O 36: Poster Session II (Organic films and electronics, photoorganics; Nanostructures; Plasmonics and nanooptics, Surface chemical reactions and heterogeneous catalysis, Surface dynamics)

Time: Tuesday 18:15–21:45 Location: Poster B2

O 36.1 Tue 18:15 Poster B2

Molecular Junctions Using Epitaxial Monolayer Graphene Electrodes — •Konrad Ullmann, Daniel Waldmann, Stefan Ballmann, and Heiko Weber — Lehrstuhl für Angewandte Physik, Universität Erlangen-Nürnberg, Germany

We report on a method to fabricate epitaxial monolayer graphene electrodes with nanometer separation grown on silicon carbide. The nanometer-gap is formed by feedback controlled electroburning of carbon atoms in presence of oxygen. A gapsize of approximately 1nm is extracted from the tunneling current.

Using these gaps we are able to form molecular junctions. Subsequently I-V measurements of a molecule possessing fullerene anchor groups exhibit prominent peaks in differential conductance, which is typical for single-molecule junctions.

O 36.2 Tue 18:15 Poster B2

THz conductivity of graphene films derived from functionalized graphene dispersions — •Christoph Testud, Martin Fabritius, Rolf Mülhaupt, Hanspeter Helm, and Markus Walther — Freiburger Materialforschungszentrum (FMF), Freiburg, Deutschland

We report THz conductivity measurements on functionalized graphene films over the frequency range 0.1-1.5 THz. The films have been produced by depositing dispersions of single graphene sheets on a substrate. The conductivity is measured by THz TDS (time domain spectroscopy), which represents a contactless and non-destructive characterization technique. To check our results for consistency we compared our extrapolated dc-values with results from four-point probe measurements. Material parameters such as plasma frequency or charge carrier scattering rates are extracted from fits to our data using the Drude Smith model, which accounts for reduced conductivity due to charge carrier localization on the few micrometer sized graphene sheets.

O 36.3 Tue 18:15 Poster B2

A novel approach to the fabrication of ultrathin poly(ethylene glycol) films — Nikolaus Meyerbröker and •Michael Zharnikov — Angewandte Physikalische Chemie, Universität Heidelberg, 69120 Heidelberg, Germany

We present a novel approach to prepare stable, ultrathin poly(ethylene glycol) (PEG) films which can of potential interest for biotechnology and nanofabrication. The approach is based on cross-linking of multifunctionalized, star-branched PEGs (STAR-PEGs). A two component mixture of amine- and epoxy-terminated four-arm STAR-PEGs dissolved in chloroform was spin-coated on a flat substrate. The complementary STAR-PEGs were then cross-linked by gentle heating at 80°C, which was monitored in situ by infrared reflection-adsorption spectroscopy. The film thickness could be tuned in a controlled fashion from 4 to 200 nm as determined by ellipsometry. The films were biocompatible as could be expected for PEG-based materials. The films were stable in aqueous solutions but exhibited pronounced swelling behavior characteristic of hydrogels. Controlling the relative humidity, it was possible to adjust precisely the extent of swelling and perform it in controlled and reversible fashion. Further, immersing the films in solution of gold nanoparticles (AuNP) we succeeded to prepare PEG/AuNP composite films of variable density which exhibited interesting and potentially useful optical properties. Combining this procedure with standard lithographic techniques, AuNP patterns in the PEG-matrix were fabricated on a broad length scale.

O 36.4 Tue 18:15 Poster B2

The adsorption of silver on lignin and its precursors — •Sebastian Dahle[1,2], John Meuthen[1], Lienhard Wegewitz[1,3], Wolfgang Viöl[2], and Wolfgang Maus-Friedrichs[1,3] — [1]Institut für Energieforschung und physikalische Technologien, TU Clausthal — [2]Hochschule für angewandte Wissenschaft und Kunst — [3]Clausthaler Zentrum für Materialtechnik, TU Clausthal

The adsorption of silver on lignin is of great interest for the modification of wood surfaces with antibacterial coatings. The natural precursors during the biosynthesis of lignin are mainly the monolignols sinapyl alcohol and coniferyl alcohol. These have been used as model systems to get a better understanding of the interaction of silver with lignin. X-ray Photoelectron Spectroscopy, Ultraviolet Photoelectron Spectroscopy, Metastable Induced Electron Spectroscopy and Atomic Force Microscopy have been employed during the investigations, we observed a formation of silver nanoparticles upon the catalytic decomposition of the lignin as well as its precursors.

