgenstern[1] — [1]II. Physikalisches Institut, RWTH Aachen and JARA-FIT, Otto-Blumenthal-Straße, 52074 Aachen — [2]Advanced Microelectronic Center Aachen (AMICA), Otto-Blumenthal-Straße 25, 52074 Aachen

Electron beam lithography is the standard method to produce electrical contacts for nanostructures made e.g. from graphene. A major disadvantage of this method is, apart from high costs, the contamination of the sample due to the residual photoresist. This problem gets even more severe, if scanning probe techniques are applied. Therefore, a more simple technique to make ohmic contacts to graphene without contamination is desirable and has been developed recently [1].

We reproduced this method by designing a setup for microsoldering of graphene flakes on silicon dioxide with multiple indium solder contacts. Mobility measurements on graphene samples using four point indium contacts have been used to characterize the contacts. Moreover, we describe the application to scanning tunneling microscopy (STM) of the microsoldered graphene samples.

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O 27.8 Tue 18:30 P2

Controlled nanoparticle manipulation along defined vector pathways — •Michael Feldmann, Dirk Dietzel, and André Schirmeisen — Institute of Physics and Center for Nanotechnology, University of Münster, Germany

Manipulation of nanoparticles with an atomic force microscope (AFM) is a very promising approach to measure friction of nanoscale objects with well defined contact area. For example, the phenomenon of frictional duality was revealed for Sb nanoparticles on graphite in vacuum [1]. However, so far the manipulation was performed during conventional image scanning with a commercial AFM control unit [2]. To optimize the control over the manipulation process a new AFM control system has been developed. This system enables AFM tip translations along arbitrary programmable vector pathways while allowing to select distinct control parameters like normal force and velocity for each single vector. Due to the systems ability to simultaneously record the lateral force along the x axis, it is thus possible to conduct nanotribological experiments with individually chosen nanoparticles in a highly controlled and reproducible fashion.

[1] Dietzel *et al.*, Phys. Rev. Lett., 101, 125505 (2008)
[2] Dietzel *et al.*, J. Appl. Phys., 102, 84306 (2007)

O 27.9 Tue 18:30 P2

Nanoscale charge transport measurements using a multi-tip scanning tunneling microscope — Philipp Jaschinsky, Jakob Wensorra, Mihail Ion Lepsa, and •Bert Voigtländer — Institute of Bio- und Nanosystems (IBN) and JARA-Fundamentals of Future Information Technology, Forschungszentrum Jülich, D-52425 Jülich, Germany

We demonstrate the ability of a multi-tip scanning tunneling microscope (STM) combined with a scanning electron microscope (SEM) to perform charge transport measurements on the nanoscale. The STM tips serve as electric probes that can be precisely positioned relative to the surface nanostructures using the SEM control and the height reference provided by the tunneling contact. The tips work in contact, noncontact, and tunneling modes. We present vertical transport measurements on nanosized GaAs/AlAs resonant tunneling diodes and lateral transport measurements on the conductive surface of 7x7 reconstructed Si(111). The high stability of the double-tip STM allows nondestructive electrical contacts to surfaces via the tunneling gaps. We performed two-point electrical measurements via tunneling contacts on the Si(111)(7x7) surface and evaluated them using a model for the charge transport on this surface.

O 27.10 Tue 18:30 P2

s-SNOM from IR to the THz with tuned scatterers — •Hans-Georg von Ribbeck[1,2], Marc Tobias Wenzel[1], and Lukas Matthias Eng[1] — [1]Institute of applied photo physics, TU Dresden, Germany — [2]Forschungszentrum Dresden-Rossendorf, Dresden, Germany

Here we present a scattering near-field optical microscope (s-SNOM) set-up established at the free-electron laser source (FEL) at the Forschungszentrum Dresden-Rossendorf. This microscope is capable to perform optical observations at nanometer scale resolution over the full wavelength range of the FEL, i.e. 3 to 250 micron (1.2 to 100 THz). Furthermore, the optical resolution governed by the near-field interaction between tip and sample and the signal-to-noise ratio is enhanced by specially designed, optically resonant probes. This ultimately results in a much better spatial confinement achieving a resolution preferably of lambda/1000 for the THz region. Also, coupling both a resonant tip and sample will lead to giant polaritonic resonances. Finally the described setup will grant access to new areas of nanoscale applications, such as observing the optical behavior of strained and mixed silicon structures, high-Tc superconductors, single quantum dots, and superlattices at THz frequencies.

