O 17: Poster Session I (Nanostructures at Surfaces; Metal Substrates: Epitaxy and Growth; Methods: Scanning Probe Techniques; Phase Transitions)

Time: Monday 17:30–20:30 Location: Poster C

O 17.1 Mon 17:30 Poster C

Growth and characterization of carbon nanotubes on silicon carbide — •Reinhard Volkmer, Alexander Hartung, and Bernd Schröter — FSU Jena, IFK, Max-Wien-Platz 1, 07743 Jena

Due to their remarkable mechanical and electronical properties, carbon nanotubes (CNTs) have acquired a significant position in the field of nano research since the discovery in 1991. The defined growth of these tubes is an essential requirement for their utilization in nanoelectronics and nanooptics. Though CNTs with various parameters such as diameter, length, chirality or number of walls can already be produced in great quantities by standard practices like arc discharge, chemical vapor deposition (CVD) and laser ablation, the task of placing single tubes with the desired properties like chirality at defined positions is a not yet solved problem.

We used an alternative fabrication technique by growing carbon nanotubes on SiC(0001) surfaces in ultra high vacuum (UHV) [1]. The UHV environment allows the diversified characterization of the substrate surfaces and CNTs by means of microscopy (STM, AFM, SEM), spectroscopy (XPS) and electron diffraction (LEED) and pulls together the parameters of growth conditions and properties of the CNTs. We succeeded in growing single wall and Y-junction nanotubes at temperatures of about 1500°C whose position, alignment and characteristics depend on the substrate geometry and which feature a high purity because of the omission of catalysts in this technique.

[1] V. Derycke, R. Martel, M. Radosavljevic, F. M. Ross and Ph. Avouris, Nano Lett., Vol. 2, No. 10, 1043 (2002)

O 17.2 Mon 17:30 Poster C

Untersuchung chemisch funktionalisierter Kohlenstoffnanoröhen mittels Rastertunnelmikroskopie — •Peter Lauffer[1], Adrian Jung[2], Ralf Graupner[1], Andreas Hirsch[2] und Lothar Ley[1] — [1]Technische Physik, 91058 Erlangen — [2]Institut für Organische Chemie, 91054 Erlangen

Einwandige Kohlenstoffnanoröhren, die man sich aus dem nahtlosen Aufrollen von Graphen entstanden denken kann, besitzen eine Vielzahl faszinierender Eigenschaften. Besonders vielversprechend für zukünftige Anwendungen erscheint die Möglichkeit, Nanoröhren mit definierten chemischen Gruppen zu versehen, sie zu funktionalisieren, um zum Beispiel deren Löslichkeit zu beeinflussen. Die Funktionalisierung mit aromatischen Molekülen mittels der π-π-Stapelwechselwirkung bietet dabei den Vorteil, die Struktur der Nanoröhre intakt erhalten zu können. Gegenstand unserer Arbeit ist die Untersuchung dieser so funktionalisierten Nanoröhren mittels Rastertunnelmikroskopie. Damit konnte der Nachweis einzelner Funktionalmoleküle auf der Seitenwand erbracht werden und deren elektronische Eigenschaften durch Abbildung ihrer differentiellen Tunnelleitfähigkeit lokal dargestellt werden. Diese Ergebnisse sind in guter Übereinstimmung sowohl mit auf Au (111) adsorbierten Funktionalmolekülen als auch mit quantenchemisch berechneten Molekülorbitalen.

O 17.3 Mon 17:30 Poster C

Structural and electronic properties of SiC and BN nanotubes — •Björn Baumeier, Peter Krüger, and Johannes Pollmann — Institut für Festkörpertheorie, Universität Münster, Wilhelm-Klemm-Str. 10, 48149 Münster

The initial discovery of carbon nanotubes (NTs) in 1991 has sparked considerable interest in this kind of nanosized one-dimensional structures due to their unique physical properties and the associated potential for applications.

We present the results of a comparative *ab initio* study of composite single-walled SiC and BN nanotubes in zigzag and armchair configurations. Using pseudopotentials that incorporate self-interaction-corrections in density functional theory calculations, we arrive at reliable quantitative results for both structural and electronic properties of the respective bulk crystals, as compared to available experimental data. Within this approach, we investigate the dependence of the strain energy, Young modulus, atomic relaxation and electronic structure on NT diameter. Qualitatively, both wide-band-gap materials show similar behavior with respect to the formation of a radially buckled geometry upon atomic relaxation or the saturation of the Young modulus and band-gap energies for large NT diameters. The calculated fundamental gap of zigzag NTs varies more strongly for small and medium tube diameters than that of their armchair counterparts, which is due to a more pronounced curvature-induced rehybridization effect on conduction band states.

O 17.4 Mon 17:30 Poster C

Optical properties of self-assembled Pb nanowires on Si(335)/Au — •M. Klevenz, M. Möller, F. Neubrech, R. Lovrincic, and A. Pucci — Kirchhoff-Institut für Physik, Heidelberg

A macroscopic array of aligned lead nanowires was produced by molecular beam epitaxy on a vicinal Si(335)/Au surface under UHV conditions. The optical properties of this system were studied by infrared spectroscopy and reflection of light in the visible range. We were able to observe a phase transition and to characterize the nanostructure during the whole growth process. This was possible due to the observation of excited resonances in the wires which provide an insight into their size. The measurements were performed at different temperatures. Temperature dependent diffusion properties of the lead atoms lead to differences in the wire shape and size.

O 17.5 Mon 17:30 Poster C

Metallic nanostructures on silicon — •Jan Rönspies, Tammo Block, Svend Vagt, and Herbert Pfnür — Institut für Festkörperphysik, Abteilung Oberflächen, Leibniz Universität Hannover, Appelstr.2, 30167 Hannover, Germany

In our experiment we produced nanowires by a lithographic process with electron-beam stimulated thermal desorption of oxygen (EBSTD) in UHV from an ultrathin SiO_2 layer deposited on $Si(557)$ substrates. Recently the $Pb/Si(557)$ system was shown to exhibit a quasi one-dimensional conductance along the $Si(557)$ step direction on a macroscopic scale, associated with a metal-semiconductor phase transition.

The electronic properties of low–dimensional systems are intimately related to their geometric structure. In ideal one dimensional systems the electron confinement is important. Particularly in one-dimensional systems the enhanced interaction is accompanied by instabilities, which can be seen by metal-insulator transitions measurements.

We apply EBSTD to bare windows of clean silicon with lateral dimensions down to $10nm$ in the oxide layer. Subsequent metal epitaxy leads to the formation of continuous thin metal nanowires in the window areas. We formed nanowires with a length of several hundred nanometers by using this lithographical method to perform measurements on only a few of these wires selected out of the "wire array"of the Pb/Si(557) system. We present first results of conductivity of such wires.

O 17.6 Mon 17:30 Poster C

Fermi-nesting in ordered Pb-chains grown on vicinal Si(557) — C. Tegenkamp[1], •T. Block[1], H. Pfnür[1], T. Ohta[2], J.L. McChesney[2], and K. Horn[3] — [1]Institut für Festkörperphysik, Leibniz-Universität Hannover, 30167 Hannover, Germany — [2]ALS, Lawrence Berkley National Laboratory, Berkley, CA. 94720, USA — [3]FHI der Max-Planck Gesellschaft, 14195 Berlin, Germany

The adsorption of 1ML Pb at low temperatures on Si(557) followed by annealing to 640K leads to the formation of Pb-chains with an interachain spacing of d=1.5nm as seen by LEED and STM. The closely packed Pb film on the micro-Si(111) facets forms locally a $\sqrt{3} \times \sqrt{3}$ structure, which shows in addition a 10-fold periodicity along the $[1\bar{1}0]$ direction. Conductivity measurements below 78K have shown that electronic transport occurs only along the chain direction, whereas insulating behavior is found in the perpendicular direction. Above 78K, the sytsem switches into a 2d-regime, i.e. activated transport is found in both directions. Using angle resolved photoemission (ARPES), we explored the origins of the quasi one-dimensional (1d) conductance found below 78K. The interchain distance is reflected directly by Umklapp structures in the $[11\bar{2}]$ direction close to E_F. As ARPES reveals further, ordering into the chain structure below 78K results in complete Fermi nesting in the $[11\bar{2}]$ direction and in energy reduction by band filling. The domain structure along the chains forms split-off valence

bands with mesoscopic λ_F, responsible for the 1d conductance.

O 17.7 Mon 17:30 Poster C

Ab initio study of electronic confinement on stepped Cu(111) surfaces — •Pavel Ignatiev[1], Valeriy Stepanyuk[1], Andriy Klavsyuk[1], Wolfram Hergert[2], and Patrick Bruno[1] — [1]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle, Germany — [2]Fachbereich Physik, Martin-Luther-Universität, Halle-Wittenberg, Friedemann-Bach-Platz 6, D-06099 Halle, Germany

We report on study of surface states on clean and decorated Cu(111) stepped surfaces by means of ab initio Korringa-Kohn-Rostoker (KKR) Green's function method [1]. Surfaces with the terrace width ranging from 12 to 21 A are considered. Confined electronic states are revealed close to the Fermi energy. This finding is in agreement with experiments of M. Hansmann et al. [2]. Our calculations confirmed that the position of such states strongly depends on the terrace width. The strength of the potential barrier at the step edges calculated using the Kronig-Penney model and our ab initio results is found to be in a good agreement with experimentally determined values. It is shown that the strength of the confining barriers on Cu(111) vicinals can be significantly affected by decoration of step edges with monoatomic Fe wires, similar to recent experimental finding of S. Shiraki et al. [3]. Due to spin-dependent scattering of surface-states electrons at Fe wires surface states become spin-polarized. The majority states remain unaffected, but the confinement picture of the minority states is suppressed by a strong scattering of surface-states electrons at the minority states on Fe wires. [1] P.A. Ignatiev et al., submitted to PRB [2] M. Hansmann et al. PRB 67, 121409 (2003) [3] S. Shiraki et al. PRL 92, 096102 (2004)

O 17.8 Mon 17:30 Poster C

The metal-insulator transition of Rb:TaS2 observed with PEEM — Jens Buck[1], •Ole Mühlfeld[1], Kai Rossnagel[1], Florian Kronast[2], Ruslan Ovsyannikov[2], Hermann Dürr[2], and Lutz Kipp[1] — [1]Christian-Albrechts-Universität zu Kiel — [2]BESSY, Berlin

The transition metal dichalcogenide TaS2 exhibits a change from metallic to insulating behavior upon deposition of rubidium. We present first results of this system studied by PEEM. Measurements with a spatial resolution of about 100 nm reveal the transition from metal to insulator in the presence of rubidium. Among other layered crystals, TaS2 shows the well-known formation of nanowire networks when rubidium is deposited. Here, evaporation-induced surface features with a mesh-like structure and a size distribution between some microns and the resolution limit were observed. They appear to be independent of local changes in rubidium concentration. The experiments were carried out at BESSY, beamline UE49-PGMa. This work was supported by the Deutsche Forschungsgemeinschaft, Forschergruppe 353.

O 17.9 Mon 17:30 Poster C

Stepped Si(111) surfaces as template for the growth of nanostructures — •Vasily Cherepanov, Konstantin Romanyuk, and Bert Voigtländer — Institute of Bio and Nanosystems (IBN 3), and cni - Center of Nanoelectronic Systems for Information Technology, Research Centre Jülich, 52425 Jülich, Germany

The preparation of template surfaces is a crucial step for the growth of nanostructures by self organization. A template surface with a desired arrangement of monoatomic steps can be used subsequently for deposition of materials which preferentially incorporate at the step edges. In this study we optimized the conditions to produce regular array of the slip steps on various inclined Si wafers. Applied external stress to a Si wafer forms an array of $(\overline{1}\overline{1}2)$ slip steps at Si(111) surface. New steps form by gliding crystal planes in the bulk during plastic relaxation of the wafer. Those new steps intersect with the surface steps which originate from the miscut of the wafer. Thus a network of "crossing"steps is formed at Si(111) surface. Subsequent step-flow growth of Ge can be used to produce a network of crossing Ge wires attached to the stepped template. Ge deposition on Bi terminated stepped Si surface was used to produce a network of crossing Ge nanowires on the atomic scale.

