O 43: Poster Session II - MA 141/144 (Surface Spectroscopy on Kondo Systems; Frontiers of Surface Sensitive Electron Microscopy; Methods: Scanning Probe Techniques+Electronic Structure Theory+Other; Time-Resolved Spectroscopy of Surface Dynamics with EUV and XUV Radiation; joined by SYNF posters)

Time: Tuesday 18:30–19:30 Location: Poster F

O 43.1 Tue 18:30 Poster F

The Kondo-resonance in photoemission spectra on ordered Ce surface alloys — •Markus Klein[1], Christina Albers[1], Juarez Da Silva[3], Kevin Beach[2], Fakher Assaad[2], and Friedrich Reinert[1] — [1]Universität Würzburg, Experimentelle Physik II, Am Hubland, 97074 Würzburg, Germany — [2]Universität Würzburg, Theoretische Physik I, Am Hubland, 97074 Würzburg, Germany — [3]National Renewable Energy Laboratory, 1617 Cole Blvd., Golden, CO 80401, USA

The physical properties of Kondo systems are determined by interactions between localized f-states and conduction electrons. Of particular interest are low-dimensional systems as they can serve as elementary model systems. Due to its surface sensitivity angle-resolved photoelectron spectroscopy (ARUPS) is an excellent tool to study directly the electronic structure of a two-dimensional Kondo system. This requires highly ordered and ultra thin singlecrystalline films. We have prepared singlecrystalline Ce surface-alloys by *in situ* deposition of Ce on noble metal surfaces. Our ARUPS results show a temperature and wave-vector dependent Kondo-resonance and other hybridization effects. We discuss our spectroscopic results with the help of data from isostructural La films, LDA+U, and DMFT calculations.

O 43.2 Tue 18:30 Poster F

Temperature Dependence of the Single Particle Spectral Function of the 2D Kondo Lattice Model using the Dynamical Cluster Approximation — •Lee Martin and Fakher Assaad — Universität Würzburg, Germany

We apply the dynamical cluster approximation, with a quantum Monte Carlo cluster solver using various cluster sizes, to the two-dimensional Kondo lattice model to investigate the evolution of the conduction electron single particle spectral function as a function of temperature. In the hole doped, paramagnetic metallic phase the problem contains two energy scales: the Kondo temperature, T_K, and the lower scale, the coherence temperature T_{coh}. With decreasing temperature, moving from the local moment to Kondo screened regime, we look for signatures of T_K in the spectral function before finally observing the formation of the coherent heavy fermion state at and below T_{coh}.

O 43.3 Tue 18:30 Poster F

Evidence for quantum confinement in lognormal size distributed nanodiamonds — •Thomas Berg[1], Edit Marosits[2], Jochen Maul[1], Peter Nagel[3], Ulrich Ott[2], Florian Schertz[1], Stefan Schuppler[3], Christa Sudek[2], and Gerd Schönhense[1] — [1]Institut für Physik, Staudingerweg 7, D-55128 Mainz, Germany — [2]Max-Planck-Institut für Chemie, Becherweg 27, D-55128 Mainz, Germany — [3]Forschungszentrum Karlsruhe, IFP, 76021 Karlsruhe, Germany

Quantum confinement (QC) in semiconductor nanoparticles was discovered more than two decades ago and received increasing interest during the recent years. In the case of nanodiamonds evidence for QC was reported by [1], but the discussion on the extend of these effects in nanosized diamonds is still ongoing [2,3,4].

We report on NEXAFS-PEEM measurements of the Carbon K-edge of meteoritic nanodiamonds. The NEXAFS spectrum of this nanodiamond population shows a broadened and asymmetric exciton which was assigned to the particles size distribution in recent publications but a detailed explanation is still missing. We present quantitative analysis of the modified peak shape in respect to energy shifts of the exciton and the onset of the carbon K-edge caused by the well known size distribution of this nanodiamond population as a consequence of QC. This project is supported by DFG (SCHO 341/10-1).

[1] Chang et al., Phys. Rev. Lett. 82, 5377 (1999) [2] Lley et al., Phys. Rev. Lett. 84, 5679 (2000) [3] Pong et al., Phys. Rev. Lett. 84, 5680 (2000) [4] Willey et al., Phys. Rev. Lett. 95, 113401 (2005)

O 43.4 Tue 18:30 Poster F

Setup and Characterization of a Standing-Wave PEEM for EUVL mask inspection — •Jochen maul[1], Jingquan Lin[2], Andreas Oelsner[1], Dima Valdaitsev[1], Nils Weber[3], Matthias Escher[3], Michael Merkel[3], Ulf Kleineberg[2], and Gerd Schoenhense[1] — [1]Institut fuer Physik, Staudinger Weg 7, Johannes Gutenberg-Universitaet, D-55128 Mainz — [2]Ludwig Maximilian-Universitaet, Am Coulombwall 1, 85748 Garching — [3]Focus GmbH, Neukirchner Str. 2, D-65510 Huenstetten-Kesselbach

Extreme ultraviolet lithography (EUVL) is one of the promising possibilities for driving the critical dimensions of semiconductor devices to the ultimate limit. One central issue for chip production using EUVL is the quality of reflective masks with patterned absorbers, employed for the structuring of semiconductor elements. Here, the density and the properties of defects are essential. For multilayer optics, two different types of defects are generally distinguished: amplitude defects and phase defects (or "buried defects") distorting the standing electrical wave inside the multilayer and leading to variations in the field strength at the surface. We show that standing-wave PEEM is a very powerful method as a spatially resolving detector for "at-wavelength (13.5 nm)" metrology. A setup has been designed that allows the study of masks with a size of six square inches. The present detection limit of our method for phase defects is 35 nm.

This work is supported by the European Union (6th Framework program) within the project "Exploring new limits to Moores law- More Moore".

O 43.5 Tue 18:30 Poster F

Optical magnetic circular dichroism in two-photon photoemission — •Kerstin Hild, Jochen Maul, Gerd Schoenhense, and Hans-Joachim Elmers — Institut fuer Physik, Staudinger Weg 7, Johannes Gutenberg-Universitaet, D-55128 Mainz

Magnetic circular dichroism in two-photon photoemission (2PPE) was demonstrated based on frequency-doubled femtosecond laserlight (pulse length ˜150fs). Thin films of Ni2MnGa and Co2FeSi Heusler alloys showed magnetic asymmetries in the integrated photoemission intensity of 0.35% and 0.43%. Thereby, 2PPE was excited by perpendicular incident polarization-modulated light, while the sample magnetization was orientated parallel and antiparallel to the laser beam by an external magnetic field. Asymmetries were measured by a phase-sensitive detection. Furthermore a magnetite thin film was investigated by frequency-tripled laser light in one-photon photoemission showing a magnetic asymmetry of 0.47%, which is much larger than the value 0.08% measured under two-photon-photoemission. The results are compared with earlier work using linearly polarized UV light [1] and circularly polarized laser light [2].

[1] G.K.L. Marx, H.J. Elmers, G. Schönhense, Phys. Rev. Lett. 84 (2000) 5888. [2] T. Nakagawa, T. Yokoyama, Phys. Rev. Lett. 96 (2006) 237402.