Basis to our approach is the recent work [1] where an optical confinement of the near field in z-direction was achieved through tuned scatterers in the form of metallic nanoparticles (MNPs) attached to the AFM tip, serving as non-resonant antennas. Tunability in the THz range will be achieved through geometrically tuned metal wires [2].

O 27.11 Tue 18:30 P2

High Order Field Emission Resonances on W(110) and Fe/W(110) studied by Scanning Tunneling Spectroscopy — •Anika Emmenegger, Stefan Krause, André Kubetzka, Gabriela Herzog, and Roland Wiesendanger — Institute of Applied Physics, University of Hamburg, Jungiusstr. 11, 20355 Hamburg, Germany

Above metal surfaces a Rydberg-like series of states exists close to the vacuum level due to the potential well created by the attractive image potential and the surface projected bulk band gap [1]. In scanning tunneling microsopy (STM) experiments these so-called image-potential states (IPS) experience a Stark Shift [2], hence they are often called field emission resonances in this context.

Neglecting the influence of the image potential, a simple triangular potential model can be applied to determine the effective electric field in the constant current spectroscopy of IPS [3]. Whereas commercial STM electronics typically provide a maximum gap voltage of 10 V, we present scanning tunneling spectra of field emission resonances above the W(110) and Fe/W(110) surface up to the order of n=30 and voltages up to 20 V. The results will be discussed in terms of electric field determination, revealing that the assumption of a constant electric field is only applicable to voltages exceeding 10 V.

[1] U. Thomann et al., Phys. Rev. B 61, 16163 (2000).
[2] S. Crampin, Phys. Rev. Lett. 95, 46801 (2005).
[3] J. H. Coombs and J. K. Gimzewski, J. of Microsc. 125, 841 (1988).

O 27.12 Tue 18:30 P2

Microscopically high speed friction measurements — •Fengzhen Zhang[1], Othmar Marti[1], Stefan Walheim[2], and Thomas Schimmel[2,3] — [1]Institute of Experimental Physics, Ulm University, 89069 Ulm — [2]Forschungszentrum Karlsruhe — [3]University of Karlsruhe

Quartz crystals have been found to be the best substrates for the Atomic Force Microscopy (AFM) high speed friction measurements. To prove the oscillation of the quartz crystals, we prepared Fischer Patterns on the surface. During the oscillation of the quartz crystals, the topographies of the Fischer Pattern show clearly the oscillation information (in tapping mode AFM). The result of the comparison of the friction under different oscillation speeds and after oscillation will be discussed. We will also present the measurement data of friction at high speeds of surfaces without and with adsorbed monolayers.

O 27.13 Tue 18:30 P2

Non-contact Atomic Force Spectroscopy using Field Ion Microscope characterized Tips — •Jens Falter[1], Daniel-Alexander Braun[1,2], Udo Schwarz[4], Hendrik Hölscher[3], André Schirmeisen[1,2], and Harald Fuchs[1,2] — [1]Physikalisches Institut, Universität Münster, Germany — [2]CeNTech, Münster, Germany — [3]IMT, Forschungszentrum Karlsruhe, Germany — [4]Department of Mechanical Engineering, Yale University, New Haven, USA

Although atomic force microscopy (AFM) is a tool for resolving surfaces with atomic resolution, the underlying contrast mechanisms is not yet fully understood. Beyond imaging this technique is capable to measure the interaction potential of tip and sample atoms in force spectroscopy experiments. What remains completely unknown is the atomic scale configuration of the tip. One method which allows determining the configuration of the probing tip apex with atomic precision is the field ion microscope (FIM). We present a home-build ultrahigh vacuum system, which combines these two microscopy techniques. The AFM head [1] is capable to operate at liquid helium temperatures and the force sensor is based on a tuning fork system [2]. The tuning fork concept allows to chose a material for the tip, which is suitable for FIM operation. A home build tip-holder is used for the in-situ tip exchange between the two microscopes. First results of both microscopy methods correlate the force spectroscopy curves from the AFM with the tip apex radii obtained from the FIM analysis.

