O 63: Posters: Scanning Probe Methods

Time: Wednesday 17:30–21:00 Location: P2

O 63.1 Wed 17:30 P2

Toward a multiprobe- high frequency- spin-polarized scanning tunneling microscope — •Johannes Friedlein, Andreas Sonntag, Jonas Harm, Stefan Krause, and Roland Wiesendanger — Institute of Applied Physics, University of Hamburg

Controlling the dynamics of domain walls in nanowires by spin-polarized currents and magnetic fields is essential for the development of new spintronic devices [1,2]. Recently, the determination of spin-relaxation times in the nanosecond regime by means of pump-probe methods using a spin-polarized scanning tunneling microscope (SP-STM) has been reported [3].
We propose a multiprobe SP-STM that is optimized for picosecond time resolution in an external magnetic field and at temperatures below 2 K. This setup will enable us to investigate ultrafast spin transport dynamics in magnetic systems down to the atomic scale using pump-probe methods, e.g. measuring the domain wall propagation velocity along an atomic chain. Applying voltage pulses shorter than 100 ps to the tunnel junction requires a high bandwidth of at least 10 GHz and a short cabling length. This is in direct contrast to the low temperature concept of minimizing thermal flux input. We will present design considerations for simultaneously achieving the desired high frequency, low temperature and multiprobe properties.

[1] D. A. Allwood *et al.*, Science **309**, 1688 (2005)
[2] S. S. P. Parkin *et al.*, Science **320**, 190 (2008)
[3] S. Loth *et al.*, Science **329**, 1628 (2010)

O 63.2 Wed 17:30 P2

Manipulating the magnetic properties of a single atom by controlled hydrogenation — Alexander Ako Khajetoorians[1], Tobias Schlenk[1], Manuel Steinbrecher[1], Maria Valentyuk[2], Benedikt Schweflinghaus[3], Manuel dos Santos Dias[3], Mohammed Bouhassoune[3], Samir Lounis[3], Alexander Lichtenstein[2], •Jens Wiebe[1], and Roland Wiesendanger[1] — [1]Institute of Applied Physics, Hamburg University — [2]I. Theoretical Institute of Physics, Hamburg University — [3]Peter Grünberg Institut and Institute for Advanced Simulation, Forschungszentrum Jülich & JARA

Utilizing a combination of inelastic scanning tunneling spectroscopy and first-principles calculations within density functional theory, we describe how the magnetic properties of a single Fe atom on Pt(111) is modified by the adsorption of hydrogen. The most prominent effect of hydrogen adsorption onto a clean Fe atom is to modify the magnetic anisotropy and thereby the excitation energy. Binding site dependent studies as a function of the number of adsorbed hydrogen atoms shows that hydrogenation favors out of plane magnetic anisotropy. For the case of the hcp adatom, where the clean adatom has an easy plane anisotropy, full hydrogenation leads to significant Kondo screening. Magnetic field and temperature dependent studies of the Kondo resonance confirm a Kondo temperature of a few Kelvin. We further illustrate, by tip induced desorption, that we can controllably reverse the magnetic properties of these Fe hydrogen complexes. These conclusions are corroborated by calculations of hydrogenation-induced modifications in the relaxation and band structure.

O 63.3 Wed 17:30 P2

Electronic and magnetic properties of $Gd_3N@C_{80}$ on Cu(100) — •Gelavizh Ahmadi[1], Christian F Hermanns[1], Matthias Bernien[1], Alex Krüger[1], Christian Schmidt[1], Sören T Wasserroth[1], Benjamin W Heinrich[1], Martin Schneider[2], Piet W Brouwer[2], Katharina J Franke[1], Eugen Weschke[3], and Wolfgang Kuch[1] — [1]Institut für Experimentalphysik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany — [2]Institut für Theoretische Physik and Dahlem Center for Complex Quantum Systems, Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany — [3]Helmholtz-Zentrum Berlin für Materialien und Energie, Albert-Einstein-Straße 15, 12489 Berlin, Germany

Rare earth elements with large magnetic moments have attracted enormous attention in spintronic studies. One promising way to gain a better control of their magnetic properties is using a carbon cage to encapsulate them. We use scanning tunneling microscopy (STM) and spectroscopy (STS) combined with angle-dependent X-ray magnetic circular dichroism (XMCD) to investigate $Gd_3N@C_{80}$ endohedral fullerenes adsorbed on Cu (100). STM topographs reveal that the molecules adsorb with different orientation with respect to the substrate. Spectra of the differential conductance show resonances which are linked to the molecular orbital of the carbon cage. Depending on the orientation of the fullerene cage the energy position of the molecular orbitals varies. Furthermore XMCD spectra evidence ferromagnetic coupling of the magnetic moments of the gadolinium atoms within one cage.