O 17.10 Mon 17:30 Poster C

Si-nanowires and 1D-electron confinement on SiC(1$\bar{1}$02) — •Chariya Virojanadara, Martin Hetzel, and Ulrich Starke — Max-Planck-Institut für Festkörperforschung, Heisenbergstr. 1, D-70569 Stuttgart

SiC surfaces oriented perpendicular or diagonal to the basal plane should expose the complicated polytype stacking sequence along the c-axis and thus provide large unit cell surface periodicities. In combination with the typical electronic correlation effects between dangling bonds found on the basal plane surfaces this opens a route for intrinsic nanostructures with low-dimensional electronic states. On the 4H-SiC (1$\bar{1}$02) surface, i.e. an orientation cut diagonally within the bulk unit cell, surface phases of according periodicities can indeed be observed. After Si deposition and annealing to 800-900°C a Si-rich surface develops which shows a well-ordered (2×1) superstructure in low-energy electron diffraction (LEED). Scanning tunneling microscopy (STM) reveals the presence of adatoms that form atomic nanowires with a separation of the (2×1) unit cell size. These adatoms are positioned on top of a Si adlayer. From core level photoemission data the Si thickness can be calculated to be about 3 Å. A prominent surface state can be observed in the valence band spectra of this phase. Applying angle resolved ultra-violet photoelectron spectroscopy (UPS) to this state we can identify a one-dimensional electron confinement. Dispersion is only observed along the direction of the nanowires, not between the wires. The band width of about 0.2 eV corresponds well to the dangling bond bands observed for several basal plane surface phases.

O 17.11 Mon 17:30 Poster C

Chemical bonding identification in metal-organic chains of trimesic acid on Cu(110) — Rishav Chopra, •Chariya Virojanadara, Thomas Classen, Giovanni Costantini, Ulrich Starke, and Klaus Kern — Max-Planck-Institut für Festkörperforschung, Heisenbergstr. 1, D-70569 Stuttgart

Functional groups of hydrocarbon molecules provide chemical selectivity, e.g. for sensing or biological interactions, or can serve as linking key for the development of molecular networks on surfaces. In this context, trimesic acid (TMA) with its carboxylic groups can interact in different ways with surfaces. In the present work the adsorption of TMA is investigated on Cu(110). Scanning tunneling microscopy (STM) and low-energy electron diffraction (LEED) experiments show that molecular linking to Cu adatoms leads to ordered metal-organic chains. The detailed bond configuration of the molecule on the surface can be determined using X-ray photoelectron spectroscopy (XPS). Analysis of chemical shifts reveals that the link is provided by a dehydrogenation of the acid groups, i.e. carboxylate groups are connected via the oxygen atoms to the Cu substrate. At low coverage this takes place already at room temperature. A denser phase at higher coverage still contains carboxylic groups at room temperature. Dehydrogenation is only observed when the chain is fully developed after 220°C annealing. The oxygen-Cu coordination is different for the two phases and depends on the density of the molecular adsorbate.

O 17.12 Mon 17:30 Poster C

Investigation of plasmon resonances and Bragg diffraction properties of metallic nanostructures — •André Siegel, Manuel Rodrigues Gonçalves, Ralf Ameling, and Othmar Marti — University of Ulm, Institute of Experimental Physics, Albert-Einstein-Allee 11, D-89069 Ulm, Germany

The excitation of surface plasmon polaritons (SPP) at metallic nanoparticles using total internal illumination and the associated local field enhancement are of special importance for surface enhanced Raman scattering. In order to understand the coupling of light with SPPs in nanoparticles of complex shape, it is important to investigate the scattering of light by these particles.

Therefore, we have built a setup to measure the scattering of light of arrays of identical nanoparticles. We found, that the diffraction patterns – besides their dependency on size, lattice constant and material – are very sensitive to the shape of the particles. The results are compared to models of Bragg diffraction using different form factors.

Moreover, by varying the angle of illumination, it is possible to measure the dispersion relation and plasmon resonances of the SPPs for these arrays of nanoparticles.

O 17.13 Mon 17:30 Poster C

Fabrication of Clean Nanostructures on Metal Surfaces via Electron-Beam Induced Deposition — •Thomas Lukasczyk, Michael Schirmer, Hubertus Marbach, and Hans-Peter Steinrück — Lehrstuhl für Physikalische Chemie II, Universität Erlangen-Nürnberg, Egerlandstr. 3, D-91058, Erlangen

Electron-beam induced deposition (EBID) is a versatile method to produce well defined deposit structures in a controlled manner. Precursor molecules are decomposed via a sharp highly focussed electron

beam, resulting in the deposition of the non-volatile fragments. In order to study EBID in an environment free of residual gases and to investigate its potential as a tool to generate pure nanostructured deposits, an ultra-high vacuum system is used. The integrated high resolution electron-column in combination with a lithographic package enables the controlled fabrication of nanostructures with lateral dimensions below 20 nm, which can be characterized via scanning electron microscopy, scanning tunneling microscopy and Auger electron spectroscopy. Iron pentacarbonyl, $Fe(CO)_5$, proved to be an effective precursor to generate iron structures of arbitrary shape on metal surfaces like rhodium or gold. Auger spectroscopy demonstrates a high purity of the deposits. The contamination level can be lowered even further by moderate heating. Exposure of the iron nanostructures to oxygen at elevated temperature leads to the formation of iron oxide, while the substrate surface remains almost unchanged. This demonstrates the capability to generate specific catalyst surfaces via EBID, which can be tuned to the requirements of certain reactions.

O 17.14 Mon 17:30 Poster C

Influence of pulsed laser light on gold triangles: Experiment vs. theory — •Andreas Kolloch[1], Juliane König-Birk[1], Kevin Shuford[2], George Schatz[2], Paul Leiderer[1], and Johannes Boneberg[1] — [1]Fachbereich Physik, Universität Konstanz, Fach M676, 78457 Konstanz — [2]Chemistry Department, Northwestern University

The optical properties of nanostructures are a topic of considerable current interest. In analogy to the near-fields around a Hertz dipole one expects in the optical range similar near-fields in the surrounding of nanostructures when they are illuminated with light. To visualize these near-fields we use a method called "optical near-field photography". In our experiments we use e.g. silicon as substrate. The nanostructures, in this case gold triangles, on the substrate are illuminated with femtosecond laser pulses. The intensity is adjusted such that no influence of the illumination is detectable on the bare substrate. In the vicinity of the nanostructures, however, local ablation of the substrate is observed due to the intensity enhancement in the optical near-field. The resulting field distribution patterns depend on both the polarization of the laser light and the size of the triangles, as well as the arrangement of the nanostructures in the case of periodic arrays. A comparison with simulations shows qualitative agreement, but also some discrepancies with the experiments.

O 17.15 Mon 17:30 Poster C

AFM-Manipulation und optische Spektroskopie von Nanopartikeln — •Reiner Jansen, Alpan Bek, Thomas Klar und Jochen Feldmann — Ludwig-Maximilians-Universität München, Photonics and Optoelectronics Group, Amalienstraße 54, D-80799 München

Das AFM gekoppelt mit einem inversen Mikroskop ermöglicht die Beobachtung der Wechselwirkungen zwischen Nanopartikeln bei gleichzeitiger Variation ihrer Anordnung auf der Nanometerskala. So können die starke Abstandsabhängigkeit des Förster-Energietransfers (FRET) sowie Feldverstärkungseffekte gemessen werden. Die verwendeten Objekte mit einigen Nanometern im Durchmesser sind zum einen Gold-Kolloide, zum anderen fluoreszierende Nanopartikel. Mit der AFM-Spitze ist es möglich, je ein Goldpartikel und ein fluoreszierendes Partikel einander langsam und kontrolliert anzunähern. Nach jedem Manipulationsschritt wird die Veränderung im Fluoreszenzverhalten des Farbstoffes beobachtet. Ziel unseres Projektes ist es, eine graduelle Abstandsvariation zwischen Gold und Farbstoff zu erreichen um ein möglichst genaues Bild der Abhängigkeit des Energietransfers vom Abstand zu erhalten.

O 17.16 Mon 17:30 Poster C

Investigation of hafnium silicide nano structures on a Si(100) surface by means of photoelectron diffraction — •C.R. Flüchter[1,2], D. Weier[1,2], A. de Siervo[3], M. Schürmann[1], A. Beimborn[1], F. Schönbohm[1], S. Dreiner[1], M.F. Carazzolle[4], R. Landers[3,4], G.G. Kleiman[4], and C. Westphal[1,2] — [1]Experimentelle Physik 1 - Universität Dortmund, — [2]DELTA - Universität Dortmund, Maria-Goeppert-Mayer-Str. 2, D 44227 — [3]Laboratório Nacional de Luz Síncrotron, C.P. 6192, — [4]Inst. de Fisica - Universidade Estadual de Campinas,

Ultrathin films of hafnium were deposited on a silicon sample and annealed at 750°C forming rectangular shaped hafnium silicide islands on the surface. This silicidation process causes the thermal instability of HfO_2 films on silicon substrates. The latter system is under investigation in the field of high-k dielectrics to replace the system SiO_2/Si(100) in MOSFET devices [1]. We investigated the structure of the $HfSi_2$ island for different initial film thicknesses of hafnium by means of atomic force microscopy, photoelectron spectroscopy and photoelectron diffraction. Synchrotron light in the soft X-ray regime ($h\nu$=180 eV) was used for excitation. The resulting diffraction patterns were compared to calculated patterns of model structures by an R-factor analysis. As a result, we propose a modified zirconium silicide model to describe the structure of the system.

[1] C. J. Först, C.R. Ashman, K. Schwarz, and P.E. Blöchl, Nature **427**, 53 (2004)

O 17.17 Mon 17:30 Poster C

Spatially resolved eletronic and vibronic characteristics of a single higher diamondoid molecule — Yayu Wang[1], •Daniel Wegner[1], Xinghua Lu[1], Ryan Yamachika[1], Andre Wachowiak[1], Emmanouil Kioupakis[1], Steven Louie[1], Mike Crommie[1], Jeremy Dahl[2], Shenggao Liu[2], and Robert Carlson[2] — [1]Department of Physics, University of California at Berkeley, and Materials Science Division, Lawrence Berkeley National Laboratory, Berkeley, California, USA. — [2]MolecularDiamond Technologies, Chevron Technology Ventures, Richmond, CA, USA

Diamondoids are hydrocarbon molecules with diamond-like cage structures. Their structural complexity and chemical bond tunability make them ideal building blocks for creating novel nanostructures. We have investigated the recently discovered higher diamandoids at the single-molecule level using cryogenic scanning tunneling microscopy (STM) and spectroscopy (STS). STM images of individual 121-tetramantane molecules display pronounced nodal features across the molecular surface. Despite a large energy gap auround the Fermi level, STS and IETS reveal strong interactions between tunneling electrons and the diamondoid C-H stretch mode. The strength of the vibronic coupling has a distinct spatial distribution and peaks strongly at the topographic line nodes. Density-functional theory calculations have been used to reproduce the basic electronic structure and the peculiar geometric features of the higher diamondoids.

O 17.18 Mon 17:30 Poster C

Atomic Structure and Electronic Properties of Pt/Si(111)-$\sqrt{3}\times\sqrt{3}$ — •Florian Sandrock, Marc Wisniewski, Jörg Schäfer, and Ralph Claessen — Universität, Würzburg, Germany

Atomic Structure and Electronic Properties of Pt/Si(111)-$\sqrt{3}\times\sqrt{3}$

An increase of the electronic interaction is expected by decreasing the dimensionality of a system. In conjuction with suitably localized electrons, a metal-insulator transition can occur. While this is known from bulk structures, it is intriguing to look for such indications in surface systems. Metal adsorbates on semiconductor surfaces show a variety of two-dimensional superstructures which provide a playground to study such correlation phenomena. Among the quasi-two-dimensional reconstructions formed on the (111) surface of silicon and germanium, there are the $\sqrt{3}\times\sqrt{3}$ phases formed by e.g. Sn or Pb and other metals. In principle, such $\sqrt{3}\times\sqrt{3}$ systems can be instable against a two-dimensional charge density wave at low temperature. Moreover, the triangular lattice of this system is reminiscent of a crystal with a frustrated spin lattice, and it may be a candidate for a Mott transition at low temperature. A fascinating and yet sparsely examined system is the Pt/Si(111) $\sqrt{3}\times\sqrt{3}$ reconstruction, bringing a d-electron transition metal into play. Images obtained by scanning tunneling microscopy show a large area reconstruction. Dislocation defects lead to domains with threefold symmetry. Furthermore, ARPES measurements are underway which can serve to identify the metallicity of the system. Studies as a function of temperature will then explore possible phase transitions in this two-dimensional noble metal surface phase.