O 43.6 Tue 18:30 Poster F

Transmission photoemission electron microscopy for lateral mapping of the X-ray absorption structure of a metalloprotein in a liquid cell — •Daniel Panzer[1], Christian Beck[2], Jochen Maul[1], Marco Möller[2], Heinz Decker[2], and Gerd Schönhense[1] — [1]Institut fuer Physik, Staudinger Weg 7, Johannes Gutenberg-Universitaet, D-55099 Mainz — [2]Institut fuer Molekulare Biophysik, Welderweg 26, D-55099 Mainz

The mechanism of oxygen incorporation in respiratoty proteins is subject of intensive discussion. We use photoemission electron microscopy in an X-ray transmission mode for full-field imaging of the X-ray absorption structure of copper in the respiratory metalloprotein hemocyanin KLH1. It contains 160 oxygen bonding sites. Each site reversibly binds one molecule oxygen between two copper atoms. In our setup, hemocyanin is dissolved in aqueous solution and enclosed in an ultra-high vacuum compatible liquid sample cell with silicon nitride membranes. The local X-ray absorption structure of the liquid sample is converted into photoelectrons at the microscope side of the cell acting as a photocathode. In this way, different copper valences are laterally distinguished under in vivo-like conditions, attributed to Cu(I) in the deoxy-state and Cu(II) in the oxy-state.

This project was funded by the DPG (SCHO 341/7).

O 43.7 Tue 18:30 Poster F

Time and energy resolved mulitphoton-photoemission microscopy of organic materials — •Florian Lindla, Gerhard Lilienkamp, and Winfried Daum — Institut für Physik und Physikalische Technologien, TU Clausthal, Leibnizstraße 4, 38678 Clausthal, Germany

Polystyrene (PS) microspheres and PS films on oxidized Pt surfaces were investigated by a photoemission-electron-microscope (PEEM) with 400nm (3.1eV) fs laser excitation. For pump-probe measurements the illumination system was equipped with a delay-line consisting of thin film polarizer plates as beam splitter/combiner.

Energy resolved measurements on PS microspheres (300nm in diameter) resulted in an energy distribution showing one peak, which slightly shifts to higher electron energies at higher laser intensities.

For further investigation first time resolved measurements were performed on an oxidized Pt surface with partial PS coverage (around 100nm thickness), revealing the expected 2-photon-photoemission (2PPE) signal for the Pt substrate, while the signal of the PS coating is independent of probe delay, presumably due to an highly filled intermediate state proposed before.

O 43.8 Tue 18:30 Poster F

Characterization of W-Tips used in Tuning-Fork Non-Contact Atomic Force Microscopy by Field Ion Microscopy — •Daniel-Alexander Braun[1], Jens Falter[1,4], Thomas König[2], André Schirmeisen[1,4], Hendrik Hölscher[4], Udo D. Schwarz[3], and Harald Fuchs[1,4] — [1]Institute of Physics, University of Münster, Münster, Germany — [2]Fritz-Haber-Institut der Max-Planck-Gesellschaft, Berlin, Germany — [3]Department of Mechanical Engineering, Yale University, New Haven, CT, USA — [4]Center for Nanotechnology (CeNTech), University of Münster, Münster, Germany

The atomic force microscope (AFM) is capable to image surfaces with atomic resolution. However, the interpretation of the atomic scale contrast is often difficult and inconclusive. This deficiency is partly caused by the unknown structure of the probing tip, as the chemical interaction between tip and surface and therefore the image contrast is largely determined by the exact configuration of the tip apex. Field ion microscope (FIM) images, on the other hand, enable a complete reconstruction of the atomic geometry of a sharp metallic tip. In this work, we present a special tip holder which can be used in both our home-built AFM and FIM. This combination allows to characterize the exact atomic structure of both interaction partners, the sample and the tip. First results are presented, where the apex radii of electrochemically etched tungsten tips are determined by FIM and subsequently correlated to force distance curves.

O 43.9 Tue 18:30 Poster F

Self-actuating self-sensing cantilever for dynamic AFM — •Henning von Allwörden, Alexander Schwarz, C. Julian Chen, and Roland Wiesendanger — Institute of Applied Physics, University of Hamburg, Jungiusstraße 11, 20355 Hamburg

Conventional AFM force sensors consist of a flexible cantilever beam made from silicon. For operation in the dynamic mode they are actuated by a driver piezo. Common methods for detection of the cantilever oscillation are optical techniques like beam deflection or interferometry. Hence, force sensor, its actuation and its detection are three separated devices. Combining them into a single device would make AFM instruments much simpler in design and handling. The qPlus sensor [1] is a tuning fork based on z-cut quartz. One arm is glued to a substrate, the other serves as a cantilever. The cantilever oscillation is detected by utilizing the piezoelectric effect of quartz via a pair of electrodes. However, excitation is still done externally. Furthermore, these sensors have large spring constants, resulting in a low force sensitivity. It is not possible to choose from a large variety of spring constants and resonance frequencies. Our idea is to place two pairs of electrodes, one for actuation and one for detection on a cantilever made from a single piece of x-cut quartz. Hence, we would have a self-actuating self-sensing cantilever [2]. Eigenfrequency and spring constant can be adjusted by choosing appropriate dimensions. The general concept of this sensor will be discussed and properties of prototypes will be presented.

[1] Giessibl, Appl. Phys. Lett. **73**, 3956 (1998)
[2] patent pending

O 43.10 Tue 18:30 Poster F

Strategies for measuring interfacial friction by lateral manipulation of nanoparticles using atomic force microscopy techniques — •T. Mönninghoff[1], D. Dietzel[1,2], L. Jansen[1,3], H. Fuchs[1,2,3], U. D. Schwarz[4], and A. Schirmeisen[1,2] — [1]Institute of Physics, University of Münster, Germany — [2]Forschungszentrum Karlsruhe (FZK), Germany — [3]Center for Nanotechnology (CeNTech), University of Münster, Germany — [4]Department of Mechanical Engineering, Yale University, New Haven, CT, USA

A promising approach for quantifying interfacial friction is to measure lateral forces during the manipulation of nanoparticles with the atomic force microscope. This technique allows addressing many current issues in the field of nanoscale friction, like the influence of contact size and interface crystallinity, which are not fully accessible with conventional friction force microscopy. We present different manipulation strategies that have been developed to either enable the defined and repeated manipulation of single nanoparticles or to gather statistical data on a larger ensemble of particles found within a particular scan area. Especially the latter approach allows fast and statistically significant data. In all cases, the particle-surface interfacial friction can be extracted from the additional torsional signal of the cantilever during the pushing process in contact mode operation [1]. As a model system for the demonstration of the different manipulation strategies, antimony nanoparticles with different diameters and crystallinity grown on a HOPG substrate have been chosen. [1] Dietzel et al., J. Appl. Phys.102, 084306 (2007)

O 43.11 Tue 18:30 Poster F

Design of an UHV-STM for applications at low temperatures and high magnetic fields — Daniel Haude[1], •Matthias Menzel[1], Kirsten von Bergmann[1], Matthias Bode[2], and Roland Wiesendanger[1] — [1]Institute of Applied Physics, University of Hamburg, Germany — [2]Center for Nanoscale Materials, Argonne National Laboratory, USA

We constructed a Scanning Tunneling Microscope (STM) for spin-polarized studies of magnetic adatoms on metallic surfaces. This STM is mounted in a commercial ^{3}He-Flow-Cryostat, which allows measurements in UHV conditions and at a magnetic field up to 9 T perpendicular to the sample. With ^{4}He in the gas loop we already reached a temperature of 1.16 K leading to an estimation of a temperature of 700 mK with ^{3}He in the cycle. Since the STM is fixed at the bottom of the cryostat insert, tip and sample are transferred without visibility using a magnetic drive for linear and rotary motions. The cryostat is mounted via a transfer chamber to an existing UHV system which has been described elsewhere [1].