O 63.4 Wed 17:30 P2

Tunneling anisotropic magnetoresistance at the single atom limit — •Johannes Schöneberg[1], Nicolas Néel[2], Silke Schröder[3], Paolo Ferriani[3], Jörg Kröger[2], Richard Berndt[1], and Stefan Heinze[3] — [1]IEAP der Christian-Albrechts-Universität zu Kiel, D-24098 Kiel, Germany — [2]Institut für Physik, Technische Universität Ilmenau, D-98693 Ilmenau, Germany — [3]ITAP der Christian-Albrechts-Universität zu Kiel, D-24098 Kiel, Germany

The spin orbit coupling (SOC) links the magnetic moment of electrons to the crystal lattice. In a scanning tunneling microscope, this enables the study of magnetic characteristics without the need for spin polarized tips. A prominent example is the second monolayer Fe/W(110) where nonmagnetic tips served to observe the domain walls at low bias in maps of the differential conductance. The observed contrast is due to different mixing of the states dominating the tunneling current caused by the changing orientation of the spin quantization axis. We use this surface to examine the SOC induced change in the differential conductance at the single atom limit. To this end atoms adsorbed on domains as well as domain walls are investigated. The different magnetic environments lead to variations in the conductance. This difference is quantified by means of the tunneling anisotropic magnetoresistance (TAMR).

O 63.5 Wed 17:30 P2

Spin-dependent scanning probe images of antiferromagnetic NiO(001) surfaces: A first-principles approach — •Mihail Granovskij, Andreas Schrön, and Friedhelm Bechstedt — Institut für Festkörpertheorie und -optik, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, 07743 Jena, Germany

We present an accurate *ab-initio* description of the magnetic exchange force microscopy (MExFM). As a prototypical system the antiferromagnetic NiO(001) surface probed with a Fe tip is investigated.[1]

The tip-surface interaction is described on two levels. Short-range chemical and exchange forces between the tip apex and surface atoms are described in the framework of spin-polarized density functional theory (DFT) while long-range van-der-Waals forces are considered within a mesoscopic tip model. Exchange and correlation (XC) are treated within the local density approximation (LDA). For the Ni atoms in the NiO surface and the Fe atoms of the tip apex, an additional on-site Coulomb interaction U acting on the transition-metal $3d$ shells is included (LDA+U).

In order to understand the tip-surface interaction, we investigate the changes in the electronic structure of tip and surface versus distance. The resulting frequency shifts and MExFM images are presented and compared with recent experimental data.

[1] M. Granovskij *et al.*, Phys. Rev. B 88, 184416 (2013)

O 63.6 Wed 17:30 P2

Ab-initio Calculation of the Vibrational Spectra of Single Molecules — •Felix Schwarz[1,2], Yongfeng Wang[3,4], Richard Berndt[3], Erich Runge[1], Werner A. Hofer[2], and Jörg Kröger[1] — [1]Institut für Physik, Technische Universität Ilmenau, D-98693 Ilmenau — [2]Stephenson Institute for Renewable Energy, University of Liverpool, Liverpool L69 3BX, United Kingdom — [3]Institut für Experimentelle und Angewandte Physik, Christian-Albrechts-Universität zu Kiel, D-24098 Kiel — [4]Department of Electronics, Peking University, Beijing 100871, China

Inelastic electron tunnelling spectroscopy with a scanning tunnelling microscope is an important tool for the chemical analysis of single molecules on surfaces. However, the amplitude of vibrational signatures in spectra of the differential conductance (dI/dV) is difficult to predict. Here, an ab-initio method to quantify contributions of molecular vibrations to dI/dV spectra following Lorente [1] is presented. The

applicability of the method for fairly large molecules is demonstrated for tin-phthalocyanine on Ag(111). Calculated and experimental data are in good agreement. The experimentally observed satellite peaks around the lowest unoccupied molecular orbital are assigned to vibrational resonances. In addition, non-local effects of the electron-vibration coupling are presented.

[1] N. Lorente, Appl. Phys. A 78, 799 (2004)

O 63.7 Wed 17:30 P2

Proposal for tracing the local ionization dynamics of adsorbed molecules by photo-assisted scanning tunneling microscopy — •Michael Schüler and Jamal Berakdar — Martin-Luther University Halle-Wittenberg, Institute for Physics, Karl-Heinrich-von-Fritsch-Straße 3, 06120 Halle, Germany

For tracing the spatiotemporal evolution of electronic systems we suggest and analyze theoretically a setup that exploits the excellent spatial resolution based on scanning tunneling microscopy techniques combined with the temporal resolution of femtosecond pump-probe photoelectron spectroscopy. As an example we consider the laser-induced, local vibrational dynamics of a surface-adsorbed molecule. The photoelectrons released by a laser pulse can be collected by the scanning tip and utilized to access the spatio-temporal dynamics. Our proof-of-principle calculations are based on the solution of the time-dependent Schrödinger equation supported by the ab initio computation of the matrix elements determining the dynamics.

O 63.8 Wed 17:30 P2

Capacitively guided tip-to-tip positioning for multiprobe spin-polarized scanning tunneling microscopy — •Jonas Harm, Johannes Friedlein, Andreas Sonntag, Stefan Krause, and Roland Wiesendanger — Institute of Applied Physics, University of Hamburg, Hamburg, Germany

To investigate magnetic transport properties on the atomic scale, we currently set up a multiprobe spin-polarized scanning tunneling microscope (SP-STM), that is designed for high-frequency applications in a magnetic field of 3 T at temperatures below 2 K in ultra-high vacuum. One of the challenges in such a system is the positioning of two tunneling tips at a distance of only a few nanometers. The external magnetic field excludes the use of a scanning electron microscope for positioning the tips within a common scan frame [1]. We present a novel tip-to-tip approach, extending known tip-to-tip tunneling methods [2,3] by utilizing distance dependence of the capacitance between two tips, allowing a fast and safe approach. Since the minimum distance between the tips is limited by their tip radii and opening angles, we adapted tip preparation techniques [4], thereby enabling future transport measurements at tip-to-tip distances in the range of $10 - 20$ nm.