O 17.19 Mon 17:30 Poster C

Homogeneous preparation of ultrathin graphitic layers on hexagonal SiC surfaces — •Christian Riedl[1], Ulrich Starke[1], Jens Bernhardt[2], and Klaus Heinz[2] — [1]Max-Planck-Institut für Festkörperforschung, Heisenbergstr. 1, D-70569 Stuttgart — [2]Lehrstuhl für Festkörperphysik, Universität Erlangen-Nürnberg, Staudtstr. 7, D-91058 Erlangen

During the last years the peculiar properties of single and few-layer graphite (graphene) have attracted much interest. One method of choice to produce graphene with a high quality is the graphitization of SiC(0001)-surfaces by high temperature annealing in vacuum. The initial stage of graphitization is the $(6\sqrt{3}\times 6\sqrt{3})$R30°-reconstruction whose nature is discussed controversially. Whereas this structure is often entitled as "(6×6)" we explicitly show by means of Low En-

ergy Electron Diffraction (LEED) and Scanning Tunneling Microscopy (STM) that the true periodicity of this inherent surface reconstruction is indeed $(6\sqrt{3}\times 6\sqrt{3})$R30°. The characteristic properties of graphene develop with the first layer of graphite on top of the $(6\sqrt{3}\times 6\sqrt{3})$R30°-structure. We analyze the growth of graphite layers by Auger Electron Spectroscopy (AES), LEED and STM. A different number of graphite layers results in a different corrugation in the STM-topography.

O 17.20 Mon 17:30 Poster C

Optical anisotropy in a self-assembled molecular film — •Thorsten Kampen[1], Simona Silaghi[2], Philipp Martin Schmidt[1], Rocio Cortes[3], Arantzazu Mascaraque[3], Norbert Esser[2], and Karsten Horn[1] — [1]Fritz-Haber-Institut der Max-Planck-Gesellschaft, Berlin, Germany — [2]Institute for Analytical Sciences, Berlin, Germany — [3]Depto. Física de Materiales, Universidad Complutense de Madrid, Madrid, Spain

Among the class of molecules which may be used as molecular switches, stilbene and its derivatives are promising candidates. Here, we present a study on the optical properties of self-assembled 4,4'-stilbene dicarboxylic acid (DCSB) layers on Cu(110). Photoemission spectra show the deprotonation of both carboxylic end-groups upon adsorption resulting in a chemical bonding of the molecule to surface. Scanning tunnelling microscopy images reveal that nucleation of the first molecular layer starts on top of the Cu step edges. The molecular growth proceeds from the stabilized steps into the terraces and two different chiral phases are observed: a metastable enantiomorphically pure phase and a thermodynamically preferred "racemic mixture". The derived surface dielectric anisotropy from the RAS spectra show features assigned to the Cu surface state which vanish for coverages above 1ML. Even for submonolayer coverages spectral features above 3eV are observed and are assigned to optical transitions in DCSB. Specifically, the HOMO-LUMO transition dipole moment which is oriented along the long symmetry axis of the molecule is almost oriented parallel to the $[1\bar{1}0]$ substrate direction. This is supported by STM.

O 17.21 Mon 17:30 Poster C

Towards Substrate-Independent Self-Assembling Monolayers: Investigation of Short Nylon Oligomers — •Manuela Pluntke[1], Sabine Letsche[2], Dirk Volkmer[2], and Othmar Marti[1] — [1]Institute of Experimental Physics, Ulm University, D-89069 Ulm, Germany — [2]Institute of Inorganic Chemistry II, Ulm University, D-89068 Ulm, Germany

Self-assembled monolayers provide a convenient and simple route to tailor the surface properties of a material. Our current efforts are focussed on the design of molecules which form stable two-dimensional monolayers on a broad variety of substrate surfaces. This requires a robust and close packing of molecules in a two-dimensional layer in which the supramolecular entities are stabilized by hydrogen bonds. For that purpose we have synthesized short nylon oligomers with different functional groups (e.g. N,N'-Bis(isonicotinyl)-1,6-hexamethylendiamin) and we have investigated their self-assembly on mica by means of atomic force microscopy and STM.

O 17.22 Mon 17:30 Poster C

Metal deposition into ordered molecular precursor layers - an STM study — •Achim Breitruck[1], Christoph Meier[2], Matthias Roos[1], Michael Roos[1], Harry E. Hoster[1], Ulrich Ziener[2], and Rolf J. Behm[1] — [1]Institut für Oberflächenchemie und Katalyse, Universität Ulm, 89069 Ulm — [2]Institut für Organsiche Chemie III, Universität Ulm, 89069 Ulm

Oligopyridine molecules vapor deposited onto single crystalline surfaces (HOPG, Au(111), Ag(111)) form highly ordered 2D networks, with a geometry depending on coverage, preparation temperature and substrate, which mainly result from C-H***N type hydrogen bridges between neighboring molecules. They can be imaged by UHV-STM with high resolution even at room temperature. Using these adlayers as precursors, we investigate the effect of metals subsequently vapor deposited onto these networks, which in many cases leads to the formation of new ordered metal organic structures. The influence of metal-molecule, metal-substrate, molecule-substrate and molecule-molecule interactions on the structure formation is discussed.

O 17.23 Mon 17:30 Poster C

Controlled fabrication of nanopit-patterns on a graphite surface using focused ion beams and oxidation — •Farhad Ghaleh[1], Robert Köster[1], Heinz Hövel[1], Lars Bruchhaus[2], Sven Bauerdick[2], Jürgen Thiel[2], and Ralf Jede[2] — [1]Universität Dortmund, Experimentelle Physik I, 44221 Dortmund — [2]Raith GmbH, Hauert 18, Technologiepark, 44227 Dortmund

We produced nanopits on a highly oriented pyrolytic graphite (HOPG) substrate arranged in a given pattern with a combination of Focused Ion Beam (FIB) irradiation and an oxidation process. The FIB irradiation was carried out using a newly developed dedicated FIB nano fabrication tool [J. Gierak et al., Appl. Phys. A 80, 187 (2005)]. After oxidation of the sample surface defects produced by single ions were imaged as one monolayer deep nanopits with scanning tunneling microscopy. The penetration depth of the ions could be measured by oxidation of the defective volume produced on points irradiated with high ion doses. An array of well separated nanopits with a periodicity of 50 nm could be produced.

O 17.24 Mon 17:30 Poster C

Modification of a HOPG and DLC/Si surface after radiation with the Free elektron LAser in Hamburg (FLASH) — •Björn Siemer[1], Carsten Thewes[1], Tim Hoger[1], Marco Rutkowski[1], Helmut Zacharias[1], Rolf Treusch[2], and Stefan Düsterer[2] — [1]Physikalisches Institut, Westfälische Wilhelms-Universität Münster, 48149 Münster — [2]HASYLAB, DESY, 22603 Hamburg

The new free electron laser (FEL) at FLASH combines high photon energy with high pulse energy. A diamond like carbon (DLC) and HOPG surface were illuminated with photon energies of 58 eV and 38 eV. The pulse energy averaged around $30\,\mu J/pulse$ and the intensity around $10^{12} W/cm^2$. DLC is commonly used for the construction of XUV mirrors. We use HOPG for chemical reactions on surfaces activated by XUV radiation. The action of these light pulses on DLC/Si and graphite under focussed radiation of 58 eV for DLC/Si and 38 eV for HOPG is analysed. A change in reflectivity is visible under a light microscope. But an AFM profile and measurements with a profilometer yield no topology changes for both surfaces. We further present recent results of STM measurements of the modified surface.

O 17.25 Mon 17:30 Poster C

Ion-induced surface ripples in silicon — •Andreas Biermanns[1], Joerg Grenzer[2], Stefan Facsko[2], Souren Grigorian[1], and Ullrich Pietsch[1] — [1]Institute of Physics, University of Siegen,Walter Flex 3, 57078 Siegen, Germany — [2]Institute of Ion Beam Physics and Materials Research,Bautzner Landstrasse 128,D-01328 Dresden, Germany

The morphological evolution of surfaces during ion-beam irradiation has attracted a significant interest due to possibility of the development and the controlling of selforganization in nanostructures. Pattering and texture on nanometer length scale at metal and semiconductor surfaces has become a topic of intense research. In particular the surface and subsurface ripple formation under 40Ar+ ion-beam irradiation of Si (100) crystal has been studied recently. Strong ripple formation has been found for an irradiation energy of 60keV and incident angles around 60°. During implantation a corrugated surface layer is formed, consisting of a strongly damaged, amorphous near-surface layer followed by a nearly sinusoidal shaped interface towards the crystalline material. In the present work, we investigate the onset and evolution of ripple-formation as function of implantation energy and incidence angle of the ion beam.

O 17.26 Mon 17:30 Poster C

Nanostructures on insects eyes—-Grasshopper — •Fengzhen Zhang[1], Alexander Schmatulla[1], Othmar Marti[1], and Harald Wolf[2] — [1]Institute of Experimental Physics — [2]Institute of Neurobiology

Abstract: Insects use compound eyes to see the world, a totally different way from us. They are excellent at detecting motions and have good ultraviolet vision. The optical system of the insects is the apposition of the ommatidia, each of which is an optical unit, composed of layers (around 100) and crystalline cones. The image formation of grasshopper eye is similar to telescopes, both of which are angle magnification. The aim of our research on insects' eyes is to get information about how the compound eyes look like both on the surface and inside. We will explain how the compound eyes function. AFM, a powerful tool for nanoscale measurement, is mainly used to get shapes and lengths of structures of the compound eyes. In general, single eyes are analyzed perfect hexagons in the center of the facets while they are squeezed on the edges. A statistics of the area of the hexagons shows differences among different parts of the eye. The images of the cross section of the grasshopper eyes are measured with AFM.

O 17.27 Mon 17:30 Poster C

CO ADSORPTION ON METAL SURFACES: A HYBRID DENSITY FUNCTIONAL STUDY WITH PLANE WAVE BASIS SET — •ALESSANDRO STROPPA, KONSTANTINOS TERMENTZIDIS, JOACHIM PAIER, and GEORG KRESSE — Institut für Materialphysik, Universität Wien, Sensengasse 8/12, 1090 Wien, Austria

We present a detailed study of the adsorption of CO on Cu, Rh, and Pt (111) surfaces in top and hollow sites. The study has been performed with a gradient corrected functional (PBE) and PBE0 and HSE03 hybrid Hartree-Fock density functionals within the framework of generalized Kohn-Sham density functional theory using a plane-wave basis set. As expected, the gradient corrected functional shows the tendency to favor the hollow sites, at variance with experimental findings that give the top site as the most stable adsorption site. The PBE0 and HSE03 functionals reduce this tendency. Indeed, they predict the correct adsorption site for Cu and Rh but fail for Pt. But even in this case, the hybrid functional destabilizes the hollow site by 50 meV compared to the GGA description. This suggests that hybrid functionals give an overall better description of the chemisorption of CO molecules on metal surfaces, but, in general, they still do not predict the correct adsorption site. The results of the total energy calculations are presented along with an analysis of the projected density of states and Loewdin charges

O 17.28 Mon 17:30 Poster C

STM study of the adsorption of Au on Mo(110) — •WOJCIECH LINHART[1], ADAM PARUSZEWSKI[1], IZABELA CEBULA[1], ZBIGNIEW JANKOWSKI[1], TOMASZ KOBIELA[2], and ALEKSANDER KRUPSKI[1] — [1]Institute of Experimental Physics, University of Wrocław, Poland — [2]Institute of Physical and Theoretical Chemistry, University of Bonn,Germany

Scanning tunneling microscopy (STM) has been used for the first time to investigate the growth of ultrathin Au films on the Mo(110) surface.The measurements were carried out in a metal ultrahigh-vacuum. The Mo(110) crystal was cleaned by repetitive flashing at 1200 K in oxygen atmosphere to remove the residual carbon contamination. The oxygen was removed by flashing the sample at 2400 K. Gold was evaporated onto the crystal surface from a tantalum crucible surrounded by a tungsten resistive heater. The clean Mo(110) surface exhibits smooth single-step terraces ranging in width from 10 to 40 nm. These terraces are long and narrow and terminate in straight step-edges.