O 36.5 Tue 18:15 Poster B2

Coverage of $[Mn_6^{III}Cr^{III}]^{3+}$ SMMs on Surfaces Analyzed by Means of Kelvin Probe Force Microscopy — •Aaron Gryzia[1], Armin Brechling[1], Ulrich Heinzmann[1], Veronika Hoeke[2], and Thorsten Glaser[2] — [1]Molecular and Surface Physics, Bielefeld University — [2]Anorganic Chemistry I, Bielefeld University

$[Mn_6^{III}Cr^{III}]^{3+}$ is a Single-Molecule-Magnet and as such consists out of metal centers and organic compounds and ligands. These organic parts are one of the two main properties playing an important role regarding the adsorption of the molecule onto surfaces, such as e.g. mica and HOPG. The other one is the SMM's charge of 3+. The resulting dipole moment of the SMM layer influences the contact potential difference (CPD). By using FM-KPFM at UHV conditions we are able to determine the CPD of the sample. Furthermore the CPD depends on the interaction of the SMM with the substrate. By achieving molecular resolution inside the adsorbed layers we are able to determine aligning of SMMs in respect to the substrate. In addition we manipulate the adsorption sites in order to increase the order of the SMMs on the surface.

O 36.6 Tue 18:15 Poster B2

Electronic and adsorption properties of perylene-tetracarboxylic-dianhydride on Au(111) — •Stephan Stremlau[1] and Petra Tegeder[1,2] — [1]Freie Universität Berlin, Institut für Experimentalphysik — [2]Rubrecht-Karls-Universität Heidelberg, Physikalisch-Chemisches Institut

Electronic and vibrational high resolution electron energy loss spectroscopy as well as temperature programmed desorption spectroscopy have been employed to gain insights into the adsorption behavior and the electronic properties of 3,4,9,10-perylene-tetracarboxylic-dianhydride (PTCDA) on Au(111). In the sub-monolayer regime the molecules adsorb in a planar geometry. With increasing coverage the molecules adopt a tilted configuration. Using sufficient high excitation energies of around 15.5 eV, the loss spectra in the multilayer regime show two strong electronic transitions at 2.3 and 2.5 eV. In the sub-monolayer regime only one transition at 2.6 eV is observed. The binding energy in the sub-monolayer range is 1.7(0.2) eV which is significantly lower than the recently published value of 2.5 eV [1].

[1] C. Wagner, N. Fournier, F.S. Tautz, R. Temirov, Phys. Rev. Lett., 109, 2012, 076102.

O 36.7 Tue 18:15 Poster B2

Impact of 2D structures on the back surface of solar cells on the absorption processes in these cells — •Jan Marc Stockschläder[1], Michael Jaax[2], Henning Fouckhardt[2], and Erich Runge[1] — [1]TU Ilmenau, 98693 Ilmenau, Germany — [2]TU Kaiserslautern, 67663 Kaiserslautern, Germany

Coupling light to the active medium of a solar cell is a crucial point for high efficiency. Therefore, structured substrates are studied to enhance the light matter coupling. Especially thin geometries are attractive because they have the potential to be fabricated low-cost. We present a 2D periodic structure based on the 1D double-periodic structures of Williamson et al. [1] as they already showed good surface-plasmon coupling capabilities. Furthermore, we analyse a structure based on Galois fields, which scatters incoming waves over a huge solid angle. This concept is well known for acoustic waves [2] and has recently been realized for the optical wavelength regime by M. Jaax et al. [3]. We show the yield enhancement as a substrate structure for solar cells.