[1] T. Nakayama *et al.*, Adv. Mater. **24**, 1675 (2012)
[2] A. Matsui *et al.*, Rev. Sci. Instrum. **78**, 106107 (2007)
[3] H. Grube *et al.*, Rev. Sci. Instrum. **72**, 4388 (2001)
[4] Y. Khan *et al.*, Rev. Sci. Instrum. **83**, 063708 (2012)

O 63.9 Wed 17:30 P2

Application of Bardeen's tunneling formula for the calculation of STM data — •Steffen Seiler[1], Roman Kováčik[2], and Bernd Meyer[1] — [1]Interdisciplinary Center for Molecular Materials and Computer-Chemistry-Center, FAU Erlangen-Nürnberg — [2]Peter Grünberg Institute and Institute for Advanced Simulation, Forschungszentrum Jülich

The tunneling current in scanning tunneling microscopy (STM) is determined by a convolution of the electronic structure of the tip and the substrate. However, in the most commonly used method for calculating STM data, the Tersoff-Hamann approximation [1], all specific details of the tip electronic structure are neglected. One step beyond this simplification is Bardeen's perturbation approach [2], in which the tip electronic structure is explicitly taken into account.
Both methods have been implemented in our STM simulation program [3]. The code was recently largely extended and modified, most importantly by including multiple k-points and fractional occupation numbers for a proper treatment of metallic systems. The program was tested for various oxidized Cu surface structures and tip models. Different benchmark tests were carried out, all confirming the correct functionality of the program and giving some interesting insights into the electronic structure of CuO_x monolayers on a Cu(111) substrate.

[1] J. Tersoff, D. Hamann, *Phys. Rev. B* **31**, 805 (1985).
[2] J. Bardeen, *Phys. Rev. Lett.* **6**, 57 (1961).
[3] R. Kováčik, B. Meyer, D. Marx, *Angew. Chem. IE*, **46**, 4894 (2007).

O 63.10 Wed 17:30 P2

Detecting the topographic, chemical and magnetic contrast at surfaces with nanometer spatial resolution — •Danilo Andrea Zanin, Mehmet Erbudak, Lorenzo G. De Pietro, Hugo Cabrera, Andreas Fognini, Thomas Michlmayr, Yves M. Acremann, Alessandro Vindigni, Danilo Pescia, and Urs Ramsperger — ETH Zurich, Switzerland

For many decades the development and investigation of magnetic nanostructured materials has been motivated by the quest for novel paradigms for magnetostorage and spintronics. The possibility of resolving magnetic-textures in real space with increasing spatial resolution has, indeed, always opened novel applicative and fundamental perspectives. Scanning-Electron-Microscopy with Polarization Analysis (SEMPA), e.g., made it possible to directly observe the re-entrant transitions of magnetic-domain patterns in thin films of Fe on Cu(001). Inspired by the Russel Young topografiner we redesigned the SEMPA setup, by replacing the primary electron beam source and the probing method. We dubbed this new technique Near Field-Emission Scanning Electron Microscopy (NFESEM). Currently, NFESEM technique is capable to resolve the topography of metals and semiconductors with nanometer lateral resolution and detect the entire spectrum of SE induced by a low-energy primary electron beam. We report on promising results of single-energy surface imaging, which confirm the technical feasibility of electron spectroscopy and magnetic-domain mapping with a nanometer spatial resolution.

O 63.11 Wed 17:30 P2

Construction of a multiscale and multitype scanning probe microscope — •Boris Gross, Hanna Fedderwitz, Hendrik Sträter, and Niklas Nilius — Carl-von-Ossietzky Universität, Oldenburg, Deutschland

Little is known about the optical and electronic phenomena that control the functionality of thin-film solar cells on a mesoscopic length scale ranging from tens of nm up to a few μm. In fact, conventional techniques to characterize dielectric surfaces average over macroscopic sample areas and are therefore unsuitable to probe local effects. In contrast, SPM approaches capable of atomic resolution are still too complex and challenging to use them for a quick sample characterization. The gap between both techniques might still hold important information on the functionality of electronic and photovoltaic devices, in particular if not only morphological but also spectroscopic techniques are available for characterization. In this poster, we present the design for a versatile scanning probe microscope that combines the capabilities of AFM and STM with local photo-luminescence spectroscopy. The microscope's key parameters are: Multi-scaling capabilities with image sizes from $10\,nm$ to $500\,\mu m$, various feedback modes to enable AFM and STM operation, use of different probe tips as nearfield sensor for local reflection and transmission studies and variable pressure and temperature ranges between $10^3 - 10^{-6}\,mbar$ and $77 - 300\,K$.

O 63.12 Wed 17:30 P2

Construction of a low-temperature STM for luminescence spectroscopy — •Hanna Fedderwitz, Boris Gross, Hendrik Sträter, and Niklas Nilius — Carl von Ossietzky Universität Oldenburg

Luminescence spectroscopy stimulated by electrons of an STM tip has recently been used to analyze the nature of point defects in ZnO films (1). The approach enabled a spectral identification of O and Zn vacancies with 100nm spatial resolution. These limits were given by the need to produce a finite number of electron-hole-pairs in the oxide band gap via impact of energetic tip-electrons. The required electron energy was determined to be 100eV, too high to map the optical response with true nm resolution and without damaging the oxide surface.