Tips and samples can be transferred throughout the pre-existing UHV system thus allowing us to investigate the same samples with different STM's. With an electron beam evaporator we can deposit different magnetic materials onto the cold substrate enabling studies of magnetic properties of single atoms or clusters of few atoms.

[1] O. Pietzsch *et al.*, Rev. Sci. Instrum. **71**, 424 (2000)

O 43.12 Tue 18:30 Poster F

Einfluss der elektronischen Struktur der Tunnelspitze auf spektroskopische Messungen — •Oliver Ferdinand, Kirsten von Bergmann, André Kubetzka, and Roland Wiesendanger — Institut für Angewandte Physik, Universität Hamburg, D-20355 Hamburg

Die Raster-Tunnel-Spektroskopie (RTS) misst die lokale differentielle Leitfähigkeit. Diese ist bei kleinen Spannungen in erster Näherung proportional zur lokalen Zustandsdichte (LDOS) beider Elektroden, Probe und Tunnelspitze, und mathematisch eine mit dem Transmissionskoeffizienten gewichtete Faltung beider LDOS. Gerade wenn der relevante Bereich um das Fermi-Niveau E_F konzentriert ist, wie z.B. bei Kondo-Systemen oder inelastischen Prozessen, wirken sich daher Oberfläche und Spitze in gleichem Maße auf die gemessenen Spektren aus, so dass eine möglichst strukturlose LDOS der Tunnelspitze erforderlich ist.

Es wird gezeigt, dass sich verschiedene Spitzen-Materialien unterschiedlich auf die Spektren auswirken. Dazu wurden Wolfram, Iridium und Gold verwendet und sowohl in-situ als auch ex-situ [1] Präparationsverfahren ausprobiert.

[1] A. J. Melmed, J. Vac. Sci. Technol. B **9**, 601 (1991)

O 43.13 Tue 18:30 Poster F

Spin-dependent Image Potential States Studied By SP-STS — •Anika Emmenegger, Stefan Krause, Gabriela Herzog, André Kubetzka, Daniel Haude, and Roland Wiesendanger — Institute

of Applied Physics, University of Hamburg, Germany

An electron approaching a metal surface feels the attractive force of the polarization charge it induces in the surface region of the solid. If the surface has a band gap near the vacuum level, the electron gets trapped by its own image, confined by the surface on the one side and the slowly decaying Coulombic potential on the other side. These image-potential induced surface states (IPS) form a Rydberg-like series close to the vacuum level. Though located relatively far away from the surface, they are still sensitive to the local elctronic, atomic and magnetic surface structure.

Consequently, spin-polarized scanning tunneling spectroscopy (SP-STS) of IPS allows to investigate the magnetic surface properties on a local scale but at tip-sample distances larger than in normal tunneling experiments, thereby reducing the probability of accidental tip-sample collisions [1]. However, STS performed by commercial scanning tunneling microscopes (STM) is usually limited to a maximum bias voltage of 10V. Going beyond this limit we are able to investigate spin-dependent IPS of higher order at further increased tunneling distances.

First measurements in a high voltage regime will be presented and discussed.

[1] A. Kubetzka *et al.*, Appl. Phys. Lett. **91**, 012508 (2007).

O 43.14 Tue 18:30 Poster F

Signature of a nanoparticle in the evanescent heat transfer measured by NSThM — •Uli F. Wischnath, Joachim Welker, and Achim Kittel — Univ. Oldenburg, Energy and Semiconductor Research, D-26129 Oldenburg, Germany

The Near-field Scanning Thermal Microscope (NSThM) allows the investigation of the heat transfer by evanescent fields in the direct vicinity of a sample that is at a distance between 1 and 100 nm. It is based on a variable-temperature ultra high vacuum scanning tunneling microscope (VT-UHV STM) with a probe designed as a thermocouple in order to measure thermal properties. The STM abilities of the microscope are used for the spatial control of the temperature probe.

For the work presented here nanoparticles were deposited on a flat surface by dip coating and scanned with the NSThM in constant current mode. They show a typical feature in the heat transfer image: higher values compared to the one on the flats are surrounding the particles whereas right on top of the particle the values are lower than the ones on the flats.

These findings might be explained by calculations which have been made by theoreticians for a similar case: A maximum in the heat transfer is found for a sphere (representing the probe) scanned in a constant height over a surface with a sphere on top at the position where the two spheres start to overlap.

O 43.15 Tue 18:30 Poster F

Dynamic Force Microscopy: Fundamental mechanism of energy dissipation for organic molecules — •Markus Fendrich[1], Kai Ruschmeier[2], Christian Weiss[1], Manfred Lange[1], Tobias Kunstmann[1], André Schirmeisen[2], and Rolf Möller[1] — [1]Fachbereich Physik, Universität Duisburg-Essen, D-47048 Duisburg — [2]CeNTech Center for NanoTechnology, Heisenbergstr. 11, D-48149 Münster

In frequency modulation atomic force microscopy (FM-AFM), the damping signal reveals information about energy dissipation processes within the tip-sample system with high lateral resolution.[1] However, the mechanisms of energy dissipation are still not fully understood; especially for organic molecular systems, few results have been achieved so far. We present experimental data on the topography and dissipation of 3,4,9,10 perylene-tetracarboxylic dianhydride (PTCDA) on Ag(111). The molecules are known to form stable islands at submonolayer coverage.[2] We achieved molecular resolution in the topography and the damping signal alike. The damping signal of the PTCDA molecules shows a sub-molecular contrast, revealing two peaks at the ends of each molecule. The origin of this dissipation signal is still under debate; a tip-induced switching of the functional groups of each molecule might act as a channel for energy dissipation.

[1] S. Morita et al., Noncontact Atomic Force Microscopy, Springer (2002) [2] K. Glöckler et al., Surf. Sci. 405, 1 (1998)

O 43.16 Tue 18:30 Poster F

Development of an UHV variable temperature STM — •Thomas Eelbo, Mike Gyamfi, Stefan Meckler, Oswald Pietzsch, and Roland Wiesendanger — Institute of Applied Physics and Microstructure Advanced Research Center Hamburg, University of Hamburg, Jungiusstraße 11, 20355 Hamburg, Germany

The design of a new VT-STM is presented together with a numerical simulation for the temperature behaviour of the system. The microscope will be installed into a two chamber ultra high vacuum system for studying local electronic and magnetic states of self-assembled nanostructures at atomic length scale.

The microscope is equipped with an inertial drive for Slip-Stick based tip-coarse approach. A mechanism for in-situ tip and sample exchange has been integrated, being crucial for spin polarized experiments using magnetically coated tips.

During the development of the microscope special attention was paid on the minimization of the base temperature. Therefore a numerical simulation was written, which describes the thermal anchoring of various parts to the flow cryostat and the chamber system.

O 43.17 Tue 18:30 Poster F

A New Scanning Tunneling Microscope for Spin-Sensitive Measurements in Ultrahigh Vacuum, at Low Temperatures, and in High Magnetic Fields — •Mike Gyamfi, Stefan Meckler, Oswald Pietzsch, and Roland Wiesendanger — Institute of Applied Physics and Microstructure Advanced Research Center Hamburg, University of Hamburg, Jungiusstrasse 11, 20355 Hamburg, Germany

To study the spin dependent local electronic structure of single magnetic nanowires and nanoislands a new scanning tunneling microscope with spin sensitivity has been developed.