[1] A. Williamson, E. McClean, D. Leipold, D. Zerulla, and E. Runge, *The design of efficient surface-plasmon-enhanced ultra-thin polymer-based solar cells* (APL **99**, 093307)

[2] T. J. Cox , P. D'Antonio, and Manfred Schroeder, *Acoustic Absorbers and Diffusers, Theory, design and application* (JASA **117**,3)

[3] M. Jaax, S. Wolf, B. Lägel, and H. Fouckhardt, *Optical reflective Galois scattering plates*, Presented at EOS Annual Meeting 2012, Aberdeen; (submitted to JEOS)

O 36.8 Tue 18:15 Poster B2

Tuning the work function of metal substrates by defined cleaning procedures and self assembling monolyers — •Marc Hänsel[1,3], Eric Mankel[1,3], Janusz Schinke[2,3], Wolfgang Kowalsky[2,3], Thomas Meyer[1,3], and Wolfram Jaegermann[1,3] — [1]Technische Universität Darmstadt, Materials Science Institute, Petersenstr. 32, Darmstadt — [2]Technische Universität Braunschweig, Institut für Hochfrequenztechnik und Photonik, Schleinitzstr. 22, Braunschweig — [3]InnovationLab GmbH, Speyerer Str. 4, Heidelberg

Understanding the contact behavior of organic semiconductors is a prerequisite to improve the efficiency of devices. Self-assembling monolayers (SAMs) are an interesting and promising way to vary and to define the work function of substrate materials. To investigate the influence of the SAMs a reproducible substrate is required. For this 150nm thick gold layers were evaporated on flat silicon substrates. Different treatments (eg. oxygen and argon plasma only and in combination with an ethanol bath, heating under atmosphere and vacuum, UV radiation, argon sputtering) for cleaning were evaluated by photo emission spectroscopy (XPS/UPS). Depending on the procedure different levels of cleanness and work functions between 3.5eV and 5.3eV were achieved. The best reproducible and practical method was argon plasma treatment leading to work functions of 4.8eV and sub monolayer adsorbate concentrations. First experiments are done with selected SAMs like Perfluorodecanethiol. XPS measurements prove a Perfluorodecanethiol layer on the gold surface and Kelvin probe force microscopy shows a work function increase of 1eV compared to an untreated gold sample.

O 36.9 Tue 18:15 Poster B2

Charge carrier separation at P3HT-SiC based solar cells — •Andreas Lücke, André Konopka, Siegmund Greulich-Weber, Eva Rauls, Wolf Gero Schmidt, and Uwe Gerstmann — Universität Paderborn, Department Physik, Paderborn, Germany

Today the standard organic solar cells consist of a polymer-fullerene interface for charge carrier separation. In order to reduce the costs and to increase the separation effiency, substitutes for the fullerenes are highly desirable. Here, silicon carbide in its cubic polytype (3C-SiC) is a promising alternative, providing HOMO and LUMO positions similar to those of fullerenes [1]. Here we study numerically the geometry, electronic structure and electron transport properties of the P3HT-SiC interface. Thereby we use the Quantum Espresso Package [2] implementation of the density-functional theory. As a model for P3HT polymers interlocked P3HT chains are utilized.

In order to get a qualitative insight into the carrier separation process, the transition probability is calculated with a ballistic transport model. Particular emphasis is given onto the orientation of the P3HT molecules at the contact and the influence of van der Waals interactions.

[1] A. Konopka et al., Mat. Sci. Eng. 15, 012013 (2010).

[2] P. Giannozzi et al., J. Phys.:Condens. Matter 21, 395502 (2009); URL http://www.quantum-espresso.org

O 36.10 Tue 18:15 Poster B2

Structural and electronic properties of P3HT/SiC interfaces — •Andre Konopka, Siegmund Greulich-Weber, Andreas Lücke, Eva Rauls, Wolf Gero Schmidt, and Uwe Gerstmann — Universität Paderborn, Department Physik, Paderborn, Germany

Organic molecules have become an interesting new class of material in optoelectronic and photovoltaic applications. For organic photovoltaic applications a key issue is the separation of the photo-generated charges in the organic component. In organic molecules the charges are strongly bound and form excitons. In order to separate the electron and the hole a second material component has to be used. For many organic solar cell concepts fullerenes serve as an effective electron acceptor. It has been shown that inorganic semiconductors can also fill this role [1]. The necessary electronic structure for an effective transfer of the electrons into the acceptor material is closely related to states introduces to the system by the interface between the organic and inorganic components [2]. In this work we present different configurations of an organic-inorganic interface (P3HT/3C-SiC). Various binding situations of P3HT on the SiC surface have been calculated by density functional theory. We also studied the influence of van der Waals interaction on the structural and electrical properties of the interface. In comparison the situation for the typically used P3HT/PCBM material system are calculated.