To overcome these limitations, we have developed a new scanning tunneling microscope suitable for low-temperature luminescence measurements. The setup is based on the beetle design, but uses a tapered and metal-coated optical fiber as sensor tip. The microscope is surrounded by a parabolic mirror for efficient photon collection. Our setup enables an all-optical characterization of sample surfaces, in which photons are either injected into or collected from the tip-sample junction via the fiber tip. The tip-sample distance is controlled by the STM-feedback loop, which also allows us to probe the sample topography with atomic resolution. The target application for our new setup

is photoluminescence spectroscopy on thin dielectric films as used in photocatalysis.

(1) Stavale, Nilius, Freund, J. Phys. Chem. Lett. 4, 3972 (2013)

O 63.13 Wed 17:30 P2

Fabrication of gold nanocone near-field scanning optical microscopy probes — •Omar Tanirah, Dieter P. Kern, and Monika Fleischer — Institute for Applied Physics, Eberhard Karls University Tübingen, Auf der Morgenstelle 10, 72076 Tübingen, Germany

Near-field scanning optical microscopy (NSOM) is an excellent method in its ability to probe the morphology of samples at the same time as their local optical properties, and can be integrated with tip-enhanced Raman spectroscopy. Hence, simultaneous investigatons of the morphology, physical and chemical properties on the nanometer scale can be obtained. The NSOM probe has an important role in enhancing the performance of the NSOM measurements. One such approach is the fabrication of probes based on plasmonic nanostructures. They exhibit localized surface plasmon resonances, and enable a resolution far beyond the diffraction limit. Gold nanocones are interesting plasmonic nanostructures for this purpose, since the near-field of the plasmons is strongly localized around the nanocone tip of radius smaller than 10 nm. We report here the fabrication process of gold nanocones as novel NSOM probes on both cantilevers and optical fibres [1, 2]. The fabrication process is achieved by wet etching, focused gallium ion beam, sputtering, electron beam evaporation, and electron beam induced deposition. Finally, a gold nanocone is formed after etching the samples in an argon-ion milling machine. The samples are characterized using scanning electron microscopy. The fabrication process and resulting probes will be shown. [1] M. Fleischer, Nanotechnol. Rev.1 (2012) 313. [2] M. Fleischer et al., ACS Nano 5 (2011) 2570.

O 63.14 Wed 17:30 P2

Wavelet analysis of inelastic electron tunneling spectra — •Matthias Stocker and Berndt Koslowski — Universität Ulm, 89081 Ulm, Germany

Experiments of inelastic electron tunneling spectroscopy (IETS) are carried out typically at the absolute noise limit. Furthermore, the interpretation of such spectra - being just the second derivative of the tunneling current - is greatly hampered by contributions which do not originate from vibrational transitions. As a consequence, data evaluation occupies a central point in IETS. We developed an analysis tool which employs continuous wavelet transform on the basis of the Mexican hat mother function. The Mexican hat function is essentially the second derivative of a Gaussian peak and thus a peak function similar to the Gaussian peaks expected for vibrational transitions in IETS. This wavelet analysis helps very much in localizing and judging vibrational transitions. We introduce the new analysis and compare it to formerly developed techniques.

O 63.15 Wed 17:30 P2

Dynamic Friction Force Microscopy on antimony nanoparticles — •Thomas Göddenhenrich, Felix Mertens, and André Schirmeisen — Institut für Angewandte Physik, Justus-Liebig-Universität Gießen, D-35392 Gießen

Dynamic Friction Force Microscopy is a valuable scanning probe technique for detection of friction properties. The nonlinear interaction between tip and sample induces a sensitive signal containing the friction information for different tip-sample contacts. The third harmonic lock-in detection on antimony nanoparticles clearly reveals the signal contrast dependence on the modulation amplitude and frequency. Therefore the detection of frictional information of the sample system requires a modulation frequency spectrum to receive the basic information of the damped system between tip and sample, namely the qualitiy factor Q and optimal excitation frequency.

O 63.16 Wed 17:30 P2

Measuring near field mediated absolute heat fluxes with the Near Field Scanning Thermal Microscope (NSThM) — •Konstantin Kloppstech, Nils Könne, Achim Kittel, Ludwig Worbes, and David Hellmann — EHF, Fak. V, Inst. f. Physik, CvO Universität Oldenburg

Experimental analysis of near-field heat transfer on the nanoscale by means of absolute fluxes is based on accurate knowledge of our thermocouple sensors thermal resistance. This sensor combines a standard scanning tunneling microscope tip with a coaxial thermocouple, consisting of a thin Pt-wire coated with a 200 nm layer of Au. We present measurements and a wide analysis for our in situ method for measuring the sensors thermal features. Therefore one needs a defined and metrological accessible heat reservoir. That for our sample is held in UHV conditions and consists of a 5 μm thin and 3-10 mm long tungsten wire which is glued to an electrically insolated copper block. The thin wire is heated with high frequency AC currents and can be described with the 1D heat diffusion equation. The wire is cooled additionally by approaching the thermocouple tip to its middle. From the decrease in heating we determine the heat flux through the thermocouple tip which then can be attributed to the additionally measured thermopower of the tip sensor. To achieve highest precision we have analyzed our system and present besides measurements the major metrological aspects that must be considered. This enables us to locally probe the near field mediated heat fluxes on the nanoscale by means of absolute values.