O 17.29 Mon 17:30 Poster C

STM study of the adsorption of Pb on Mo(110) — •IZABELA CEBULA, WOJCIECH LINHART, ZBIGNIEW JANKOWSKI, DOMINIKA GRODZINSKA, MIROSLAW KARPICKI, JAKUB CICHOS, and ALEKSANDER KRUPSKI — Institute of Experimental Physics, University of Wrocław, Poland

Scanning tunneling microscopy (STM) has been used for the first time to investigate the growth of ultrathin Pb films on the Mo(110) surface.The measurements were carried out in a metal ultrahigh-vacuum. The Mo(110) crystal was cleaned by repetitive flashing at 1200 K in oxygen atmosphere to remove the residual carbon contamination. The oxygen was removed by flashing the sample at 2400 K. Lead was evaporated onto the crystal surface from a tantalum crucible surrounded by a tungsten resistive heater. The clean Mo(110) surface exhibits smooth single-step terraces ranging in width from 10 to 40 nm. These terraces are long and narrow and terminate in straight step-edges.

O 17.30 Mon 17:30 Poster C

UPS investigations of ultrathin Au films deposited on Pt(111) — •TOMASZ KOBIELA[1], MARCO MOORS[1], WOJCIECH LINHART[2], IZA CEBULA[2], ALEKSANDER KRUPSKI[2], CONRAD BECKER[1], and KLAUS WANDELT[1] — [1]Institute of Physical and Theoretical Chemistry, University of Bonn, Wegelerstr. 12, 53115 Bonn, Germany — [2]Institute of Experimental Physics, University of Wroclaw, pl. Maxa Borna 9, 50-204 Wroclaw, Poland

The structure and the local electronic properties of ultrathin Au films deposited on Pt(111) under UHV conditions have been studied by UPS and LEED. Investigations of bimetallic systems concerning morphology and adsorption properties are of great interest for the development of new catalysts with higher efficiency and durability. LEED measurements indicated an initial pseudomorphic growth of the Au films. UPS and PAX experiments showed a strong temperature dependence of the surface morphology. The Au-Pt surface prepared at 150 K is quite rough and smoothens significantly only above RT. At a temperature of 900 K gold starts to diffuse into the bulk forming a surface alloy with platinum and gold sites. The electronic properties of the resulting Au-Pt surface alloy seem to be nearly independent from the deposited Au amount in the investigated range of 1 - 10 monolayers. The removal of Au from the surface regions has been verified by STM. Adsorption experiments with various probe molecules showed a significant lower affinity of the Au-Pt surface alloy towards e.g. CO, but similar adsorption properties concerning butadiene in comparison to the clean Pt surface.

O 17.31 Mon 17:30 Poster C

Interaction of nitric oxide with the clean and oxygen-covered Re(10-10) surface — •VIKTOR SCHERF, CHRISTIAN PAULS, and KLAUS CHRISTMANN — Institut für Chemie und Biochemie, FU Berlin, Germany

The molecular and dissociative adsorption of nitric oxide (NO) on the Re(10-10) surface was studied in UHV between 120 and 1200K by means of LEED, HREELS, TDS, and work function change ($\Delta\Phi$) measurements. On the initially oxygen-free Re surface and at 120K, a minor fraction of NO spontaneously dissociates into O_{ad} and N_{ad}, while the majority of NO adsorbs in two molecular α states. Exposing NO at about 490K, however, leads exclusively to the dissociation products. TDS exhibits both associative (first-order kinetics) and dissociative (second-order kinetics) desorption states, the work function increases (at 120K) by 750meV, and the N=O stretching vibrations ν_{NO} appear at 1706cm^{-1} (α_1 state) and at 1468cm^{-1} (shoulder, α_2 state) and are associated with NO held in the terminal and the bridge position, respectively. Pre-adsorption of oxygen ((1x5)-O-phase) facilitates molecular NO adsorption and causes a decrease of $\Delta\Phi$, thus reflecting a strong influence of co-adsorbed O on the NO-Re bonding chemistry. Our data are discussed and compared with similar investigations reported in the literature for Ru and Pt surfaces.

O 17.32 Mon 17:30 Poster C

Interaction of propene with the clean and oxygen-covered Au(110)*(1x2) surface — •INGA SPREINE and KLAUS CHRISTMANN — Institut für Chemie und Biochemie, FU Berlin, Germany

The adsorption and reaction of propene (C_3H_6) on the (1x2) reconstructed Au(110) surface has been studied in the temperature range from 30 K to 500 K by means of low energy electron diffraction (LEED), UV photoemission (UPS), temperature-programmed thermal desorption (TPD) and work function change ($\Delta\Phi$) measurements. On the clean Au surface increasing exposures ($0,06 \cdots 9,0$ L) lead to molecular adsorption in monolayers and multilayers; six different adsorption states can be attributed to chemisorbed and weakly held (physisorbed and condensed) propene, respectively. Upon heating, associative desorption sets in at 85 K and ends at 260 K. In the accessible temperature and coverage range, no ordered LEED phases can be observed indicating the absence of phases with long-range order. According to a recipe by Gottfried et al. [1] we used electron irradiation of physisorbed O_2 layers to accumulate reactive oxygen atoms at the surface and studied both the adsorption and reaction of propene with the O-covered Au(110). Our results are discussed and compared with similar investigations reported recently for the Au(100) and Au(111) surfaces [2,3].

[1] M.Gottfried et al., Surf.Sci. 511 (2002) 65; [2] K.A.Davis and D.W.Goodman, J.Phys.Chem. B 104 (2000) 8557; [3] X.Deng et al., J.Phys.Chem. B 110 (2006) 15982.

O 17.33 Mon 17:30 Poster C

Phthalocyanines on Surfaces — •STEFAN KUCK, JENS BREDE, FRANCOIS VONAU, GERMAR HOFFMANN, and ROLAND WIESENDANGER — Institute of Applied Physics, University of Hamburg

Phthalocyanines are aromatic metallo-organic complexes with a single metal atom (M) in its central position and used, e.g., as dye molecules in industrial applications. Phthalocyanines have a planar geometry and are volatile and therefore ideally suited for experiments in ultra high vacuum with local probes. We prepared different Phthalocyanines (M = Cu, Co, Fe) on various substrates from bare metallic surfaces to sandwiched structures with insulating interface layers in an ultra high vacuum environment at a coverage below a monolayer. These molecular systems were then investigated by scanning tunneling microscopy and spectroscopy. The experiments were performed in an home-built variable-temperature scanning tunnling microscope working at temperatures down to 17 K. We will discuss the preparation and the role of the substrates on the orientation and on the electronic molecular states of studied Phthalocyanines.

O 17.34 Mon 17:30 Poster C

Interface molecular dipoles on metal surfaces — •Fernández-Torrente Isabel[1], Sergio Monturet[2], Katharina Jennifer Franke[1], Nils Henningsen[1], Nicolás Lorente[2], and José Pascual[1] — [1]Institut für Experimentalphysik, Freie Universität Berlin, Germany — [2]Université Paul Sabatier, Toulouse, France

Association of molecules with donor and acceptor character forms the so called molecular charge transfer complexes. Tetrathiafulvalene 7,7,8,8-tetracyanoquinodimethane (TTF-TCNQ) is a well-known example of a compound with a metal conducting behaviour governed by charge transfer interactions between the TTF (donor) and the TCNQ (acceptor). Here we report on the submonolayer growth of TTF on a Au(111) surface studied by Low Temperature Scanning Tunneling Microscopy. We find that TTF lies tilted on the surface and two S atoms dominate the adsorption. As a function of coverage we resolve several phases of the growth with different dimensionalities. In combination with DFT calculations we show that the growth is mediated by the balance between a repulsive and an attractive interaction. The repulsive force is associated to the creation of a dipole between TTF and the metallic surface while the attractive interaction is related to the formation of intermolecular H-bonds. At low coverage, molecules show primarily repulsion and they adsorb as monomers. As the coverage increases the attractive interaction gains importance and the molecules self-assemble in one and two dimensional structures.

O 17.35 Mon 17:30 Poster C

Adsorption and diffusion of CH_3S–Au(111) — •Andreas Franke and Eckhard Pehlke — Institut für Theoretische Physik und Astrophysik, Christian-Albrechts-Universität zu Kiel

Alkanethiols have adopted the role of model systems for the bonding of organic molecules on metal surfaces via sulfur anchors and the formation of self-assembled monolayers. So far, however, little is known about the detailed diffusion mechanism of such molecules on the surface. As a starting point, we present a DFT-study of the adsorption and diffusion of CH_3S–radicals on the Au(111)(1×1) surface in the low coverage regime using *ab initio* methods as implemented in the VASP code [1]. Unreconstructed Au(111) surfaces can be prepared under certain conditions at electrochemical interfaces [2]. In accordance with other DFT-studies (see e.g. [3] and references therein) we find that the most stable adsorption position is a tilted fcc-bridge geometry for all analysed coverages (Θ=1, 1/3, 3/16 molecules per $(\sqrt{3}\times\sqrt{3})$ Au(111) surface unit cell) with a S-Au bond strenght of 1.86 eV (Θ = 1) to 1.99 eV (Θ = 3/16) and a tilt angles of 51° and 50° to the surface normal. Using the nudged elastic band (NEB) and the dimer-method, local transition states along the minimum energy path with diffusion barriers of 130 meV, 240 meV and 270 meV are identified. Calculations for CH_3S adsorbed ontop of Au adatoms are underway.

[1] G. Kresse, J. Hafner, Phys. Rev. B **47**, 15 (1993).

[2] M.A. Schneeweiss, H. Hagneström, M.J. Esplandiu, D.M. Kolb, Appl. Phys. A **69**, 537 (1999).

[3] C. Masens, M.J. Ford, M.B. Cortie, Surf. Sci. **580**, 19 (2005).

O 17.36 Mon 17:30 Poster C

Towards real surfaces: adsorption of ferrocene dithiolate between defective Ag(111) surfaces — •Thomas Bredow[1], Herbert Pfnür[2], Christoph Tegenkamp[2], and Jörg Meyer[3] — [1]Universität Bonn, Institut für Physikalische und Theoretische Chemie, Wegelerstr. 12, 53115 Bonn, Germany — [2]Leibniz-Universität Hannover, Institut für Festkörperphysik, Appelstr. 2, 30167 Hannover, Germany — [3]Fritz-Haber-Institut, Faradayweg 4-6, 10033 Berlin, Germany

In recent experiments ferrocene-1,1'-dithiol (FDT) has been successfully tested as a molecular contact between silver electrodes. A large conductance without activation thresholds was observed and confirmed by theoretical studies. Our earlier model calculations considered FDT adsorption at perfect Ag(111) surfaces. As real electrode surfaces are expected to contain defects such as adatoms, steps and vacancies, the adsorption of FDT at defective Ag(111) surfaces has been studied. Periodic slab calculations are performed at DFT level with the plane-wave code VASP employing the projector-augmented wave method. Based on our previous experience FDT is adsorbed dissociatively as thiolate via the sulfur atoms. Various adsorption sites above or near single point defects or small 2x2 terraces are considered. We found that FDT-surface interaction is substantially enhanced by the presence of defects. The molecule is slightly deformed for optimal bond formation with the surface atoms. The projected density of states near the Fermi level is compared to previous results for the perfect surfaces and related to the measured conductivity.