The microscope is operated in a liquid helium bath cryostat with a base temperature of 5K and a superconducting magnet that provides a magnetic field in arbitrary direction to the sample. It is equipped with an inertial drive for tip coarse approach and an additional one for sample rotation. The latter one allows the preparation of samples directly in the microscope at cryogenic conditions. Furthermore, a tip exchange mechanism has been integrated that enables spin dependent measurements with magnetically coated tips.

The microscope, the ultrahigh vacuum system with the magnet cryostat, and first measurements are presented to demonstrate the functionality of the recently installed system.

O 43.18 Tue 18:30 Poster F

Interferometric detection methods for scanning near-field optical microscopy — •Christoph Zeh, Susanne C. Schneider, and Lukas M. Eng — Institute of Applied Photophysics, TU Dresden, D-01062 Dresden

Scanning near-field optical microscopy (SNOM) is a scanning probe technique which allows optical examination of nanostructures with a resolution ways below the classical diffraction limit. Hence, it finds many applications in nano science. Basically, there are two types of SNOM: the aperture-type, utilizing a tapered optical fibre for local illumination and/or detection, and the (apertureless) scattering type, in which light is scattered from a small particle, e.g. an AFM tip. Both types suffer from weak signal strengths, due to coupling losses at the fibre tip, or due to the small scattering cross sections. In order to amplify the optical near field signal, detection systems based on heterodyne or homodyne interferometry are very appropriate. Furthermore, the heterodyne detection method allows us to separate the near field's optical amplitude and phase, since the near-field signal is compared with a well known, but frequency shifted, reference signal. In this work we compare interferometric detection schemes with respect to their resolution limit and signal-to-noise ratio, for both free-beam version as well as fibre-based version.

O 43.19 Tue 18:30 Poster F

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

Eddy current microscopy (ECM) provides a unique method to gain qualitative insight into the local electrical conductivity of nano structures. ECM is based on the well established method of non-contact scanning force microscopy. The basic principle is as follows: Either the time-dependent magnetic field of an oscillating magnetic probe induces eddy currents within conducting materials or the magnetic stray fields of magnetic domains induce eddy currents within a conducting probe. In any case, the induced currents lead to an electrodynamic interaction between the probe and the sample. Therefore, the oscillation of the probe is damped according to Lenz's rule, leading to a contrast in either the phase or in the damping signal. This technique, thus, provides standard force microscopy with a material sensitive contrast in addition to the conventional topography signal. Since not much

is known yet about the experimental limitations of the technique, we used several reference samples such as magnetic recording tapes, conducting wires written by e-beam lithography, and SNOM samples. The latter samples offer the advantage of a high difference in conductivity. We will present results from ex situ as well as from in situ measurements. The method will be applied to nanostructured samples such as thin films and metallic islands on silicon, in order to characterize the influence defects and size effects on the resistivity.

O 43.20 Tue 18:30 Poster F

High-Resolution Combined Low-Temperature Scanning Tunneling/Atomic Force Microscope for 3D Force Spectroscopy — Boris J. Albers[1], Todd Schwendemann[1], Mehmet Z. Baykara[1], Nicolas Pilet[1], •Marcus Liebmann[1], Markus Heyde[2], and Udo D. Schwarz[1] — [1]Deptartment of Mechanical Engingeering, Yale University, New Haven, USA — [2]Lawrence Berkeley National Laboratory, University of California, Berkeley, USA

We present the design and first results from a new home-built low-temperature scanning probe microscope enabling high-resolution experimentation in both scanning tunneling microscopy (STM) and non-contact atomic force microscopy (NC-AFM) modes. An exchangeable tuning fork based Q-plus style sensor is used to allow for flexibility in choosing probe tip materials. The system features an on-top cryostat, where the microscope is enclosed in a double set of thermal shields. Tip as well as sample can be changed in-situ at low temperatures to keep turn-around times low. By opening the front shutters of the shields, unrestricted access from dedicated flanges permits the direct deposition of molecules or atoms on either tip or sample while they remain cold. As examples for the microscope's performance, we present data measured on Cu(111) in STM mode as well as on graphite in NC-AFM mode, featuring atomic resolution with corrugations of 4-5 pm and corrugations below 1 pm could be measured. In addition, atomic resolution data obtained by means of three-dimensional force spectroscopy is shown.

O 43.21 Tue 18:30 Poster F

Energy dissipation of ballistic injected electrons and holes through individual molecules — •Alexander Bernhart[1], Mark Kaspers[1], Bastian Weyers[1], Evgeny Zubkov[1], Christian Bobisch[2], and Rolf Möller[1] — [1]Department of Physics, University of Duisburg-Essen, 47048 Duisburg, Germany — [2]University of California, Irvine, USA

Ballistic Electron Emission Microscopy (BEEM) not only represents an ideal technique to study the electronic transmission at the Schottky-interface between a metal and a semiconductor, but moreover it allows to analyze the ballistic transport through adsorbates on top of a metal. Bismuth (Bi) films with a thickness of 3-4nm were grown on n-doped and p-doped Si(100) and Si(111). Recently we could analyze the ballistic transport of electrons through two different molecular adlayers, PTCDA and C_{60}, deposited on top of the Bi film. In addition the ballistic transport of holes through an adlayer of C_{60} was studied. All experiments were performed by a modified "Nanoprobe"system (Omicron) providing four STM units which may be operated independently on the same sample. In this case one STM unit was used to contact the metal layer, and other one is operated as a conventional STM at negative or positive tip bias, hence injecting electrons or holes into the sample surface.

O 43.22 Tue 18:30 Poster F

surface velocity of shear quartzes for high speed friction measurements — •fengzhen zhang[1], othmar marti[1], stefan walheim[2], and thomas schimmel[2] — [1]Uni Ulm — [2]Uni Karlsruhe/FZK

Investigations of the friction properties with the relative low speeds(micrometer/s) have been carried out with Atomic Force Microscopy(AFM). Technologically relevant friction processes operate at speeds of several m/s. Due to the limitation of the piezo scanners in standard AFM, a new oscillation setup is required for the microscopic research on high speed friction. We have measured the surface velocity of shear quartzes. In this presentation we show the calibration setup and results of the surface speed for 3MHz quartzes. We discuss the influence of surface inhomogeneities on the accuracy of the velocity measurement. As a first application we present friction measurements obtained on structured films deposited on shear quartzes.

O 43.23 Tue 18:30 Poster F

Scanning tunneling microscopy measurements of graphene on an insulating substrate. — •Viktor Geringer[1], Sven Runte[1], Marcus Liebmann[1], Tim Echtermeyer[2], Reinhard Rückamp[1], Max Lemme[2], and Markus Morgenstern[1] — [1]II. Physikalisches Institut, RWTH Aachen and JARA-FIT, Otto-Blumenthal-Straße, 52074 Aachen — [2]Advanced Microelectronic Center Aachen (AMICA), AMO GmbH, Otto-Blumenthal-Str. 25, 52074 Aachen

We present scanning tunneling microscopy (STM) measurements of single and few layer graphene examined under ultrahigh vacuum conditions. The samples were prepared on a silicon dioxide surface by mechanical exfoliation of a graphite crystal and contacted by depositing gold electrodes around the graphene flake. An instrumental challenge in STM investigations of small graphene flakes is the tip positioning with respect to the sample. We solved this technical problem by using an optical long-distance microscope and a x-y-positioning drive for the STM sample stage. A lateral pre-positioning precision of 5-10 μm has been achieved.