O 63.17 Wed 17:30 P2

Single molecule heat transport — •Nils Könne, Konstantin Kloppstech, Ludwig Worbes, David Hellmann, and Achim Kittel — EHF, Fak. V, Physik, Carl von Ossietzky Universität Oldenburg

The heat transport and dissipation in molecular junctions is a topic of high interest [1] and scientific value. To overcome the experimental challenges of contacting a single molecule and detecting the heat transport we are using our self-developed near field scanning thermal microscope (NSThM) which consists of a STM with a nanoscale build in thermocouple in the tip. This allows us, to measure simultaneously the electrical $I(t)$ and heat $\dot{Q}$(t) current as a function of time and temperature under ultra high vacuum conditions. Analogous to the determination of the electrical transport through a molecule we are using the so called $I(t)$-Method, introduced by W. Haiss et al [2] which reveals the spontaneous formation of metal - molecule - metal junctions leading to an on-and-off switching process of a single molecule. This will be used to identify the heat transport through a single molecule. First results are presented for octanedithiol as a typical linear switching molecule. [1] Woochul Lee et al, Nature 498, 209 (2013). [2] Wolfgang Haiss et al, Phys. Chem. Chem. Phys. 6, 4330-4337 (2004)

O 63.18 Wed 17:30 P2

Electronic pump-probe experiments in STM using THz-pulses — •Steffen Rolf-Pissarczyk[1,2], Jacob Burgess[1,2], Deung-Jang Choi[1,2], Shichao Yan[1,2], and Sebastian Loth[1,2] — [1]Max-Planck Institute for the Structure and Dynamics of Matter, 22761 Hamburg — [2]Max-Planck Institute for Solid State Research, 70569 Stuttgart, Germany

Fast dynamics at picosecond timescales are full of interesting phenomena such as depinning of charge density waves, molecular vibrations or spin precession on surfaces. The challenge is to observe those effects on this timescale with atomic or nanometer spatial resolution. For this propose we combine a scanning tunneling microscope (STM) with ps THz-laser pulses. This technique couples directly to the STM tip with THz radiation instead of exciting the sample with optical pulses. This technique enables control of the electric field at the tunnel junction with the THz pulses independent to the nature of the sample. This generality allows exciting and probing a various number of systems. The experimental setup is similar to all-electronic pump-probe methods but without limitations imposed by the electrical bandwidth of wires. Progress on the new instrument is described and first measurements will be presented.

O 63.19 Wed 17:30 P2

Laser induced Time Resolved Scanning Tunneling Microscopy — •Philipp Kloth, Christian Werner, Karen Teichmann, and Martin Wenderoth — IV. physik. Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

We present a detailed description of a combined setup of a pulsed laser source and a Scanning Tunneling Microscope (STM) in Ultra High Vacuum. The most demanding issue of light excitation in STM is the handling of thermal effects. For time resolved operation this challenge results in a transformation of standard pump-probe pulses into complex laser pulse patterns. Triggered by the groundbreaking results of Shigekawa [1] our intention was to develop a setup with a stronger focus on the flexibility.

We generate pulsed laser light in a pure electronic way. A diode laser in combination with a high-bandwidth electro-optical modulator produces light excitation from continuous-wave mode to single nanosecond pulses. The voltage pulses are supplied by a commercial function generator. This allows to adapt the pulse pattern exactly to the timescale needed in the experiment.

Results on the GaAs(110) surface show a huge impact on the spectroscopic properties due to the light excitation. Electron-hole pair generation is not only affecting the always present charge region in the sample but also opens new tunnel channels resulting in extra current. Time resolved studies allow to probe these processes individually revealing characteristic decay constants in the nanosecond regime.

[1]Terada et al., Nature Photonics, 4(12), 12 2010.

O 63.20 Wed 17:30 P2

Design of a variable temperature scanning tunneling microscope — •Sebastian Schimmel[1,2], Christian Salazar[1], Martha Scheffler[1], Ronny Schlegel[1], Danny Baumann[1], Torben Hänke[1], Bernd Büchner[1,3], and Christian Hess[1,3] — [1]IFW Dresden, Institute for Solid State Research, P.O. Box 270116, D-01171 Dresden, Germany — [2]Westsächsische Hochschule Zwickau — [3]Center for Transport and Devices of Emergent Materials, TU Dresden, 01069 Dresden, Germany

We present the design of a variable-temperature scanning tunneling microscope (STM) in ultra-high vacuum (UHV) conditions and operating temperatures between room temperature and 15 K. Our UHV system comprises a separated STM and preparation chamber which is equipped with all required devices for organic molecular beam epitaxy and spin-polarized scanning tunneling microscopy.