[1] A. Konopka et al., IOP Conf. Series: Mat. Sci. Eng. 15, 012013 (2010). [2] A. Konopka et al., Mater. Res. Soc. Symp. Proc. Vol. 1322, (2011).

O 36.11 Tue 18:15 Poster B2

Simulation of charge transport in C_{60} self-assembled monolayers for applications in field-effect transistors — •Susanne Leitherer[1], Christof Jäger[2], Tim Clark[2], and Michael Thoss[1] — [1]Institut für Theoretische Physik, Interdisziplinäres Zentrum für Molekulare Materialien, Friedrich-Alexander-Universität Erlangen-Nürnberg, Staudtstr. 7/B2, 91058 Erlangen, Germany — [2]Computer-Chemie-Centrum, Interdisziplinäres Zentrum für Molekulare Materialien, Friedrich-Alexander-Universität Erlangen-Nürnberg, Nägelsbachstraße 25, 91052 Erlangen, Germany

Charge transport through self-assembled monolayers (SAMs), which are used in field-effect transistors [1], is studied employing the Landauer transport formalism. In particular, SAMs consisting of C_{60} as active layer, functionalized by octadecyl phosphonic acids and insulating alkyl phosphonic acids are investigated [1]. The structure of the SAMs is characterized by molecular dynamics simulations [2] and semi-empirical electronic structure calculations [3]. Using small test systems, we analyze pathways for efficient charge transport by examining the transmission eigenchannels [4]. Moreover, the dependence of the transport properties on the mixing ratio of the molecules is discussed.

[1] M. Novak *et al.*, Nano Lett. 11, 156 (2011)
[2] M. Novak *et al.*, Organic Electronics 11, 1479 (2010)
[3] C. Jäger *et al.*, Nat. Chem., submitted 2012
[4] J. C. Cuevas *et al.*, Phys. Rev. Lett. 80, 1066 (1998)

O 36.12 Tue 18:15 Poster B2

Photovoltaic effect of light carrying orbital angular momentum — •Jonas Wätzel, Andrey Moskalenko, and Jamal Berakdar — Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, Heinrich-Damerow-Str. 4, 06120 Halle (Saale), Germany

Intensive research is devoted to the improvement of the efficiency of the photovoltaic elements by adjusting their material and structure properties. A promising alternative approach might be based on the adjustment of the structural properties of light before it is used to create currents in the cells, e.g. employing twisted light (TL) that is the idea followed in this presentation. TL is created routinely from usual light sources, e.g. via traversing a spiral wave plate that can be deposited onto the solar cell. One may think of enhancing the TL light intensity via self-focusing effect, an issue addressed recently. Strongly-focussed TL beams deliver additional opportunities to manipulate optical properties of nanostructures.

To explore the potential of TL for photovoltaics we investigate how the focussed TL beam influences an electron wave packet in a two-dimensional semiconductor stripe. We show that application of a TL beam results effectively in a voltage drop across the stripe with its sign being determined by the sign of the topological charge of TL. This is a photovoltaic effect that can be registered by measuring the generated voltage drop across the stripe and/or the current increase.