We show atomically resolved and large-scale topographic images of the graphene surface as well as first scanning tunneling spectroscopy (STS) results.

O 43.24 Tue 18:30 Poster F

A UHV-STM system for measurements at 300 mK and 14 T — •Stefan Becker, Marcus Liebmann, and Markus Morgenstern — II. Physikalisches Institut B, RWTH Aachen and JARA-FIT, Otto-Blumenthal-Straße, 52074 Aachen

We have designed an ultrahigh vacuum (UHV) system featuring a homebuilt scanning tunnelling microscope (STM) inside of a 300 mK cryostat with a 14 T solenoid magnet exhibiting a single-shot time of 100 h. Two independent chambers hold various instruments for sample and STM tip preparation, including sample heaters, a sputter gun, evaporators and a combined LEED/Auger system. The STM body is compact and rigid (Ø 30 mm) for stability and high resonance frequencies. It has an *in situ* tip exchange mechanism and a sample positioning stage. The whole system is supported by air damping legs inside an acoustically insulating room.

O 43.25 Tue 18:30 Poster F

Development of TERS System with Scanning Capability — •Seth White, Dietrich Wulferding, Alexander Doering, Hongdan Yan, Pushpendra Kumar, and Peter Lemmens — IPKM, TU-Braunschweig

The combination of Tip-Enhanced Raman Spectroscopy with real-time surface characterization in one experimental setup shows great promise as a method for precise local measurement of spatially confined systems. After employing an AFM with an etched [1] nano-apex scanning tip made of Ag or Au[2] to gain structural information one can immediately use the same tip to substantially increase Raman activity at a particular point of interest. Single molecules trapped near the surface of nano-porous oxidized silicon and alumina can be investigated using this finely tunable, highly directed approach.

O 43.26 Tue 18:30 Poster F

Use of a "needle-sensor" for non-contact scanning force microscopy and simultaneous measurement of the tunneling current — Bert Voigtländer[1] and •Irek Morawski[1,2] — [1]Institute of Bio- and Nanosystems (IBN 3), and cni – Center of Nanoelectronic Systems for Information Technology, Research Centre Jülich, 52425 Jülich, Germany — [2]Institute of Experimental Physics, University of Wrocław, pl. Maxa Borna 9, PL 50-204 Wrocław, Poland

A simultaneous measurement of forces and tunneling current during imaging of surfaces is of great interest. We present AFM/STM images of graphite and metal surface obtained by means of the quartz needle-sensor with an attached tungsten tip at ambient conditions. The needle sensor is an extensional mode quartz oscillator operating at a frequency of 1 MHz and one is similar to a tuning fork sensor more frequently used in scanning force microscopy. This sensor has been operated with a phase locked loop (PLL) control extended with an additional electronic circuit, namely an attenuator, two band-pass amplifier stages, providing both: sub-angstroms mechanical oscillation amplitude and high signal/noise ratio. Dependences of the frequency shift against a tip-surface displacement measured for mentioned surfaces are presented. A "feedback circuit enabled"method of a calibration of the needle-sensor vibration amplitude is proposed and discussed.

O 43.27 Tue 18:30 Poster F

Construction of a Fibre-Tip SNOM for Investigation of

Soft Organic Materials — •Philipp Lange[2], Omar Al-Khatib[1], Dörthe M. Eisele[1], Mario Dähne[2], Jürgen P. Rabe[1], and Stefan Kirstein[1] — [1]HU-Berlin, Institut für Physik, Newtonstr. 15, 12489 Berlin — [2]TU Berlin, Institut für Physik, Hardenbergstr. 36, 10623 Berlin

The setup of a fibre-tip scanning near field optical microscope (SNOM) is presented that was specially designed for the investigation of soft organic materials in air providing low tip-sample interaction, low thermal drift, and high topographic resolution. For topographic scanning the shear force of a fibre probe is detected. For this a tapered glass fibre probe is mounted on a tuning fork piezo which is forced to oscillate above the resonance frequency. The phase shift induced by the tuning fork is taken as a sensitive signal for damping of the tip oscillation due to tip-sample interaction and used for distance control. A dye laser is coupled into the fibre for near field optical excitation of the sample. The scanning unit is mounted on top of an inverted fluorescence microscope that allows comfortable adjustment and micro-positioning of tip and sample, preselection of scan areas of prior interest, and very efficient far-field detection of the luminescence. First images of fluorescent nano-particles and dye aggregates on solid surface are presented.

O 43.28 Tue 18:30 Poster F

The nanoscale electrochemical potential of a current carrying surface state resolved with Scanning Tunneling Potentiometry — •Jan Homoth[1], Martin Wenderoth[1], Thomas Druga[1], Lars Winking[1], Rainer G. Ulbrich[1], Mark Kaspers[2], Alexander Bernhart[2], Bastian Weyers[2], Evgeny Zubkov[2], Rolf Möller[2], and Christian Bobisch[3] — [1]IV. Physikalisches Institut, Georg-August-Universität Göttingen — [2]University of Duisburg-Essen, Department of Physics, Duisburg, Germany — [3]University of California, Irvine, USA

Charge transport through the surface state of the $Si(111)\sqrt{3}\cdot\sqrt{3}-Ag$ surface has been investigated with a lateral resolution of Angstroms. Across line defects like monatomic terrace steps the electrochemical potential $\mu_{ec}(x,y)$ varies strongly. Transport across such defects occurs as tunneling through a quantum mechanical barrier. We demonstrate that the variation in μ_{ec} responds linearly to the applied current density and does not depend on the local current direction. Furthermore, the variation of μ_{ec} does not coincide with the topography data: A lateral shift is observed and the widths differ. Using a variety of tip configurations we analyze the experimental widths and lateral shifts in detail. Comparing these results with STM-calculations, we conclude that the change of μ_{ec} is unaffected by tip convolution artefacts and cannot be described with a step-like change in μ_{ec}. A qualitative model describing the spatially dependent electron distribution and the variation of μ_{ec} is derived, extending the early approach of Datta. This work was supported by the DFG, SFB 602 Tp A7.

O 43.29 Tue 18:30 Poster F

Analyzing and determination of the different shear force interactions — •Kai Braun, Catrinel Stanciu, Dai Zhang, and Alfred J. Meixner — Institut für Physikalische und Theoretische Chemie, Auf der Morgenstelle, 72076 Tübingen

Shear-force feedback is among the most common used mechanisms for distance control in scanning near-field optical microscopes (SNOM). A reliable SNOM measurement requires extremely precise tuning of the distance between the tip and the sample. Although being widely used, the nature of the shear-force interaction is still not fully understood. The oscillating probe is usually modelled as a driven harmonic oscillator, influenced by different forces due to the interaction of the tip with the sample. We present here an extensive study of this interactions for different combinations of substrates (Au, Si, HOPG and glass) and tips (Au, W and glass). We measured the amplitude and phase of the tip oscillation as a function of the tip-sample distance in the non-contact range. The measurements allow us to distinguish the different forces between the tip and the substrate. The dominating nature of the interactions strongly depends on the material of both the tip and the substrate and also with the distance. In particular, gold tips on gold samples, of actual interest in tip-enhanced microscopy, undergo mainly elastic interaction for larger distances, with an attractive component evident for smaller distances. These results can help for a better understanding of optical near-field measurements, in particular for avoiding artefacts when measuring heterogeneous samples.