O 63.21 Wed 17:30 P2

A combined LT-STM/FIM for tip specific tunnelling experiments — •Ben Wortmann, Matthias Müller, and Rolf Möller — Faculty of Physics, Center for Nanointegration Duisburg-Essen, University of Duisburg-Essen, 47048 Duisburg, Germany

We present details on a homebuilt, compact, low temperature scanning tunnelling microscope that allows in situ field ion microscopy of a cooled tunnelling tip inside the STM. The tip can be characterised without transfer to a different position in the UHV system, so that the probability for the modification of the tip can be strongly reduced. Ideally the tip remains unchanged. The geometry of the microscope resembles a cylinder with a height of 13 cm and a diameter of 4 cm. The STM is screwed directly onto a commercially available continuous flow cryostat which allows cooling to about 5-7 K. The very compact design minimises helium consumption to about 1 litre/hour. Insulation from vibration is provided by a combination of springs and eddy current damping. Shutters at the bottom of the microscope can be opened to expose the tip to a channel plate or closed to assure lower temperatures and minimal thermal drift while tunnelling. A combination of two piezos is used to move a magnetically attached slider holding the tip. The slider can be easily exchanged in vacuum. The performance of the STM setup has already been shown for an almost identical system [1]. [1] (H. Karacuban, M. Lange, J. Schaffert, O. Weingart, Th. Wagner and R. Möller, Surf. Sci. Lett., 603, Issue 5, L39 (2009).

O 63.22 Wed 17:30 P2

z-resolution of 5 nm in a scanning electron microscope using a nanofinger — •Martin Grob[1], Eva Maynicke[2], Ivo Burkart[2], Marcus Liebmann[1], Volker Klocke[2], and Markus Morgenstern[1] — [1]II. Inst. Phys. B, RWTH Aachen University, 52074 Aachen — [2]Klocke Nanotechnik, 52076 Aachen

Scanning electron microscopy (SEM) is a common technique for investigating surfaces on the nanometer scale. One main disadvantage is the low vertical resolution compared to the lateral resolution which can only be achieved by proper focussing. To overcome this limitation we implemented a small scanhead which operates the same way as an atomic force microscope (AFM) in the dynamic mode. With this additional sensor in the SEM we can reach a vertical resolution better than 5 nm. With this tool, a direct in-situ control mechanism is given, e.g. structures grown by electron beam induced deposition (EBID) can be characterized under vacuum conditions. In addition, this scanner can provide coordinates on a surface for the navigation of other tools such as contacting tips.

O 63.23 Wed 17:30 P2

STM investigations of iron thin films on W(110) — •christian salazar[1], martha scheffler[1], tim kühne[1], danny baumann[1], bernd büchner[1,2], and christian hess[1,2] — [1]Institute for Solid State Research, IFW Dresden, Germany — [2]Center for Transport and Devices of Emergent Materials, TU Dresden, 01069 Dresden, Germany

We have investigated the growth and the magnetic structure of iron thin films on a W(110) single crystal by scanning tunneling microscopy. We found that the growing conditions such as temperature and evaporation rate influence the growth of the nanostructures, so that, we observe the formation of islands, large patches with and without dislocation lines and nanowires. The magnetic properties were studied via spin-polarized scanning tunneling microscopy using different magnetic probes: iron coated tungsten tips, chromium coated tungsten tips and chromium bulk tips. Our data reveal in some cases magnetic domains in the first atomic layer of iron, indicative of in-plane magnetization and in other cases magnetic domains in the second atomic layer of iron, indicative of out-of-plane magnetization.

O 63.24 Wed 17:30 P2

Kelvin Probe Force Microscopy on the submolecular scale — •Florian Albrecht[1], Martin Fleischmann[2], Manfred Scheer[2], and Jascha Repp[1] — [1]Institute of Experimental and Applied Physics, University of Regensburg, 93053 Regensburg, Germany — [2]Institute of Inorganic Chemistry, University of Regensburg, 93053 Regensburg, Germany

Kelvin Probe Force Microscopy (KPFM) has been shown to be a powerful tool to detect the distribution of charges within a single molecule [1].

We performed KPFM measurements on two derivates of cyclic trimeric ortho-phenylene mercury (TPM) molecules in a low temperatures combined scanning tunneling and atomic force microscope with functionalized tips.

Whereas one of the derivates has hydrogen atoms bonded to the phenyl rings the other molecule is perfluorinated. For the latter the KPFM signal shows clear signatures of the polar fluorine carbon bonds. In addition, the fluorine influences the electron density also at the center of the molecule. The charge redistribution within the molecule was made responsible for the weak attraction of electron rich ligands at its center [2]. This charge redistribution is visualized in KPFM maps.

[1] F. Mohn, L. Gross, N. Moll, and G. Meyer, Nature Nanotechnology, 7, 227, (2012)

[2] M. R. Haneline, and F. P. Gabbai, Inorg. Chem., 44, 6248, (2005)

O 63.25 Wed 17:30 P2

Investigation of 1,6,7,12-tetraazaperylene molecules on an insulating film by means of LT-STM — •Nemanja Kocić[1], Peter Weiderer[1], Stephan Keller[2], Shi-Xia Liu[2], Silvio Decurtins[2], and Jascha Repp[1] — [1]Institute of Experimental and Applied Physics, University of Regensburg, 93053 Regensburg, Germany — [2]Departement für Chemie und Biochemie, Universität Bern, Switzerland