[1] B.Albers et al., Rev. Sci Instrum. 79 033704 (2008)
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O 27.14 Tue 18:30 P2

Scanning Tunneling Spectroscopy at the [110]-[1$\bar{1}$0] Cleaved Edge of GaAs — S. Siewers, M. Wenderoth, L. Winking, •P. Kloth, and R. G. Ulbrich — IV. Phys. Inst. Georg-August-Universität Göttingen

We report the first cross-sectional scanning tunneling spectroscopy (STS) study of zincblende [110]-[1$\bar{1}$0] cleaved edges with atomic resolution. The samples were prepared in-situ by a double cleavage procedure applied to $6 \cdot 10^{18}$ cm^{-3} Si-doped GaAs in UHV. In edge-approaching scans and for positive sample bias we observed a monotonically decreasing tunnel current within a few tens of nm from the edge. For negative bias we found the onset of this decrease within a few nm from the edge, followed by a considerable increase directly at the edge. Comparing these observations with scans over charged defects embedded in plane surfaces, we conclude that the edge contains a negative line charge density. The data suggests that the observed effect is not simply caused by tip-induced band bending and screening of bulk states confined within the 90°-edge geometry. Spectroscopic measurements on edges support the concept of a negatively charged quasi-1d electronic state localized along the edge. It is laterally confined within ~2 lattice constants and is clearly observed in the local density of states derived from the STS data. To estimate the absolute value of its charge density we simulated the shape and spatial extension of the screening cloud of a negative line charge located at the center of the "quarter-space"geometry. By adjusting this potential to the spectroscopic data we find a line charge density of ~0.7 electrons per unit cell.

O 27.15 Tue 18:30 P2

Frictional properties of a mesoscopic contact with engineered surface roughness — •Johannes Sondhauss[1], Harald Fuchs[1,2], and André Schirmeisen[1,2] — [1]Institute of Physics, University of Münster, Münster, Germany — [2]Center for Nanotechnology (CeNTech), University of Münster, Münster, Germany

Friction force microscopy (FFM) is a standard tool to measure friction down to atomic scales. In this work, we use FFM to investigate the influence of interface roughness of mesoscopic contacts on friction, where both sliding partners, tip and sample, have precisely engineered properties. We use a focused ion beam (FIB) to modify commercial cantilevers in order to firmly attach spherical titanium particles with diameters between 4 and 15 μm. As sample we produce groove-like patterns on a silicon surface with the FIB with a lattice periodicity ranging from 1 to 9 μm and a depth of 25 nm. The average friction force was measured systematically for different tip radii as a function of load and lattice periodicity of the sample grooves. For the 5 μm tip the maximum friction force was found where the geometry of the spherical tip and the lattice are commensurate. These findings highlight the importance of surface structure on tribological properties of mesoscale contacts.

O 27.16 Tue 18:30 P2

SFM manipulation techniques applied to graphene — •Stefan Eilers, Tobias Liebig, and Jürgen P. Rabe — Humboldt-Universität zu Berlin

The properties of graphene render it a promising candidate for future generation electronic devices. For the investigation of properties and possible applications or devices structuring and manipulation techniques are needed. Thinness, flexibility and flatness make it possible to apply SFM techniques to single or multilayer graphene well known from using with molecules on graphite. Here, some effects produced by a SFM tip are demonstrated. First, manipulation of graphene itself is shown, in detail sawing were a gap and a nanoribbon is produced and manipulating parts of graphene without destruction. In both cases the manipulation is started on SiO2 substrate and kept in contact with it while moving the SFM tip. It appears that the graphene can only be desorbed and turned when the manipulation is done near an edge of graphene or when the graphene piece is small enough because there the adsorption force between graphene and the substrate is smaller than the force to breake the bonds in graphene. Second, adsorption and manipulation of DNA on an amphiphile interlayer is presented. The interlayer is needed to make sure that the DNA is mobile enough to be manipulated. It appears that a force can be found large enough to manipulate DNA but to small to damage the graphene.