O 43.30 Tue 18:30 Poster F

Design of a vacuum system for the local study of molecules — •Matthias Prostak, Germar Hoffmann, and Roland Wiesendanger — Institute of Applied Physics, University of Hamburg

Molecules are a fascinating class of materials and have a large potential impact for the design of novel, molecule-based devices. One major advantage is the possibility of low temperature preparation in industrial processes. Therefore, the precise control of growth parameters is relevant for the preparation of clean and homogeneous molecular structures.

Here, we will present the design of a new, very versatile and compact vacuum system for such a preparation study. The vacuum system is equipped with a scanning tunneling microscope, a LEED optics and an Auger spectrometer for surface analysis. In this vacuum system, flexible exchange of molecule evaporators through the load-lock and the preparation of metal-insulator-molecule sandwiches is possible. Since commercially available samples of molecules are often not sufficiently clean for high-quality investigations, the vacuum system is additionally equipped with an extra side chamber to degas molecular samples for purification over several hours and days. We will discuss the design and the first realization.

O 43.31 Tue 18:30 Poster F

Towards a quantitative determination of charge distribution and local potential by Phase-Electrostatic Force Microscopy: theory and applications — •Cristiano Albonetti, Paolo Annibale, and Fabio Biscarini — CNR-Institute for the Study of Nanostructured Materials (ISMN), Bologna, Italy

The cantilever phase signal of the atomic force microscope, in conjunction to lift-mode operation, is used to map the electrostatic interaction between the cantilever's tip and the sample with a lateral resolution less than 50 nm. The detection of the phase, sensitive to tip-sample force gradient, allows to gain a higher resolution with respect to more conventional electrostatic probes based on force detection. Relevant organic and inorganic samples, with well-defined morphology, were measured by modeling the tip-sample electrostatic interaction in the prolate spherical coordinates reference system. Layered α-sexithiophene ultra-thin films grown on Si/SiO_x substrate show a monotonic decrease of the local surface potentials with the increase of the surface coverage, consistently with the predicted confinement at the first few monolayers of the charge accumulation layer (organic sample). Silicon oxide nano-stripes, made by scanning probe lithography, show a variable electrostatic contrast due to a different amount of charges trapped in the oxide, thus yielding significant information about the mechanism of the oxidation process (inorganic sample). The application of this technique to operating thin film organic field effect transistors allows to correlate local surface potential with the morphology of the transistor channel.

O 43.32 Tue 18:30 Poster F

Design criteria for scanning tunneling microscopes to reduce the response to external disturbances — •Maximilian Assig[1], Alexandra Ast[2], Christian R. Ast[1], and Klaus Kern[1] — [1]MPI für Festkörperforschung, Stuttgart, Germany — [2]ITM, Universität Stuttgart, Germany

In a scanning tunneling microscope (STM) the tip-sample distance is the crucial aspect of the measurement process as the tunneling current depends on it exponentially. Since it is *a priori* impossible to distinguish in the tunneling current the actual signal from external disturbances, care must be taken to isolate the measurement setup as effectively as possible from the outside environment. Here we present an approach to reduce the response of the tip-sample distance to external disturbances, which are unwanted in the tunneling current. The idea is to optimize the design of the STM itself, so that the response of the tip and the sample to external disturbances is minimized. A design criterion has been developed based on experimental measurements of the tip-sample transfer function as well as a simple theoretical model.

O 43.33 Tue 18:30 Poster F

The x-ray experimental endstation of beamline BL9 at DELTA — •Michael Paulus, Christian Sternemann, Christina Krywka, Andreas Schacht, and Metin Tolan — Experimentelle Physik I/DELTA, Technische Universität Dortmund, Maria-Goeppert-Mayer Str.2, 44221 Dortmund, Deutschland

The Dortmund Electron Accelerator DELTA is a synchrotron radiation source located at the TU Dortmund, Germany, and is operated a 1.5 GeV with a maximum electron current of 120 mA and lifetimes of about 10 hours. The beamline BL9 is attached to a superconducting asymmetric wiggler which supplies radiation in the energy range be-

tween 4 keV and 30 keV. The incident radiation is monochromatized by means of a Si (311) double crystal monochromator with sagittally bend second monochromator crystal. The experimental endstation of BL9 is equipped with a Huber six-circle diffractometer and is dedicated to (grazing incidence) x-ray diffraction and x-ray reflectivity studies on solid surfaces, thin films and liquid - solid interfaces. Recently, the end station was extended to perform small and wide angle x-ray scattering experiments making use of an image plate scanner. Moreover, a spectrometer in Rowland geometry is accessible to perform resonant inelastic x-ray scattering experiments.

O 43.34 Tue 18:30 Poster F

Positron annihilation induced Auger electron spectroscopy on Si single crystals — •Jakob Mayer[1], Klaus Schreckenbach[1,2], and Christoph Hugenschmidt[1,2] — [1]Technische Universität München, Physikdepartment E21, James-Franck-Str., 85748 Garching — [2]ZWE FRM II, Lichtenbergstr.1, 85747 Garching

Positron annihilation induced Auger electron spectroscopy (PAES) is a powerful technique for the element selective investigation of surfaces. Due to the different hole creation process compared to conventional EAES, i.e. ionisation by means of positron electron annihilation instead of collision, the impact energy of the positrons can be chosen very low and hence the secondary electron background ends at this low energy. Furthermore only the topmost atomic layer is examined, due to the positron diffusion back to the surface. The main challenge in PAES is the low positron current, which is on the order of pA. Even at the high intensity positron source NEPOMUC at the FRM II the measurement times are on the order of hours. In order to reduce the acquisition time a new electron energy analyser with a higher efficiency has been installed. First measurements on polycrystalline Cu and Si single crystals will be presented and compared to previous measurements.

O 43.35 Tue 18:30 Poster F

Order-N scaling of the Full-potential Linearized Augmented Plane Wave method — •Frank Freimuth, Daniel Wortmann, and Stefan Blügel — Institut für Festkörperforschung, Forschungszentrum Jülich, 52425 Jülich, Germany

Density functional theory codes based on the Full-potential Linearized Augmented Plane Wave (FLAPW) method have been highly successful due to their generality and wide applicability. In particular, in the field of surfaces, open structures and complex magnetic materials with many chemical elements, the FLAPW method sets the standart for precision among the *ab initio* methods. On the other hand, the computational effort of the FLAPW method is relatively high, obeying a cubic scaling law with system size, making the applicability to larger systems increasingly more difficult.

We will present new ideas to combine the Green-function embedding method and the transfer-matrix formalism [1] with the LAPW basis set to construct a computer code with a (roughly) linear scaling of the computational effort with increase of system size in one dimension. The total problem is decomposed into layers which can be calculated individually and are joint together with the help of the embedded Green function technique. This opens new perspectives in the calculation of complex nanoferronic junctions. Support by the DFG-SPP 1243 is gratefully acknowledged.

[1] D. Wortmann, H. Ishida, and S. Blügel, Phys. Rev. B **66**, 075113 (2002).

O 43.36 Tue 18:30 Poster F

Topology-dependent life-time of surface states — •Koray Köksal and Jamal Berakdar — Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, Heinrich-Damerow-Str. 4, D-06120 Halle(Saale), Germany

On the ground of analytical and numerical calculations we show that the life time of surface states of noble metals can be tuned by the appropriate topology of surface. Results are presented for curved Cu(111) surface. We also discuss how the predicted effect can be realized experimentally and measured by means of scanning tunneling spectroscopy [1] and two-photon photoemission [2,3].