In recent years, metal-organic hybrid structures have received considerable attention because of their tunable electronic and magnetic properties. A promising strategy to obtain thermally and chemically stable structures through covalent bonding of suitable precursors directly on the substrate is the concept of on-surface synthesis. So far, successful demonstrations of on-surface synthesis have been limited to metallic substrates, however, a useful molecular electronic device would require its construction on an insulating surface. To this end, we performed low temperature scanning tunneling microscopy (LT-STM) on the 1,6,7,12-tetraazaperylene molecule (TAPE), which is a highly symmetric, planar, bi-facial bridging ligand with a large extended π-system. As such, TAPE is an attractive bridging ligand for the formation of new multimetallic systems of regularly spaced spin centers. Molecular self-assembly is investigated on an ultrathin insulating film that provides efficient electronic decoupling from the metal substrate, allowing detailed characterization of the molecular orbitals. When thermally activated at 300 K, individual metal atoms and TAPE molecules form metal-molecular complexes.

O 63.26 Wed 17:30 P2

Versatile and compact UHV-System for Scanning Tunneling, Scanning Force and Transport Measurements exhibiting an operation time of 10 days below $T = 400$ mK and at $B = \pm 14$ T — •Jan Raphael Bindel, Mike Pezzotta, Stefan Becker, Marcus Liebmann, and Markus Morgenstern — II. Institute of Physics B, RWTH Aachen, Germany

We use a UHV cryostat which hosts a fully UHV compatible He_3 cryostat with charcoal pump. The He_3 is condensed in mechanical contact with a 1 K pot, but decoupled afterwards providing low mechanical noise. The base temperature is 380 mK with a hold time greater than 10 days. Optical access enables *in-situ* tip and sample exchange and evaporation into the cooled microscope at 4.2 K. The home-built mi-

croscope allows conventional scanning tunneling microscopy and spectroscopy, non-contact atomic force microscopy via a qPlus sensor and magnetotransport measurements of the samples using five contacts at the same sample position, where scanning tunneling microscopy is performed. An xy table allows positioning of the tip with respect to the sample over 2x2 mm^2. For sample preparation and analysis, a three chamber ultrahigh vacuum system with a base pressure of 10^{-8} Pa has been built including low-energy electron diffraction (LEED), Auger electron spectroscopy, sputtering, annealing and evaporation. The whole system has a total height of only 2.60 m. STM images are presented with noise level in z-direction below 2 pm, lateral drift below 40 pm/h obtained at currents down to 500 fA.

O 63.27 Wed 17:30 P2

Shot noise measurements at atomic contacts — •Andreas Burtzlaff, Alexander Weismann, and Richard Berndt — IEAP, Christian-Albrechts-Universität zu Kiel, D-24098 Kiel, Germany

Transport in atomic contacts is commonly characterized by measuring the conductance, which is the sum of the contributions of a set of quantum states, the so called transport channels. From the conductance alone, those contributions cannot be disentangled. By measuring the current dependent noise of an atomic contact it is possible to gain information on the number of channels contributing to the transport process and their transmission probabilities. Previously this approach has been successfully applied to semiconductor heterostructures as well as molecules and atomic contacts in MCBJ experiments. We perform such noise measurements using an STM at 4K and under UHV conditions. Preliminary results for single atom contacts will be shown.

O 63.28 Wed 17:30 P2

Solid State Sample Environment at the European XFEL — •Carsten Deiter, Oleksiy Drachenko, and Joachim Schulz — European X-Ray Free-Electron Laser Facility GmbH, Notkestr. 85, 22607 Hamburg, Germany

Free-electron lasers offer a variety of unique properties for spectroscopy and imaging. The combination of high peak brilliance and a high repetition rate opens a window to experiments that have not been feasible so far but also introduces challenges in sample preparation and refreshment, especially for solid state samples.

We present a concept and first prototype of a 10Hz sample changer opening the opportunity to expose every bunch train of the XFEL with its 2700 pulses to a new and virgin sample location, combined with temperature control, magnetic fields and optical pump lasers.

O 63.29 Wed 17:30 P2

A quantum yield measurement setup for the charge compensation for the LISA Pathfinder space mission — •Indro Biswas[1], Mathias Schulze[1], Gerald Hechenblaikner[2], Tobias Ziegler[2], Nico Brandt[2], Patrick Bergner[2], Felix Erfurth[3], and Markus Pfeil[3] — [1]Deutsches Luft- und Raumfahrtzentrum e.V., Pfaffenwaldring 38-40, 70569 Stuttgart — [2]Astrium Satellites GmbH, 88039 Friedrichshafen — [3]TWT GmbH Science & Innovation, Ernsthaldenstraße 17, 70569 Stuttgart

The evolved Laser Interferometry Space Antenna (eLISA) is an international fundamental research project with the aim of the detection of gravitational waves by monitoring the distance between two test bodies in space. The LISA pathfinder mission will perform experiments in a small scale with lower precision and identify upcoming challenges for the future mission. A contactless minimally invasive discharge system based on the photoemission process is necessary in order to avoid electrostatic forces on the test bodies. For the development the photoemission quantum yields of possible coatings were determined and uprising methodical issues were evaluated. An experimental setup was designed in a high vacuum chamber for the recording of the energy distribution of electrons emitted by UV radiation. The differences between the ideal spherical and a cylindrical setup with a possibility for quick sample exchange are explained.