O 17.37 Mon 17:30 Poster C

Photoelectron microscopy on inhomogeneously alkali adsorbed transition-metal dichalcogenides — •Dirk Rahn[1], Hans Starnberg[2], Jens Buck[1], Sönke Harm[1], Kai Rossnagel[1], and Lutz Kipp[1] — [1]Institut für Experimentelle und Angewandte Physik, Universität Kiel, D-24098 Kiel, Germany — [2]Department of Physics, Göteborg University and Chalmers University of Technology, SE-41296 Göteborg, Sweden

The behavior of alkali metals deposited on transition-metal dichalcogenides (TMDC) is of great interest in basic research and in applications, for example in battery development.

The question in which way the alkali metal adsorbs on the TMDC is not finally answered. On the one hand, a certain amount of alkali atoms intercalates into the van der Waals gaps of the TMDC, while a small amount remains at the surface. On the other hand, the formation of nano-structures in the uppermost layer is observed. To get better insight into the differences between the two scenarios and to determine in particular the diffusion length of the alkali atoms on the TMDC surface, we have prepared samples with two different concentration domains. We have investigated such a sample with the photoelectron microscope at BL 31 at the Max-lab in Lund (Sweden) with a spacial resolution of 4 μm. Photoelectron images of the sample surface at constant kinetic energies and photoelectron spectra with different alkali metal concentrations for TaS_2 and $TaSe_2$ will be presented.

This work is supported by the DFG Forschergruppe FOR 353.

O 17.38 Mon 17:30 Poster C

Development of a fast SPM controller — •Christopher Zaum and Karina Morgenstern — Institut für Festkörperphysik, Gottfried Wilhelm Leibniz Universität , Appelstr. 2, D-30167 Hannover, Germany

Results in scanning probe microscopy depend heavily on the quality and stability of the utilized microscope controller. Therefore commercial SPM controllers make up roughly half the price of a microscope assembly. We developed a low-cost SPM controller based on National Instrument's CompactRIO real-time system. The controller features a low noise level, scan speeds up to one image per second, and full remote access over Ethernet at only tenth of the price of a commercial electronics. Furthermore, our system can control different piezo scanners, supplies two HV-channels for external approach mechanism, and controls the approach-process over a build-in RS-232 interface. The SPM controller is accessed via a menu-driven software based on LabVIEW. It offers a full range of microscope control options as well as advanced image processing and analyzing functions in a multi-monitor environment. Due to its compact and lightweight design, our SPM controller is part of the SONOS-project of the European Space Agency.

O 17.39 Mon 17:30 Poster C

Measurement of stress in AFM cantilevers by Raman spectroscopy — •Michael Bauer, Alexander M. Gigler, and Robert W. Stark — Crystallography, Dep. Earth and Environmental Sci., Ludwig-Maximilians-Universität München, 80333 München, Germany

The most prominent Raman peak of silicon at 523 wave numbers (1/cm) is known to shift upon stress. The peak shift is caused by a change in the crystal structure of the silicon and, hence, a change in the phonon bands under stress. This shift can be used to measure and visualize the spatial distribution of surface stresses in bent AFM cantilevers. The measurements were done using a confocal Raman microscope with diffraction limited lateral resolution. With a estimated resolution of 0.02 1/cm, the system has a nominal resolution of 9 MPa (shifts up to -12 1/cm were observed). The measured stresses can be compared qualitatively to results from finite elements methods (FEM). In this contribution, the Raman shift observed in the cantilever will be discussed in comparison to the shift introduced by the strain of a Vickers indent. The algebraic sign of the shift depends on the type of strain compressive or tensile. Together with the shift, a broadening of the peak and a lower maximum at the centre occurs. The procedure helps to tailor the cantilever properties such as resonant frequencies or bending shape to desired values.

O 17.40 Mon 17:30 Poster C

Material contrast measurement with a multifrequency AFM — •Maximilian Baumann, Alexander M. Gigler, and Robert W. Stark — CeNS and Crystallography, Dep. Earth and Environmen-

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 sawtooth 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. Mönninhoff[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 Mysliveček, 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.

O 17.53 Mon 17:30 Poster C

Experimental setup of a combined scanning tunnelling microscope and atomic force microscope at ultrahigh vacuum conditions and low temperature — •Thomas König, Georg Hermann Simon, Markus Heyde, Hans-Peter Rust, and Hans-Joachim Freund — Fritz-Haber-Institute of the Max-Planck-Society, Faradayweg 4-6, D-14195 Berlin, Germany

Scanning tunnelling microscopy (STM) is sensitive to the electronic structure of conducting and semiconducting samples. A different technique which has been improved over the last years is the atomic force microscope (AFM). This technique gained atomic resolution on metals [1], semi conductors [2] and insulators [3] and has still not reached its limit in scientific work. Here we present the experimental setup and challenges of our combined STM and AFM in an ultrahigh vacuum chamber at low temperatures. Our setup is similar to the one developed by P.S. Weiss et al. [4]. An insight into the sensor setup of the microscope will be given as well as description of our amplifier arrangement [5]. Moreover we point out the next challenges we are facing on the way to enhanced the sensitivity of our combined STM and AFM.

[1] Ch. Loppacher, M. Bammerlin, M. Guggisberg, S. Schär, R. Bennewitz, A. Baratoff, E. Meyer, H.J. Güntherrodt, Phys. Rev. B, 62, 16944 (2000). [2] Y. Sugawara, M. Ohta, H. Ueyama, S. Morita, Science, 270, 1646 (1995). [3] C. Barth and M. Reichling, Nature, 414, 54 (2001). [4] P.S. Weiss, D.M. Eigler, NATO ASI Series E, 235, 213 (1993). [5] H.-P. Rust, M. Heyde, H.-J. Freund, Rev. Sci. Instr., 77, 043710 (2006).

O 17.54 Mon 17:30 Poster C

Miniaturised Columnar Sensors for Ultrasensitive Mass Detection — •Jenny Kehrbusch[1,2], Matthias Hullin[1], and Egbert Oesterschulze[1,2] — [1]Physics and Technology of Nanostructures, University of Kaiserslautern, D-67663 Kaiserslautern, Germany — [2]Nano+Bio Center, University of Kaiserslautern, Germany

Cantilever based microsensors are commonly used as ultrasensitive mechanical balances operating in gases and liquids. They are sensitive to changes of the viscosity of the surrounding fluid, chemically induced surface effects, and mass loading of their surface. So far their sensitivity with respect to mass loading in fluidic media is limited due to the strong viscous damping of the vibrating cantilever. The quality factor in liquids is by orders of magnitude smaller compared to gases even with active stimulation. Furthermore, the huge dimension of conventional cantilevers hinders to achieve high quality factors.

To overcome this limitation an improved concept of a columnar strongly miniaturized sensor is introduced. This sensor is oscillating in air where only the top surface is immersed in the liquid analyte. Thus both the quality factor and the signal-to-noise-ratio are improved. The new design combines additional advantages. Instead of an intricate double-sided fabrication process, simple single sided few steps manufacturing applying high aspect ratio deep plasma etching offers the possibility of further miniaturisation. Reduction of the geometrical dimensions implies higher resonance frequencies and thus an improved sensitivity per area. This is an important issue for the application of miniaturized balances, e.g. single-cell detection in liquid media.

O 17.55 Mon 17:30 Poster C

A UHV-STM system for measurements at 4 K with 3D-rotatable magnetic field — Torge Mashoff, Marco Pratzer, and •Markus Morgenstern — 2. Physikalisches Institut B, RWTH Aachen, Otto-Blumenthal-Straße, 52074 Aachen

We designed and built a 3-chamber ultra high vacuum system with a 4.2 K cryostat containing three superconducting magnets which allow us to apply fields of 7 T, 3 T and 0.5 T in different directions and a full rotatable field of 0.5 T. The system will be equipped with a homebuilt scanning tunnelling microscope providing a tip exchange mechanism and a sample positioning stage. The STM features a very compact design to increase its stability and resonance frequencies. The satellite chambers contain several devices for sample and tip preparation including heating up to 2300 K, sputtering and material evaporation. The whole system is placed on damping legs inside an acoustically insulating room. First test measurements will be presented.

O 17.56 Mon 17:30 Poster C

Higher harmonics and frequency mixing in electrical force microscopy (EFM) — •Benjamin Graffel[1], Falk Müller[2], Anne-Dorothea Müller[2], and Michael Hietschold[1] — [1]Chemnitz University of Technology, Institute of Physics, 09107 Chemnitz, Germany — [2]Anfatec Instruments AG, 08606 Oelsnitz (V), Germany

Electrical force microscopy (EFM) in the dynamic non-contact mode is a suitable technique to measure local distributions of surface potentials on electronic devices as well as to detect different doping concentrations in semiconductors. The electrical force between tip and sample is proportional to the derivative of the capacitance of the tip-sample arrangement with respect to the tip-sample distance z and proportional to the potential difference U squared. In our experiments this voltage consists of a direct voltage and an additional alternating voltage with the frequency f_{el}. While the capacitance of a completely metallic tip-sample arrangement only depends on z, it also depends on U in the case of a semiconductive sample.

In this work we show that these nonlinear effects lead to further signals at higher harmonics of f_{el} and at frequencies that arise from mixing with the mechanical excitation frequency of the oscillating cantilever. The frequency spectrum of the cantilever was measured for different parameters such as various set points and different values of U. Detailed studies of the distance dependencies in connection with imaging indicate that the lateral resolution can be improved by detecting signals at mixed frequencies.

O 17.57 Mon 17:30 Poster C

Dynamic Force Spectroscopy on Gadolinium Islands epitaxially grown on W(110) — •Rene Schmidt, Alexander Schwarz, and Roland Wiesendanger — Institut für Angewandte Physik, Universität Hamburg,

Gd/W(110) is prepared in UHV by evaporating gadolinium onto a clean tungsten substrate. Additional annealing leads to the growth of Gd islands on a base Gd-wetting layer. Atomic force microscopy in the dynamic mode using the frequency modulation technique (FM-AFM) and a Gd coated tip is employed for imaging these islands. Some parts of the Gd-islands are covered by hydrogen, which is the main compound present in the residual gas of the UHV-system. Hydrogen locally alters the work function of the Gd islands[1] and can therefore be distinguished by bias spectroscopy. Moreover, the application of dynamic force spectroscopy enables to quantify the complex interaction of the different surface species on a local scale. With the focus on the distance dependence of the forces between tip and surface, we perform single $\Delta f(z)$-curves while retracting into the long-range regime and single curves and spectroscopy fields whilst approaching the surface. As all the curves are taken with varying amplitudes due to the feedback regulation, the force-calculation uses a formalism given by Schirmeisen *et al*[2]. A model of the tip-surface interaction potential allows to fit the force-distance-curves and to determine the influence of the hydrogen on the tip-sample force.

[1] M. Getzlaff *et al.*, Phys. Rev. B **59**, 8195 (1999)
[2] A. Schirmeisen *et al.*, Nanotechnology **16**, S13 (2005)

O 17.58 Mon 17:30 Poster C

Scanning tunneling spectroscopy on the chalcopyrite solar cell absorber material Cu(In,Ga)Se_2 — •Harry Mönig[1], Sascha Sadewasser[2], Ahmed Ennaoui[2], Christian Kaufmann[2], Timo Kropp[2], Iver Lauermann[2], Tim Münchenberg[2], Rodrigo Saez-Araoz[1], Hans-Werner Schock[2], Ferdinand Streicher[2], and Martha Lux-Steiner[1,2] — [1]Freie Universität Berlin — [2]Hahn-Meitner-Institut Berlin

Cu(In,Ga)Se_2-based thin film solar cells have reached efficiencies close to 20 % [1]. Nevertheless, little is known about electronic transport and carrier recombination in this material on a microscopic scale. Especially grain boundaries in these polycrystalline materials are considered to play an important role in the performance of these solar cells [2]. We applied scanning tunneling microscopy and spectroscopy to gain more insight in the electronic microstructure of the material. Our results point to lateral electronic inhomogeneities on the absorber surface and to an enhanced density of states at grain boundaries. The influence of charging effects is discussed.