- [1] L. Limot, E. Pehlke, J. Kröger, and R. Berndt, Phys. Rev. Lett. **94**, 036805 (2005)
- [2] R. W. Schoenlein, J. G. Fujimoto, G. L. Eesley, and T. W. Capehart, Phys. Rev. Lett. **61**, 2596 (1988)
- [3] A. Winkelmann, F. Bisio, R. Ocaña, W.-C. Lin, M. Nývlt, H. Petek, and J. Kirschner, Phys. Rev. Lett. **98**, 226601 (2007)

O 43.37 Tue 18:30 Poster F

Multilayer-Optiken für die fs-Röntgendiffraktometrie — •Jörg Wiesmann und Carsten Michaelsen — Incoatec GmbH, Geesthacht, Germany

An mehreren Orten auf der Welt befinden sich gepulste Synchrotron-Röntgenquellen im Bau, so genannte Freie Elektronen Laser. In Vorbereitung hierauf beschäftigt sich eine zunehmende Zahl von Forschergruppen mit vorbereitenden Laborexperimenten, wobei lasergenerierte Plasmaquellen zur Erzeugung von gepulster Röntgenstrahlung im sub-Pikosekunden Bereich verwendent werden. Derartige Laborquellen erfordern die Entwicklung von Röntgenoptiken, die auf der einen Seite ein großes Lichtsammelvermögen besitzen, und die auf der anderen Seite die Brillanz und die Zeitstruktur der Röntgenstrahlung aufrechterhalten. In diesem Beitrag werden verschiedene Röntgenoptiken im Hinblick auf diese Erfordernisse anhand jüngster experimenteller Ergebnisse vorgestellt.

O 43.38 Tue 18:30 Poster F

An XUV- Split and Delay Line at the Free Electron Laser in Hamburg — •Torben Beeck[1], Mitsuru Nagasono[1,2], Holger Meyer[1], Sven Gieschen[1], Martin Beye[1], William F. Schlotter[1], Florian Sorgenfrei[1], Alexander Föhlisch[1], and Wilfried Wurth[1] — [1]Institut für Experimentalphysik Universität Hamburg, Germany — [2]XFEL Project Head Office, RIKEN, Hyogo, Japan

At the Free Electron Laser in Hamburg (FLASH) we are integrating a soft x-ray beam split and delay line to the plane grating monochromator beamline (PG2). This system will enable pump-probe spectroscopy of ultrafast dynamics. Pulse to pulse timing jitter is circumvented by the controlled synchronisation of the delay line. The wavefront of the incoming beam is divided by illuminating the edge of a mirror. By controlling the optical path length for each beam, pulse delays as short as 10 fs or as long as 20 ps can be generated.

The system employs four mirrors to split and mix the beam and four mirrors to control the delay. Each mirror is a silicon single crystal with a diamond like carbon coating. The four delay mirrors are arranged at grazing incidence forming a parallelogram. Together with the beam splitters this forms an adjustable path Mach-Zehnder interferometer. For stability the delay mirrors are fixed to a rigid support structure. Simply translating the structure imparts a delay between the pulses.

This work is supported by the BMBF in the framework of the Forschungsschwerpunkt 301, "FLASH: Matter in the light of ultrafast and extremely intense x-ray pulses".

O 43.39 Tue 18:30 Poster F

Transient surface temperature of ultralthin Bi(111) heterolayers on Si(001) upon fs-laser excitation — •Anja Hanisch, Boris Krenzer, Simone Möllenbeck, Tobias Pelka, Paul Schneider, and Michael Horn-von Hoegen — Department of Physics, Universität Duisburg-Essen, D- 47048 Duisburg, Germany

The transient temperature rise of ultrathin epitaxial Bi(111) films on Si(001) substrates upon excitation with fs-laser pulses is studied by ultrafast time resolved reflection high energy electron diffraction (RHEED). Spot intensities taken at different time delays between pumping laser pulses and probing electron pulses are converted to the transient surface temperature using the Debye-Waller Effect.[1]

A rapid increase of the surface temperature from 80 K up to 190 K is followed by a slow exponential decay with a time constant of 640 ps for a 5.5 nm thin Bi film.[2] The slow cooling is determined by the thermal boundary resistance at the interface between Bi and Si. We observe a linear dependence of the decay constant with the film thickness for films thicker than 6 nm, which is in agreement with the general theory of the thermal boundary resistance. In contrast films thinner than 6nm show an enhanced thermal boundary resistance with a decay constant up to two times larger than expected. In order to explain this deviation, we suggest that for thinner films the discretisation of the phonon dispersion compared to the bulk-like behaviour of thicker films plays an important role.

[1] A. Janzen et al., Rev. Sci. Inst. 78, 013906 (2007).
[2] B. Krenzer et al., New J. Phys. 8, 190 (2006).

O 43.40 Tue 18:30 Poster F

Influence of Laser Heating on the X-ray Diffraction Intensity

of InSb — •Jessica Walkenhorst, Eeuwe S. Zijlstra, and Martin E. Garcia — Theoretische Physik, Fachbereich Naturwissenschaften, Universität Kassel, Heinrich-Plett-Str. 40, 34132 Kassel

Hillyard et al. have measured the x-ray diffraction intensity of the (111) peak of InSb after intense laser excitation, which provides insight in the first stages of laser-induced ultrafast melting. They found that the diffraction peak follows a Gaussian decay. This time-dependence has been analyzed using the Debye model for the atomic vibrations, assuming the laser heating to produce a uniform softening of all phonon frequencies. We performed (i) first principle electronic structure calculations, (ii) molecular dynamic simulations to calculate the phonon frequencies at the Γ-, X- and L-point and the resulting x-ray intensity. We found, that dramatic phonon softening does not occur at all the investigated k-points but instead the softening of the transverse acoustic phonons at the X-point suffices to explain the measured Gaussian x-ray intensity decay and perfectly reproduces the decay's measured time constant.

O 43.41 Tue 18:30 Poster F

Time-, energy- and ANGLE-resolved photoelectron spectroscopy of surface dynamics using femtosecond XUV pulses — •Stefan Mathias[1], Luis Miaja-Avila[2], Margaret Murnane[2], Henry Kapteyn[2], Martin Aeschlimann[1], and Michael Bauer[3] — [1]Department of Physics, TU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]JILA, University of Colorado, Colorado 80309-0440, USA — [3]Institut für Experimentelle und Angewandte Physik, Christian-Albrechts-Universität zu Kiel, Germany

The *angle* resolved photoelectron spectroscopy (ARPES) has emerged as a leading technique in identifying static key properties of complex systems such as adsorbed molecules, ultrathin quantum-well films or high temperature superconductors. We present an experimental setup combining the ARPES technique with a pump-probe scheme for time-resolved measurements using a 1 kHz femtosecond XUV source [1]. The performance of the system with respect to time-, energy- and momentum-resolution will be discussed on the basis of ARPES spectra recorded with ultra short photon pulses of an energy of 42 eV. Furthermore, the potential of time-resolved ARPES to study surface dynamics in future experiments is considered.