O 36.13 Tue 18:15 Poster B2

Deposition and spectroscopic study of Palladium complex on pyridine terminated quartz surface — •Deb Kumar Bhowmick[1,2], Helmut Zacharias[1,2], Wenchong Wang[1], and Lifeng Chi[1] — [1]Physikalisches Institut, WWU Münster, Münster, Germany — [2]Graduate School of Chemistry, WWU Münster, Münster, Germany

Particular interest exist in the formation of hybrid organic-inorganic material layers on semiconductor and insulator surfaces in which it is possible to control the function and properties by the nature and type of the incorporated metal ions [1]. A palladium (II) metal-organic complex with terpyridine ligand is synthesized in solution and deposited on a pyridine terminated quartz surface. The deposition process through organometallic complex can be one of the ways to functionalize surfaces with various organic molecules like dyes. This can be possible by further modifying the terpyridine ligand with different kind of organic molecules of interest. AFM, FT-IR spectroscopy and contact angle measurements are performed to characterize both the linker as well as organometallic functionalized quartz surfaces. The UV ab-

sorption spectrum yields two maxima at 353 nm and 370 nm of the organometallic functionalized quartz surface.

1] Altman, M.; Shukla, A. D.; Zubkov, T.; Evmenenko, G.; Dutta , P.; van der Boom, M. E. J. Am. Chem. Soc. 2006, 128, 7374-7382.

O 36.14 Tue 18:15 Poster B2

Glaser coupling at metal surfaces — •Hongying Gao[1], Hendrik Wagner[2], Dingyong Zhong[1], Armido Studer[2], and Harald Fuchs[1] — [1]Physikalisches Institut Muenster university,Wilhelm-Klemm-Straße 10, 48149 Münster — [2]Organisch-Chemisches Institut,Westfälische Wilhelms-Universität Münster,Corrensstraße 40, 48149 Münster

the Glaser coupling can be used highly efficiently to generate linear oligomer / polymer chains in spatial confinement at surfaces, which is impossible in conventional solution schemes. The generation of π-conjugated linear polymers directly at the interface is possible by using appropriate precursors and subsequent on-surface-coupling. It turned out that the Glaser coupling worked most efficiently on Ag(111) surfaces, as compared with Au(111) and Cu(111). The surface acts as a 2D supporting system that lets the molecules adsorb and orient in a plane, and may also mediate the reactions. The substitution pattern of the organic precursor molecules is also of great importance and simple steric shielding of the alkyne led to a suppression of side reactions. We believe that the approach presented herein is not restricted to the formation of π-conjugated linear chains but also allows for the formation of defined π-conjugated two-dimensional networks.

O 36.15 Tue 18:15 Poster B2

Nanoparticles droplets on a polymer brush studied by dissipative particle dynamics simulations — •Olga Guskova[1] and Christian Seidel[2] — [1]Leibniz Institute of Polymer Research, Dresden, Germany — [2]Max Planck Institute of Colloids and Interfaces, Potsdam, Germany

We use DPD simulations to investigate the self-assembly of nanoparticles (NPs) at a polymer brush/solvent (B/S) interface. Depending on the strengths of both the NP-solvent interaction and the NP-polymer one, NPs randomly distributed in solvent volume migrate to the polymer surface where they aggregate into droplets because of their solvophobic nature. We analyze the shape of the floating droplets as well as their effect on the free brush surface. In addition, the contact angles of NP droplets at the B/S interface are extracted from our simulations.

O 36.16 Tue 18:15 Poster B2

Clustering of adsorbed molecules on amorphous silica surfaces — •Yulia Rozhkova[1], Andrey Gurinov[1], Anna Orlova[2], Vladimir Maslov[2], Ilya Shenderovich[3], and Valentin Korotkov[1] — [1]St. Petersburg State University, St. Petersburg, Russia — [2]St. Petersburg National Research Institute on Information Technologies, Mechanics, and Optics, St. Petersburg, Russia — [3]University Regensburg, Germany

The specific current aim of this work is to inspect study the feasibility of spectral methods to characterize host-guest interactions and the dynamics of complex heterocycles loaded into silica pores of 4 to 20 nm in diameter. Acridine was adsorbed on the silica surface from vacuum and from solution. The strong hydrogen bound with proton shared is likely formed between hydroxyl groups and heteroatoms of acridine molecules in the first case. By comparing the luminescence spectra of acridine solution in the water and acridine adsorbed on silica from vacuum it was concluded that silica surface, dried in high vacuum at 420 K, contained a variety of adsorption centers, including adsorbed water. Adsorption of acridine from solution of dichloromethane results in formation of acridine aggregates on the surface. It can be happened in the case of island-type of adsorption. Acridine in dichloromethane solutions at different concentrations are investigated in detail. Concentration increasing was accompanied by formation of two types of aggregates. So, acridine self-aggregation was observed in solution. It may cause islet adsorption of acridine in the silica surface in the case of adsorption from solution.