[1] M.A. Contreras et al. Prog. Photovoltaics Res. Appl. 13, 209 (2005)
[2] S. Siebentritt et al., Phys. Rev. Lett. 97, 146601 (2006)

O 17.59 Mon 17:30 Poster C

Towards the ultimate STM: design, modeling and characterization — •Mark den Heijer, Vincent Fokkema, Arjen C. Geluk, and Marcel J. Rost — Kamerlingh Onnes Laboratory, Leiden University, P.O.Box 9504, 2300 RA Leiden, The Netherlands

We developed a video-rate scanning tunneling microscope (STM) for

in-situ and *real-time* observation of film growth. The key element in achieving high frame rates is a rigid mechanical structure, but the objective of imaging the surface during deposition poses severe restrictions on the geometry of the STM.

To achieve an optimal design we used finite element analysis (FEA) to model the complete STM. By including damping and piezoelectric properties, we obtained not only the eigenfrequencies and eigenmodes but also the real amplitudes of the vibrations. Finally we compare our calculated predictions with the measured characteristics of the microscope.

O 17.60 Mon 17:30 Poster C

Erste Experimente mit einem EBIT-basierten Edelgas-FIB — Falk Ullmann[1], •Frank Grossmann[1], Vladimir Ovsyannikov[1], Jacques Gierak[2], Erik Bourhis[2] und Günter Zschornack[3] — [1]DREEBIT GmbH, Dresden — [2]Technische Universität Dresden, Dresden — [3]LPN/CNRS Marcoussis, Frankreich

In FIB formierte hochfokussierte Ionenstrahlen sind von speziellen Interesse für Anwendungen in der Materialforschung, der Halbleiterindustrie und anderen Applikationsfeldern. Beschrieben wird hier die Formierung von Edelgasionenstrahlen in einer am LPN/CNRS Marcoussis entwickelten Nano-FIB-Säule, wobei als Quelle für die verwendeten Edelgasionen eine Dresden EBIT diente.

Die Dresden EBIT zeichnet sich durch eine gute Strahlemittanz, ihre Kompaktheit und ihre robuste Betriebsweise aus. In ersten Experimenten wurde das Funktionsprinzip eines Edelgas-FIB mit einem He^{1+}-Ionenstrahl demonstriert. Dabei wurde gezeigt, dass die Ionenstrahlen bis in den Submikrometerbereich fokussiert werden können.

An verschiedenen Beispielen wird vermittels von Sekundärelektronenspektroskopie die Leistungsfähigkeit der Anlage als Ionenmikroskop demonstriert und über den Einsatz von Helium- Argon- und Xenonstrahlen wird berichtet.

Prinzipiell können mit der Kopplung einer FIB-Säule mit einer Dresden EBIT auch Strahlen hochgeladener Ionen erzeugt werden. Mögliche Parameter einer solchen Anlage werden diskutiert.

O 17.61 Mon 17:30 Poster C

Design of a UHV/300 mK/9 T scanning tunneling microscope (STM) system — •Torben Hänke, Grzegorz Urbanik, Christian Hess, Marko Kaiser, Steffen Lessny, Ralf Voigtländer, Dirk Lindackers, and Bernd Büchner — IFW Dresden, Institute for Solid State Research, P.O. Box 270116, D-01171 Dresden, Germany

To study electronic and spin structures of high temperature superconductor (HTS) and related transition metal oxide materials (TMO) with high resolution scanning tunneling spectroscopy (STS) we are designing an ultra high vacuum (UHV) low temperature STM for temperatures down to 300 mK and magnetic fields up to 9 T. The microscope will be placed inside a UHV compatible ^{3}He cryostat which is integrated into a three-chamber UHV system for *in situ* tip and sample preparation including LEED/Auger analysis and molecular beam epitaxy (MBE). The STM is equipped with a tip-exchange mechanism, x, y-sample positioner and five additional leads to the sample to combine STM with transport measurements. For vibration isolation the entire system is mounted on a rigid supporting frame on air damping stages.

O 17.62 Mon 17:30 Poster C

Calibration of a thermal profiler in a scanning tunneling microscope in terms of measuring the near-field heat transfer — •Andreas Knübel, Uli Wischnath, and Achim Kittel — University of Oldenburg, Institute of Physics, Department of Energy and Semiconductor Research, D-26111 Oldenburg

The fabrication of a novel thermocouple sensor as a thermal profiler has enabled us to set up a very sensible scanning thermal microscope (SThM) based on a scanning tunnelling microscope (STM) under ultrahigh vacuum conditions with high spatial resolution. This provides the possibility to an improved analysis of the frequently discussed near-field heat transfer on a nanometer scale. Because theory already provides a statement for the distance dependence of the heat transfer this quantity has to be determined experimentally for comparison. Therefore, it is essential to characterize the thermal resistance. By means of the thermal resistance of the microscope tip its possible to quantify the heat transfer through the vacuum gap between the thermocouple tip and a cooled planar material surface from the measured temperatures. We developed a specially designed set-up to evaluate the thermal resistance of the thermocouple tip under ultra-high vacuum conditions. Current experimental results are presented.

O 17.63 Mon 17:30 Poster C

Conductivity of Thin Films and Nanostructures Analysed by EFM — •Thomas Koch[1,2], Patrick Dupeyrat[1,2], Roland Gröger[1,2], Sheng Zhong[1,2], Norman Mechau[2], Gabi Schierning[2], Roland Schmechel[2], and Thomas Schimmel[1,2] — [1]Institute of Applied Physics, University of Karlsruhe, D-76128 Karlsruhe, Germany — [2]Institute of Nanotechnology (INT), Forschungszentrum Karlsruhe, D-76021 Karlsruhe, Germany

ITO (Indium Tin Oxide), Si or Ge nano-particles and small micron and submicron metal structures, mixed together with polymers and other carrier systems, are promising materials in the field of micro electronics and especially printable electronics to build thin conducting or dielectric films. Independently pure nano-particle systems or metals are also of interest for these applications.[1] For the exploration of these topics AFM is a powerful tool which can give information to identify the electric properties of materials at surfaces with local contrast on the nanometer scale. In this work we demonstrate the use of Electrostatic Atomic Force Microscopy (EFM) to map the conductive properties of nano-particle based sintered thin ITO films, of ITO/Baytron composite systems and of metal based ribbon cable nano structures. References 1. J. R. Sheats, J. Mater Res. 19 (7), 1974, (2004)

O 17.64 Mon 17:30 Poster C

Homoepitaxy under the influence of step edge barriers in the presence of screw dislocations — •Oliver Ricken[1], Alex Redinger[1], Joachim Krug[2], and Thomas Michely[1] — [1]II. Physikalisches Institut, Universität zu Köln — [2]Institut für Theoretische Physik, Universität zu Köln

The presence of screw dislocations solves the nucleation problem in crystal growth and allows growth even for supersaturation too small for nucleation. Growth spirals are also frequently observed in thin film deposition. In classical models for spiral growth a fixed slope of the resulting cone is predicted. Motivated by the observation of growth spirals in organic thin film growth with shapes similar to those of mounds in homoepitaxy with step edge barriers, we performed a set of model experiments. The growth of Pt on Pt(111) is studied by STM after creation of screw dislocations on the surface in a temperature range from 250 K to 450 K. The screw dislocations are produced by the mechanism of "dislocation loop punching" through He^+ bombardment. Growth spirals and normal mounds are observed after deposition and can be directly compared in the STM images. Both mound types show the typical 3D-growth mound forms with a plateau on top and deep crevices between them. However, growth spirals show much smaller plateaus and average base areas than normal mounds, but are, on average, taller. The smaller plateaus of growth spirals compared to mounds result, because the dislocation obviates the nucleation problem on the top terrace, which is analogous to an increase in the effective step edge barrier energy.

O 17.65 Mon 17:30 Poster C

Preparation of two-dimensional Fe-Cr-Fe multistripes on W(110) — •Torsten Methfessel and Hans Joachim Elmers — Johannes Gutenberg-Universität Mainz, Institut für Physik, Staudingerweg 7, D-55099 Mainz

Multilayers consisting of alternating layers of Fe an Cr are interesting because of the discovery of the giant magnetoresistance effect (GMR). In analogy to these multilayersystems we were interested in the possibility to prepare two dimensional multistripes on W(110) by sequential epitaxy and self organized growth of pseudomorphic Fe and Cr. These multistripes have been investigated using scanning tunneling microscopy (STM) and scanning tunneling spectroscopy (STS). With these methods we were able to distinguish between different materials along the edges of the W-substrate. Comparing the STS spectra of the multistripes with those of pseudomorphic pure element monolayers we could show that multistripes of alternating pure Fe and Cr stripes grow at appropriate substrate temperatures. Interdiffusion occurs for temperatures larger than 500 K, while deposition at room temperature leads to island growth.

O 17.66 Mon 17:30 Poster C

Effective interaction energies for the description of two dimensional alloys: calculation from experimental and density functional theory data — •Andreas Bergbreiter[1], Harry E. Hoster[1], Yoshihiro Gohda[2], Axel Gross[2], and R. Jürgen Behm[1] — [1]Institut für Oberflächenchemie und Katalyse, Universität Ulm,

89069 Ulm — [2]Institut für Theoretische Chemie, Universität Ulm, 89069 Ulm

The atomic distribution in two-dimensional, surface confined alloys can be approximately described by an Ising Hamiltonian based on pairwise and trio interactions. We show, how the effective interaction energies can be derived from atomic resolution STM images in an inverse Monte Carlo (IMC) approach. In addition, the total energy of ordered surface alloys can be calculated via density functional theory (DFT). Based on the energies for a number of unit cells with varied composition and internal geometry it is possible to derive a second set of ECIs in a least-squares approach, i.e., by simple matrix inversion, which can be compared to the one generated by IMC.

O 17.67 Mon 17:30 Poster C

Laser-assisted Carbon Burning (LACB) - Removal of Organic Impurities at Room Temperature — •Jonas Bock, Andreas Assmuth, Ulrich Abelein, Torsten Sulima, and Ignaz Eisele — Universität der Bundeswehr München, Institut für Physik, 85579 Neubiberg, Germany

The cleaning of silicon surfaces is one of the most important issues for the fabrication of novel semiconductor devices. Taking into account out-diffusion of dopants or mechanical stress of SiGe hetero structures, high temperatures have to be avoided. Therefore a maximum processing temperature of $T = 700\,^{\circ}\mathrm{C}$ must not be exceeded by any processing step, which applies accordingly to the removal of the two main contaminants of Si wafers - organic impurities and the native oxide. One possible approach is using gaseous precursors excited by plasma or laser. Because high energy ions caused by plasma excitation roughen the surface and laser beam radiation perpendicular to the substrate may lead to high temperatures, the investigations have been carried out using an excimer laser combined with an UHV system where the laser beam is guided parallel to the wafer. An in-situ cleaning step based on laser excitation of oxygen will be presented. The influence of temperature, oxygen partial pressure and laser energy have been studied, the effectiveness will be shown by SIMS analysis and I-V-measurements of devices, that were built on LACB cleaned substrates.

O 17.68 Mon 17:30 Poster C

Time-resolved two-photon photoemission study of C_{60} — Benjamin Göhler, •Arne Rosenfeldt, and Helmut Zacharias — Physikalisches Institut, Westfälische Wilhelms-Universität, 48149 Münster, Deutschland

Ordered films of C_{60} with different thicknesses between 10 and 200 ML are evaporated onto Cu(111) and cooled down to 130 K. Using four-wave mixing in Xenon photons with 8.27 eV (150 nm) are generated. They have sufficient energy to probe low lying and occupied states and are used to check the preparation. Photons with 5.88 eV have sufficient energy to probe the excitons. Photons with 4.71 eV have sufficient energy to probe half of the LUMO, the LUMO+1, and the LUMO+2.