O 63.30 Wed 17:30 P2

The new multipurpose ARPES end-station on the SGM3 beamline at ASTRID2 — •Marco Bianchi[1], John E. Vad Andersen[1], Henrik Kjeldsen[1,2], Nykola Jones[1,2], Søren V. Hoffmann[1,2], and Philip Hofmann[1,3] — [1]Department of Physics and Astronomy, Aarhus University, Denmark. — [2]Center for Storage Ring Facilities, Aarhus University, Danmark. — [3]Interdisciplinary Nanoscience Center (iNANO), Aarhus University, Denmark.

A new multipurpose end-station for electronic, geometrical and chemical characterisation has been built on the renewed SGM3 beamline at the synchrotron radiation source ASTRID2 in Aarhus (DK). The beamline covers photon energies from 14 to 150 eV. The system is particularly well suited for electronic structure studies along arbitrary direction in $k_{||}$, Fermi surface mapping, bulk bands mapping and temperature dependent measurements.

The end-station allows ARPES multichannel detection with a combined energy resolution better than 7 meV and angular resolution better than 0.1° with a 4 degree of freedom manipulator at 200-1300 K, or 5 degree of freedom manipulator at 70-800 K, or 6 degree of freedom manipulator at 25-500 K; sample preparation (sputtering, annealing 180-2300 K, chemical treatment, cleaving); STM measurement; Auger spectroscopy and epitaxial/MBE growth of thin films followed by RHEED. The poster describes the light source and the many opportunities of the end-station.

O 63.31 Wed 17:30 P2

New PEEM and NEXAFS/EXAFS experiments at the synchrotron source DELTA: Ready for user — •Christoph Keutner, Ulf Berges, Dominique Handschak, and Carsten Westphal — DELTA/Experimentelle Physik I, TU Dortmund, Maria-Goeppert-Mayer-Straße 2, 44221 Dortmund, Germany

We report on the setups of two new experiments at the PGM undulator beamline 11 (30 eV - 1000 eV) of Dortmund's synchrotron source DELTA.

The first experiment is a photoemission electron microscope (PEEM), which uses electrons emitted from an illuminated sample to generate a spatially resolved image of its surface. PEEM can be used for spatially resolved x-ray absorption spectroscopy (XAS) by scanning the photon energy and recording individual images within the sequence. Here, a Staib PEEM 350-20 with a spatial resolution of up to 220 nm is used. In combination with our self-developed S.P.A.M.M. software it enables a fully automatized data acquisition (image-squences and beamline flux) for XAS. The experimenter just has to specify basic parameters - e.g. energy range and step width.

The second setup is an extension to the existing XPS/XPD-machine. By using our NEMeSUS software it is now possible to preform near-edge x-ray absorption fine structure (NEXAFS) and extended X-ray absorption fine structure (EXAFS) by using the total electron yield (TEY). Hence, a combination of highly surface sensitive XPS/XPD with deeper reaching NEXAFS/EXAFS-techniques in the identical geometric setup can be realized.

O 63.32 Wed 17:30 P2

Spin-resolved core-level photoemission spectroscopy of W and TaS_2 — •Tim Haase, Arndt Quer, Erik Kröger, Lars Oloff, Matthias Kalläne, Lutz Kipp, and Kai Rossnagel — Institute of Experimental and Applied Physics, University of Kiel, 24098 Kiel, Germany

Electron spin polarization shows up in a number of effects at solid surfaces, most prominently via the spin-momentum locking in Rashba systems and topological insulators, but also of course via the exchange splitting in itinerant ferromagnets. All these effects may be used to validate spin detection schemes in photoemission spectroscopy. Here, however, to characterize a commercial 3D Mott detector, we have used an effect first described by Cherepkov [1,2], i.e., the spin specific photoemission from the core levels of nonmagnetic materials due to excitation with circularly polarized light. Employing the variable polarization soft X-ray beamline P04 of PETRA III (DESY), we have performed electron-spin- and photon-polarization-dependent $4f$ core-level photoemission spectroscopy of W and TaS_2. The results are interpreted in the context of free atom theory and possible deviations from the theory are discussed. The results are finally used to determine the Sherman function of the detector.

[1] N. A. Cherepkov, Phys. Lett. 40A, 119 (1972).
[2] N. A. Cherepkov, Soviet Physics JETP 38, 463 (1974).

O 63.33 Wed 17:30 P2

3D nanofabrication of subsurface structures inside photosensitive glass with fs laser — •Tobias Milde[1], Ulrike Brokmann[2], Edda Rädlein[2], and Klaus Liefeith[1] — [1]Department of Biomaterials, Institute for Bioprocessing and Analytical Measurement Techniques Heiligenstadt — [2]Group of Inorganic-Nonmetallic Materials, Department of Mechanical Engineering, Technische Universität Ilmenau

The development of miniaturized structures on or below the surface of

glass is an issue of present research. Femtosecond-laser-radiation combined with the two photon process is a promising approach to push the written structures towards the nanometer scale. Here we used the photosensitive glass FS21 with its three step photoform process (irradiation, annealing, HF-etching). For the irradiation we used a TiSa oscillator only. These structures and steps are developed to realize a distinct miniaturization of glass components and to improve biocompatibility for specific cells. These structured glass are interesting for microfluidic and lab-on-a-chip devices.