[1] S. Mathias, L. Miaja-Avila, M. Murnane, H. Kapteyn, M. Aeschlimann, M. Bauer, Rev. Sci. Instrum. 78, 083105 (2007)

O 43.42 Tue 18:30 Poster F

first test of a beam splitter and delay line for the XUV at FLASH — •Rolf Mitzner[1], Björn Siemer[1], Marco Rutkowski[1], Sebastian Roling[1], Matthias Neeb[2], Tino Noll[2], Kai Tiedtke[3], Wolfgang Eberhardt[2], and Helmut Zacharias[1] — [1]Physikalisches Institut, Westfälische Wilhels-Universität, 48149 Münster — [2]BESSY GmbH, Albert Einstein Str. 15, 12489 Berlin — [3]HASYLAB, DESY, 22603 Hamburg

In order to do jitter-free X-ray pump and probe experiments at the Free Electron Laser in Hamburg (FLASH) as well as to characterize the temporal structure of its high power pulses a novel beam splitter and delay unit (autocorrelator) has been designed and constructed [1]. Based on geometrical beam splitting by a mirror edge the apparatus covers the XUV energy range up to photon energies of 200 eV providing a total delay of about 20 picoseconds with femtosecond resolution. Using 13.5 nm radiation from the FEL the beam has been split in two beams delayed to each other. The shape of the split beams as well as its fluctuations has been recorded for different delays up to several picoseconds. Overlapping the split beams under a small angle 10 m behind the autocorrelator lateral interference fringes have been observerved at zero delay between the two beams. When changing the path difference the fringes have been disappeared thus demonstrating the proper function of the delay line in the XUV. The visibility of the fringes as a function of the delay (path length difference) should allow the direct determination of the average coherence time of the FEL pulses. [1] R. Mitzner et.al., Proc. Of SPIE 592000D (2005)

O 43.43 Tue 18:30 Poster F

A femtosecond X-ray/optical cross-correlator: Free-electron laser X-ray pulse induced transient optical reflectivity — •Cornelius Gahl[1,4], Armin Azima[3], Martin Beye[2], Martin Deppe[2], Kristian Döbrich[1], Urs Hasslinger[2], Franz Hennies[2,5], Alexej Melnikov[1], Mitsuru Nagasono[2], Annette Pietzsch[2], Martin Wolf[1], Wilfried Wurth[2], and Alexander Föhlisch[2] — [1]Fachbereich Physik, Freie Universität Berlin — [2]Institut für Experimentalphysik, Universität Hamburg — [3]HASYLAB/DESY, Hamburg — [4]Max-Born-Institut Berlin — [5]MAX-lab, Lund Universitet, Sweden

Due to their short pulse duration and high brilliance over a wide range of photon energies free-electron-laser (FEL) based femtosecond x-ray pulse sources make possible completely new classes of experiments. Since it is extremely difficult to precisely synchronize a FEL with an external femtosecond laser source, one has to measure the relative arrival time of x-ray and optical pulse to perform pump-probe experiments with optimal time resolution. At the Free-Electron-Laser in Hamburg (FLASH) we exploited the high peak brilliance for this purpose by measuring the x-ray induced transient change in optical reflectivity at a GaAs surface. The ultrafast drop in reflectivity on the time scale of the pulse duration enables us to determine the temporal overlap of x-ray and optical pulses as well as the statistical timing jitter and a systematical drift within a pulse train. Therefore this easy to implement technique denotes an important step towards delay control for femtosecond time-resolved experiments and opens up the field of femtosecond X-ray induced dynamics.

O 43.44 Tue 18:30 Poster F

An angle-resolved time-of flight spectrometer for low-energy photoelectron spectroscopy — •Laurenz Rettig, Patrick S. Kirchmann, Uwe Bovensiepen, and Martin Wolf — Freie Universität Berlin, Fachbereich Physik, Arnimallee 14, 14195 Berlin

We developed and constructed a two-dimensional position-sensitive time-of-flight spectrometer (pTOF) for the angle-resolved analysis of low-energy electrons photoemitted from a metal surface by femtosecond laser pulses. The spectrometer design combines a field-free drift tube with 22° acceptance angle and a microchannel plate stack with a delay-line anode [1] for position encoding. The pTOF spectrometer allows to determine both surface in-plane electron momentum components p_x and p_y along with the kinetic energy. The pTOF concept is optimized to study the electron scattering dynamics of laterally anisotropic electronic systems such as self-assembled quasi-1D atomic nano-wires or stepped surfaces.

Here, we present the working principles as well as the hard- and software implementation of the pTOF, which includes real-time analysis of multiple electron hits per laser pulse. This multihit capability is crucial for pulsed laser spectroscopy with repetition rates of $\sim$ 100 kHz. To demonstrate the performance of the spectrometer measurements on a Cu(111) single-crystalline surface were performed using UV femtosecond laser pulses of 6.20 eV photon energy.

[1] O. Jagutzki, A. Cerezo, A. Czasch, et al., IEEE Trans. Nucl. Sci. **49**, 2477 (2002).

O 43.45 Tue 18:30 Poster F

Spectral Line Shape Variations in Time-Resolved Photoemission from a Solid — E.E. Krasovskii[1,2], •Karsten Balzer[2], Sebastian Bauch[2], and Michael Bonitz[2] — [1]Insititute of Metal Physics, National Academy of Science of Ukraine, 03142 Kiev, Ukraine — [2]Institut für Theoretische Physik und Astrophysik, Christian-Albrechts-Universität Kiel, Leibnizstrasse 15, 24098 Kiel, Germany

Time resolved photoemission with (sub)femtosecond UV pulses is of hight current interest [1] and is, here, studied by solving the time-dependent Schrödinger equation for a one-dimensional model crystal [2]. Without the laser field the shape and the energy location of the spectrum is determined by the energy dependence of photoemission cross section. In the presence of the laser field, the time growth of the population of the final state is predicted to cause extremely sharp variations of spectral width as a function of release time. This can help enhance resolution of the measurements. A simple phenomenological model to describe the line shape is proposed and shown to accurately reproduce the numerical results.

[1] M. Hentschel et al., Nature 414, 509 (2001).

[2] E.E. Krasovskii, and M. Bonitz, accepted for publication in Phys. Rev. Lett. (2007).

O 43.46 Tue 18:30 Poster F

Spin-dependent electron lifetimes in 3*d* ferromagnet thin films — •Andreas Goris[1,3], Ilja Panzer[1,3], Martin Pickel[2], Anke B. Schmidt[2], Fabian Giesen[1], Jürgen Braun[4], Markus Donath[2], and Martin Weinelt[1,3] — [1]Max-Born-Institut, Max-Born-Strasse 2A, 12489 Berlin — [2]Physikalisches Institut, Universität Münster, Wilhelm-Klemm-Strasse 10, 48149 Münster — [3]Freie Universität Berlin, Arnimallee 14, 14195 Berlin — [4]Institut für Mathematik und angewandte Informatik, Universität Hildesheim, Samelsonplatz 1, 31141 Hildesheim

The experimentally found values of the lifetime ratio (τ_{maj}/τ_{min}) of hot electrons in $3d$ ferromagnetic thin films are by a factor of 4-5 smaller than predicted by values of modern *ab initio* calculations [1,2].

We have measured the spin-dependent hot-electron lifetime for varying excitation density in a 20 ML Co film on Cu (001) with spin-resolved two-photon photoemission. We identify three contributions to the time resolved spectra: the off-resonant excitation of the image-potential state, the hot electron decay, and the signature of a spin flip exchange-scattering process with an occupied surface-resonance state. In this process a minority hole is filled in the surface-resonance while a majority electron is in turn lifted above the Fermi energy . These results are supported by recent self-consistent LSDA + DMFT calculations of the Co bandstructure. For comparison the lifetime ratio of hot electrons in Ni is discussed.

[1] Aeschlimann et al., Phys. Rev. Lett. **79**, 5158 (1997)
[2] Zhukov et al., Phys. Rev. Lett. **93**, 096401 (2004)