Two-photon photoemission is employed to populate intermediate states and probe their dynamics. The excitation probability of these states is measured as a function of photon energy. Time-resolved measurements are performed with both a Q-switched laser delivering 2.33 eV pulses with 150 ns duration and 3.50 eV pulses with 100 ns duration, and a mode-locked laser tunable between 2.35 and 5.88 eV with 75 ps pulse duration. A rate equation fitted to the electron dynamics suggests a lifetime of about 126 ps for the LUMO, 1 ns for the singlet exciton, $(21 \pm 3)\,\mu s$ for the triplet exciton, and shorter lifetimes for LUMO+1 and LUMO+2. Pumping with 2.3 eV the result depends on pulse energy and pulse length.

The project is financially supported by the DFG in the SPP1093 "Dynamik von Elektronentransferprozessen an Grenzflächen".

O 17.69 Mon 17:30 Poster C

Nanoparticle removal by laser induced acoustic waves — •Tobias Geldhauser, Florian Merkt, Florian Ziese, Johannes Boneberg, and Paul Leiderer — Fachbereich Physik, Universität Konstanz, Fach M676, 78457 Konstanz

Different approaches can be used for particle removal from surfaces like Ultra-/Megasonic or Dry/ Steam Laser Cleaning. Here we analyze an alternative approach where a laser pulse hits the back of a wafer and thereby initiates a bulk acoustic wave which travels towards the opposing wafer surface, leading to surface displacements and particle removal. We relate the cleaning efficiency for colloidal contaminants of different diameters (measured by light scattering) to the surface expansion, and hence the acceleration, which is measured with a ns-time-resolved Michelson Interferometer. In order to develop a model for the removal process of the particles we measure in addition the detachment velocity of the particles by a light-scattering technique.

O 17.70 Mon 17:30 Poster C

Ablation dynamics of solid carbon dioxide after ns laser illumination — •Johannes Graf, Laura Hennemann, Johannes Boneberg, and Paul Leiderer — Fachbereich Physik, Universität Konstanz, Fach M676, 78457 Konstanz

In recent publications we already introduced a new laser based cleaning technique called Matrix Laser Cleaning. In this technique a matrix of an cryogenic solid , e.g. carbon dioxide, is condensed onto the substrate prior to the laser pulse. After ns laser irradiation the subsequent vaporization of the matrix molecules constitutes the dominant cleaning mechanism. By a careful adjustment of the process parameters cleaning down to at least 50 nm sized particles can be achieved with an efficiency close to 100%. In contrast to Steam Laser Cleaning this technique does not face wetting problems or the formation of watermarks.

In this presentation we want to focus on first experiments on the underlying mechanism, the ablation of the cryogenic matrix. Therefore we built a reflectometry and scattering light setup with sub-ns time resolution to investigate the ablation dynamics with a vertical resolution of a few nanometers. By careful analysis of these signals conclusions on the underlying mechanisms can be drawn. The results of ns- and fs-illumination will be compared.

O 17.71 Mon 17:30 Poster C

Steam laser cleaning with infrared pulses — •Pascal Frank, Florian Lang, Paul Leiderer, and Johannes Boneberg — Fachbereich Physik, Universität Konstanz, Fach M676, 78457 Konstanz

Steam Laser Cleaning is a powerful technique for removing very small contaminating particles from sensitive surfaces like Si wafers. The traditional concept of this method is to adsorb a thin liquid film (e.g. water or isopropanol) on the sample surface and then heat the sample with a short laser pulse. Heat transfer from the substrate to the liquid leads to explosive evaporation of the adsorbed film, connected with a removal of the particles. We have investigated here an alternative route by not heating the substrate, but rather the liquid layer directly with an appropriate laser pulse. For this purpose we use an optical parametric oscillator which generates light at 2.94 um, right at the maximum of the OH stretching mode in water and isopropanol. The absorption depth is around 1 micron. First experiments with model contaminants (PS colloid spheres between 200 and 1000nm diameter) show that cleaning of Si as well as glass surfaces is possible, both by irradiation from the front or the back side of the sample. This holds a number of advantages compared to the commonly used technique.

O 17.72 Mon 17:30 Poster C

Combined ab initio quantum-mechanical/molecular-mechanical molecular-dynamic simulations for Si(001) — Jan van Heys and •Eckhard Pehlke — Institut für Theoretische Physik und Astrophysik, Christian-Albrechts-Universität Kiel, 24098 Kiel

There is an ongoing interest in how fast and due to which mechanism surface atomic vibrations decay after an initial excitation by a fs laser-pulse. When such vibrational processes are to be simulated directly by ab initio molecular dynamics, slabs with a thickness of more than 1000 layers become inevitable in order to exclude artefacts due to unwanted back-reflections of phonons from the bottom surface of the slab. In order to carry through such simulations we have implemented a combined quantum-mechanical (for the surface atoms) and molecular-mechanical (for the atomic vibrations sufficiently far away from the surface) molecular-dynamics scheme. One should be extremely cautious, however, when choosing standard empirical potentials for the molecular-dynamics part of the simulation, because slight deficiencies of the empirical potentials to correctly describe the bulk-phonon dispersion may considerably flaw the calculated surface vibrational lifetimes. To circumvent this problem, we suggest to use a simulation with truly ab initio quality by using ab initio force constants up to 8th-nearest neighbors for the molecular-mechanical part of the simulations. Results for Si(001) using slabs with 6400 atoms and simulation times up to 10 ps will be presented.

O 17.73 Mon 17:30 Poster C

Adsorption of molecular hydrogen on SiC(001), Si(001) and C(001) surfaces: An ab-initio investigation — •Xiangyang

Peng, Peter Krüger, and Johannes Pollmann — Institut für Festkörpertheorie, Wilhelm-Klemm-Str. 10, 48149 Münster

In experiment, the exciting observation has been made that H_2 molecules readily adsorb dissociatively on the c(4×2) but not on the 3×2 surface of SiC(001) at room temperature. To unravel this spectacular reactivity difference, we have investigated a variety of H_2 reaction scenarios within density functional theory using the generalized gradient approximation. It turns out that *intradimer* adsorption is unlikely at both surfaces while *interdimer* adsorption depends crucially on the distinct spatial arrangement and dangling-bond topology of the Si dimers at the surfaces. The results clearly reveal barrierless reaction pathways for dissociative H_2 adsorption on the c(4×2) surface as opposed to pathways with significant energy barriers on the 3×2 surface. The latter finding also allows us to explain the inertness of self-organized Si addimer nanolines on the c(4×2) surface to H_2 uptake. To better understand the influence of the surface atomic structure and the dangling-bond topology on H_2 adsorption at group IV semiconductor surfaces, we have investigated the adsorption of H_2 molecules on Si(001) and C(001), as well.

O 17.74 Mon 17:30 Poster C

Adsorption of ethylene and acetylene on the SiC(001)-(3×2) surface — •Jürgen Wieferink, Peter Krüger, and Johannes Pollmann — Institut für Festkörpertheorie, Universität Münster

Most studies on the adsorption of small hydrocarbons on semiconductor surfaces have been focused on Si(001). Here, we present a complementary investigation of the adsorption on the silicon rich SiC(001)-(3×2) surface. This surface is characterized by two partial Si adlayers and a buckled Si dimer in the top adlayer which is remarkably similar to the Si(001) surface dimer.

Ethylene (C_2H_4) only adsorbs in an *on top* position above this dimer. Due to the saturation of the Si dangling bonds the buckling of the Si dimer is removed. Our calculations reveal that a twist in the C-C axis with respect to the Si dimer is energetically slightly favorable. This behavior is well known from C_2H_4 on Si(001) at saturation coverage and has been explained by intermolecular hydrogen Pauli repulsion. The existence of a twist on the more isolated dimers on SiC(001)-(3×2) strongly indicates that also *intra*molecular Pauli repulsion may play a vital role.

Acetylene (C_2H_2), on the other hand, may additionally adsorb on lower adlayers, though also in this case the *on top* structure is energetically favored. We show that *on top* acetylene impedes adsorption of acetylene on other layers due to a shift of the Fermi level. Thus, our studies suggest that the *on top* sites will rapidly become occupied while very high exposures would be needed for further acetylene adsorption.

O 17.75 Mon 17:30 Poster C

UV laser induced desorption of NO from C_{60}/Cu(111) — •Tim Hoger, Daniel Grimmer, and Helmut Zacharias — Universität Münster, Physikalisches Institut, Wilhelm-Klemm-Str. 10, 48149 Münster

The laser induced desorption of NO from an epitaxially grown C_{60}/Cu(111) surface is reported. The pump-probe experiment detects desorbing NO molecules with respect to their rovibrational population and their kinetic energy. Two channels are observed of which the first channel yields highly excited molecules with a rotational temperature of $T_{rot} = 800\,\mathrm{K}$, a kinetic temperature of $T_{kin}/(2k) = 1000\,\mathrm{K}$ and a comparatively low vibrational excitation below $T_{vib} = 600\,\mathrm{K}$. A strong translational-rotational coupling is observed. The second channel yields less excited molecules with a rotational temperature of $T_{rot} = 260\,\mathrm{K}$ and an arrival time spectrum of slow molecules far below the thermal desorption temperature. This desorption is probably caused by a long-lived electronic excitation in the substrate for which a lifetime of $\tau = 155\,\mu\mathrm{s}$ is derived.

O 17.76 Mon 17:30 Poster C

Adsorbate Induced Modifications of SiC Surfaces studied by High Resolution Electron Energy Loss Spectroscopy — Maxim Eremtchenko, Rolf Öttking, Jens Uhlig, Anita Neumann, •Syed Imad-Uddin Ahmed, and Juergen A. Schaefer — Institut für Physik und Institut für Mikro- und Nanotechnologien, Technische Universität Ilmenau, P.O. Box 100565, 98684 Ilmenau, Germany

Silicon carbide (SiC) is a wide band gap semiconductor that is suited for high power, high temperature and high frequency applications in which surface and interface chemical reactivity need to be thoroughly understood. For this material, we are able to monitor changes in carrier concentration profiles and band bendings owing to the C- and Si-terminated cubic and hexagonal SiC as well as vibrational properties of atmospheric adsorbates like, for e.g, oxygen, by comparing HREELS-data with simulations based on dielectric theory. The surface state density is directly related to the type of reconstruction and surface composition and plays an important role in correlation with the substrate temperature. In particular, on 6H-SiC (0001), we observed for the first time new vibrational modes, which can be identified with distinct Si-O-Si vibrations, namely its asymmetric- and symmetric stretching vibrations and its wagging motion. In particular, the energy and intensity of the asymmetric stretching frequency is strongly dependent upon oxygen coverage and substrate temperature, analogous to the situation of initial stage oxidation of Si surfaces.

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O 17.77 Mon 17:30 Poster C

Oxidation of lateral polarity heterostructure GaN — •Pierre Lorenz, Vadim Lebedev, Richard Gutt, Juergen A. Schaefer, Oliver Ambacher, and Stefan Krischok — Institut für Mikro- und Nanotechnologien, TU Ilmenau, P.O. Box 100565, 98684 Ilmenau, Germany

We study GaN-based lateral polarity heterostructures (LPH) for nonlinear optics using surface sensitive techniques. The GaN was grown on Al_2O_3 substrates by molecular beam epitaxy (MBE). The N-face was directly grown on Al_2O_3 whereas the Ga-face was grown on a 20 nm thick AlN nucleation layer structured by photolithography. The examined LPH GaN samples consist of a stripe pattern with a periodicity of 1-100 μm of the N-face and Ga-face domains. The GaN surface properties were studied using atomic force microscopy (AFM), X-ray and ultraviolet photoelectron spectroscopy (XPS, UPS). The samples exhibit smooth Ga-face regions and lower quality N-face areas, separated by sharp and well defined inversion domain boundaries. The changes in the work function and the valence band structure are investigated upon adsorption of oxygen at room temperature. Special attention has been drawn to the interaction of O_2 with the inversion domain boundary region by employing photoelectron emission microscopy (PEEM).