O 27.17 Tue 18:30 P2

Development of a Scanning Tunneling Microscope for measurements below 100mK — •Maximilian Assig, Fabian Zinser, Wolfgang Stiepany, Andreas Koch, Peter Andler, Christian R. Ast, and Klaus Kern — Max-Planck-Institut für Festkörperforschung,

The investigation of novel physical phenomena implies the design and the construction of new setups and measurement techniques, which can break through instrumental limitations and open new areas in measurement accuracy. Scanning Tunneling Microscopy (STM) is a technique for probing the electronic structure of single adsorbed atoms and nanostructures at surfaces with atomic resolution. As the energy resolution increases with decreasing temperature, cooling the STM below 100mK results in an energy resolution which is better than 24μeV. To achieve this goal, we want to connect a home-built STM to the mixing chamber of a custom-designed bottom-loading dilution cryostat. Tip and sample can be transferred directly from the preparation chamber into the STM without breaking the ultra high vacuum (UHV), which allows *in situ* sample preparation. Measurements can be performed in high magnetic fields of 14T perpendicular and 500mT parallel to the sample surface. We present design and concept of the STM as well as milestones in the project realization.

O 27.18 Tue 18:30 P2

Eddy current microscopy — •Benedict Kleine Bussmann, Tino Roll, Marion Meier, and Marika Schleberger — Universität Duisburg-Essen, Fachbereich Physik, Lotharstrasse 1, D-47048,Germany

We present eddy current microscopy [1] measurements on geometrically confined conductive structures on insulating substrates. The principle of eddy current microscopy is as follows: A magnetic tip of an Atomic Force Microscope oscillates above a sample and induces eddy currents in the conducting areas of the sample due to the time-dependent magnetic field they are exposed to. This leads to an electromagnetic interaction between the sample and probe: Thus, according to Lenz's rule a damping of the oscillation occurs and leads to a contrast in the phase and/or dissipation signal[2,3]. By using the well established technique of AFM this method can thus be used to perform conductivity measurements on submicron scale without any need to contact the sample (like for example four-point-probe techniques). We will present measurements we recently performed under ambient conditions as well as in situ measurements.

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[2]T. Roll, M. Meier, S. Akcöltekin, M. Klusmann, H. Lebius and M. Schleberger Conductive nanodots on the surface of irradiated CaF2 phys. stat. sol. (RRL) 2, 209 (2008) [3] Tino Roll, Marion Meier, Ulrich Fischer and Marika Schleberger Distance dependence of the phase signal in eddy current microscopy Thin Solid Films 516, 8630 (2008)

O 27.19 Tue 18:30 P2

Detecting resonant modes of plasmon-polaritons and phonon-polaritons using a NSThM — •David Hellmann, Achim Kittel, and Uli F. Wischnath — EHF, Fak. V, Physik, Carl von Ossietzky Universität Oldenburg

With a Near-field Scanning Thermal Microscope (NSThM) the heat transfer between a sample and a probe can be measured [1,2]. The NSThM combines a STM tip with a coaxial thermocouple sensor and, thus, can collect data concerning the heat transfer a few nm above the scanned surface along with usual STM maps. Evanescent thermal radiation has been investigated recently by De Wilde et al. at larger sample-tip distances (200 nm to some μm) [3]. The authors find resonant modes of surface plasmon-polaritons and phonon-polaritons on certain structures. Subject of this study are NSThM measurements on structures where such resonances can be expected. With the NSThM