O 17.78 Mon 17:30 Poster C

Au induced faceting of Si (112) surfaces and their relevance for vapour-liquid-solid epitaxy — •Christian Wiethoff, Frank Meyer zu Heringdorf, and Michael Horn-von Hoegen — Universität Duisburg-Essen

Silicon nanowires formed during vapour-liquid-solid (VLS) epitaxy, with Au as a catalyst [1] show sidewalls with [112]-orientations. These sidewalls are faceted and it was suggested that Au is the driving force for the faceting [2]. In order to investigate the influence of the catalyst in more detail, we studied Au induced faceting of [112] surfaces at 750°C with spot-profile-analysing-LEED (SPALEED). After quenching to room temperature the structure and step morphology was determined by reciprocal space mapping [3]. After some different phases of faceting a hill and valley structure with giant facets of [111] and [113] orientation form. They reach height modulations of more than 20nm at a periodic length of about 200nm. We suggest that the facets found on the nanowires consist of these orientations. With further Au adsorption, the [113] facets level off and the surface reaches a stable and reasonably smooth faceting configuration.

[1] J. B. Hannon, S. Kodambaka, F. M. Ross and R.M. Tromp, Nature 440, 04574 (2006)

[2] F. M. Ross, J. Tersoff and M. C. Reuter, Phys. Rev. Lett. 95, 146104 (2005)

[3] Frank-J. Meyer zu Heringdorf and Michael Horn-von Hoegen, Rev. Sci. Instrum. 76, 085102, (2005)

O 17.79 Mon 17:30 Poster C

GIXRD and XRR Studies on Thin Bi(111) Films on Si(001) — •Carsten Deiter[1], Giriraj Jnawali[2], Boris Krenzer[2], Michael Horn-von Hoegen[2], Thomas Weisemoeller[1], Lars Boewer[1], and Joachim Wollschläger[1] — [1]Fachbereich Physik, Universität Osnabrück, Barbarastr. 7, 49076 Osnabrück, Germany — [2]Fachbereich Physik, Universität Duisburg-Essen, Lotharstr. 1, 47057 Duisburg, Germany

Investigating the phenomena of quantum transport and finite-size effects, bismuth has been extensively studied due to its large Fermi wavelength and long carrier mean free path. Its material properties are advantageous for the realization of spin based electronic devices, and result also in large magnetoresistance effects. Here we report on bis-

muth films with a thickness of 6nm investigated by grazing incident x-ray diffraction (GIXRD) and x-ray reflectivity (XRR) measurements.

MBE fabricated samples were examined by AFM and spot profile analysis low energy electron diffraction (SPA-LEED) directly after the growth process. Thereafter the x-ray experiments were performed at the beamlines BW2 and W1 at HASYLAB. Sample A was fabricated at 150K with additional annealing at 450K for 30min (solid phase epitaxy, SPE). Contrary to this two step method the substrate of sample B was kept at a temperature of 300K during the coating and no additional annealing step was performed.

The experimental results show that the deposition method of SPE with its two step process leads to flat films with less roughness than the conventional technique.

O 17.80 Mon 17:30 Poster C

Initial stages of Pt nanowire formation on Ge(001) — •Daan Kockmann, Marinus Fischer, Arie van Houselt, Bene Poelsema, and Harold Zandvliet — Physical Aspects of NanoElectronics & Solid State Physics, MESA+ Institute for Nanotechnology, University of Twente, P.O. Box 217, 7500 AE Enschede, The Netherlands

Recently, the formation of defect- and kink-free Pt nanowires with a cross section of only one atom and lengths up to 500 nm on Ge(001) surfaces was reported. Here we present scanning tunneling microscopy data that reveal the initial stages of the Pt nanowire formation process. Upon room temperature deposition the Pt atoms first dive into the Ge(001) substrate. However, annealing at temperatures of 1000 K or higher causes the Pt atoms to pop up again. The Pt atoms form dimers and are positioned within the troughs between the substrate dimer rows. The Pt-Pt dimer bond is aligned along the substrate dimer bonds. Most of the Pt dimers are found in isolation or units of two dimers. Amazingly the Pt dimers in the trough seem to push both neighboring substrate dimer rows apart, leading to a zipper like structure. In case the concentration of Pt dimers within a trough is sufficiently high, they rotate by 90 degrees and line-up in virtually perfect Pt chains.

O 17.81 Mon 17:30 Poster C

Heteroepitaxial Praseodymium sesquioxide films on Si(111): A future model catalyst system for praseodymium oxide based catalysts — •Andreas Schaefer[1], Thomas Schröder[2], Gregorz Lupina[2], Yulia Borchert[1], Jarek Dabrowski[2], Christian Wenger[2], and Marcus Bäumer[1] — [1]Universität Bremen, Institut für Angewandte und Physikalische Chemie, Leobener Str. 2, 28359 Bremen — [2]IHP-Microelectronics, Im Technologiepark 25, 15236 Frankfurt (Oder)

Rare Earth Oxides (REO) are promising candidates for applications in catalysis based on their high oxygen storage capability and oxygen mobility. In order to look into the atomic details of oxygen transport and transfer of such materials interacting with adsorbed molecules, a simplified two dimensional model system of the generally three dimensional catalyst may be prepared and studied under controlled conditions in an UHV environment. The structure, growth and stoichiometry of heteroepitaxial Pr_2O_3 films on Si(111) were characterized by a combined RHEED, XRD, XPS and UPS study as a prerequisite for any future model catalytic investigations. RHEED and XRD confirm the growth of a (0001) oriented hexagonal Pr_2O_3 phase on Si(111). After an initial nucleation stage RHEED growth oscillation studies point to a Frank-van der Merwe growth mode up to a thickness of approximately 12 nm. XPS and UPS prove that the initial growth of the Pr_2O_3 layer on Si up to 1 nm thickness is characterized by an interface reaction with Si. Nevertheless stoichiometric Pr_2O_3 films of high crystalline quality form on top of these Pr-silicate containing interlayers.

O 17.82 Mon 17:30 Poster C

Electronic Structure of Mn_{12} Derivatives on the Clean and Functionalized Au(111) Surface — •Sönke Voss[1], Mikhail Fonin[1], Michael Burgert[2], Yuriy S. Dedkov[3], Ulrich Groth[2], and Ulrich Rüdiger[1] — [1]Fachbereich Physik, Universität Konstanz, 78457 Konstanz — [2]Fachbereich Chemie, Universität Konstanz, 78457 Konstanz — [3]Institut für Festkörperphysik, Technische Universität Dresden, 01062 Dresden

Single-molecule magnets (SMMs) like Mn_{12}-acetate and its derivatives have attracted much attention due to their unique magnetic properties such as quantum tunneling of magnetization. Up to date, most experiments on Mn_{12} have been performed on bulk material while there are only a few reports on transport properties and electronic structure of individual molecules. Here, we present a study on the electronic structure of monolayers of Mn_{12} SMMs grafted on clean as well as on functionalized Au(111) surfaces. X-ray absorption spectroscopy indicates the fragmentation of the Mn_{12}-core after deposition on clean Au(111). However, resonant photoemission spectroscopy was employed to show that the structural integrity of Mn_{12} clusters can be retained by using an appropriate pre-functionalization of the Au(111) surface. The obtained spectra are in good agreement with previous LDA+U calculations [1]. Scanning tunneling microscopy and spectroscopy measurements confirm the ResPES results for the valence band structure near E_F.

[1] Boukhvalov *et al.*, J. Electron Spectrosc. Relat. Phenom. 137-140, 735 (2004).

O 17.83 Mon 17:30 Poster C

Ab initio calculation of image potential states — •Alexander Hanuschkin, Daniel Wortmann, and Stefan Blügel — Institut für Festkörperforschung, Forschungszentrum Jülich, Germany

Recently image-potential states were investigated using spin-polarized STM. A potential well between metal surfaces with a band gap at the vacuum energy and the image potential creates hydrogenlike states above the surface. Additionally this states exhibit a small spin splitting if the surface is ferromagnetic. DFT calculations with the Greenfunction embedding technique allow to treat surfaces with a semi-infinite substrate. To capture the image potential states the DFT potential has to be modified to include the correct 1/z like asymptotic behavior towards the vacuum. In our scheme this is efficiently done by calculating and adding the correspondent embedding potential for the vacuum. We will present details of the computational scheme as well as results for image potential states of transition metal surfaces.

O 17.84 Mon 17:30 Poster C

Dynamics of laser induced phase transitions of liquids at surfaces — •Sebastian Fischer, Florian Lang, Johannes Boneberg, and Paul Leiderer — Fachbereich Physik, Universität Konstanz, Fach M676, 78457 Konstanz

The phase-transition dynamics of isopropanol films with thicknesses on the order of 100 nm deposited on silicon wafers are investigated. A nanosecond laser pulse is used to heat the substrate. Due to heat transfer, the fluid adjacent to the interface evaporates and the film on top is ejected as an intact liquid layer. The phase transition and the ejection process are monitored by reflectometry with a temporal resolution of about 200 ps and a spatial sensitivity on the nanometre-scale in the direction perpendicular to the substrate.We demonstrate that this approach allows us to determine the generated pressures, the achievable superheating and the relevant timescales of the process and as a consequence provides insight into the nature of the very early stages of the phase transition.

O 17.85 Mon 17:30 Poster C

Transmission increase upon switching of VO2 films on micro-structured surfaces — •Stephen Riedel[1], Ismael Karakurt[2], Johannes Boneberg[1], Paul Leiderer[1], and Richard Haglund[3] — [1]Fachbereich Physik, Universität Konstanz, Fach M676, 78457 Konstanz — [2]Department of Physics, Isik University, Maslak, Istanbul , Turkey — [3]Department of Physics and Astronomy, Vanderbilt University , 6301 Stevenson Center Lane, Nashville TN 37235-1807, USA

Vanadium dioxide is one of the most-studied transition metal oxides due to its reversible thermochromism. It shows a semiconductor-metal phase transition occurring at a critical temperature Tc of 68 oC. The material is a semiconductor below the critical temperature while above Tc it is a metal. The Optical properties of the oxide, as well as the electrical properties, change upon the phase transition. The transmission through VO2 films decreases dramatically in the metallic state in the infrared region. We prepare VO2 films on different substrates (smooth glass substrates and on spherical SiO2 colloidal monolayers) and compare their switching behaviour upon heating with a ns-pulsed Nd:YAG-laser at 532nm. The observed behavior of the films on the two substrates is qualitatively different: while the smooth layers show the expected transmission decrease, the film on the micro-structured surfaces exhibit an increase in transmission when heated. We show that this at first glance unexpected behaviour can be explained by the additional contribution of diffraction which also changes at the phase transitions.

O 17.86 Mon 17:30 Poster C

Dynamics of nanobubble formation around absorbing nanoparticles in liquid — •Stefan Weber, Sebastian Fischer,

Paul Leiderer, Anton Plech, and Johannes Boneberg — 1.Fachbereich Physik, Universität Konstanz, Fach M676, 78457 Konstanz

Nanosecond laserpulses (wavelength of 532nm) are used to illuminate Au nanoparticles of different sizes in aqueous solution. At sufficient high intensities bubbles form around the nanoparticles, expand and collapse again on a time scale of nanoseconds. Time-resolved optical transmission and scattering measurements simultaneously performed at different wavelengths - and especially on both sides of the plasmon resonance of the particles - allow to follow these processes in detail.

O 17.87 Mon 17:30 Poster C

On the freezing and melting of water confined in mesoporous silica thin films investigated by X-ray Reflectivity — •Sandrine Dourdain[1], Heiko Schroeder[1], Markus Mezger[1], Sebastian Schoeder[2], Harald Reichert[1], and Helmut Dosch[1] — [1]Max-Planck-Institute for Metallforschung, Heisenbergstr.3, D-70569 Stuttgart — [2]ESRF, 6 rue Jules Horowitz, F-38000 Grenoble

Since water in nano-scaled pores is involved in many biological systems, it is of paramount interest to probe its behavior in such conditions. We study the solid-liquid phase transition of water when it is confined in mesoporous silica thin films. Templates of mesopores organized in a thin film give the possibility to resolve the electron density profile by X-ray reflectivity on the nanometer scale. Changing the temperature or the size of the mesopores, the density of the confined water, as well as the mechanical deformations of the mesostructure, can be followed during the freezing and the melting transitions. In addition, owing to the possibility to chemically modify the walls of the mesopores, the effect of a varying hydrophilicity is accessible.