O 36.17 Tue 18:15 Poster B2

Self-organized controlled positioning of nanoparticles in periodical arrays by horizontal dip coating — •Kathrin Kroth, Sabrina Darmawi, Limei Chen, and Peter J. Klar — I. Physikalisches Institut, Justus-Liebig-Universität, Heinrich-Buff-Ring 16, 35392 Gießen, Germany

With the help of a periodic array of cavities in the micrometer range, nanoparticles in colloidal particle suspension can be separated and arranged. The PMMA cavity structure is fabricated by EBL on a glass substrate. A drop of particle suspension, containing Au and polystyrene-latex particles (300nm), is deposited onto the array. Similar to standard dip coating, a second, motor-powered, plate slowly shoves the suspension above the structured surface. During this process the nanoparticles are arranged inside the cavities by the meniscus force. A characterization of the particles inside the cavities was carried out by SEM and Raman measurements. The Raman results will be discussed with respect to surface-enhancement effects of the signals.

O 36.18 Tue 18:15 Poster B2

***In Situ* Measurements of Protein Solutions with Nanoantenna Enhanced Infrared Spectroscopy** — •Robert Wolke[1], Jörg Bochterle[1], Frank Neubrech[1,2], and Annemarie Pucci[1] — [1]Kirchhoff-Institute for Physics, Heidelberg University, Im Neuenheimer Feld 227, 69120 Heidelberg, Germany — [2]4th Physics Institute and Research Center SCoPE, University of Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart, Germany

Fourier Transform Infrared spectroscopy (FT-IR) of aqueous solutions is a difficult task due to the strong absorption bands of water in the range of 1550-1750 cm^{-1} and 3000-3700 cm^{-1}. In order to enable measurements in transmission geometry, the thickness of the water layer should not exceed 10 μm. We created a microfluidic device (MFD) having nanoscopic metal rods inside the flow channel to utilize the signal enhancement seen in Surface-Enhanced Infrared Spectroscopy (SEIRS). This approach allows *in situ* SEIRS experiments in transmission geometry. Using photolithography, a flat microfluidic channel is inscribed on a calcium fluoride (CaF_2) wafer and closed off using a second CaF_2 wafer. SEIRS enhancement is achieved by micrometer long gold nanoantennas featuring localized surface plasmon resonance (LSPR) frequencies in the IR range. They are attached to the surface of the second wafer and can be exchanged easily. Our setup enables many new possibilities like *in situ* monitoring of protein binding kinetics to functional layers on the antennas or temperature dependent monitoring of protein conformation changes.

O 36.19 Tue 18:15 Poster B2

Investigation of surface plasmons on structured surfaces — •Tammo Böntgen[1], Jan Lorbeer[2], Marc Teichmann[2], Frank Frost[2], Rüdiger Schmidt-Grund[1], and Marius Grundmann[1] — [1]Universtät Leipzig, Institut für Experimentelle Physik II, Linnéstr. 5, Germany — [2]Leibniz-Institut ür Oberflächenmodifizierung e.V., Permoserstr. 15, Leipzig, Germany

Nanoscale ripple pattern with a period of ≈90 nm were formed on SiO_2 surfaces by low-energy ion beam erosion ($E_{ion} < 2$ keV) at oblique ion incidence angles. The pattern was than coated with a gold film of ≈40 nm thikness. A Kretschmann configuration with a SiO_2 prism was used to allow surface plasmon excitation at the gold/air interface. Subsequently the sample was analyzed using a spectroscopic ellipsometer in the range from 370 nm - 1700 nm and angles of incidence (AOI) between 40° - 45°. This setup is similar to attenuated-total-internal-reflection readily used for study of surface plasmons. With this setup we were able to unravel a strong dependence of the surface plasmon resonance (SPR) frequency and strength on the in-plan orientation of the sample and the AOI. While the SPR is mostly independent of the in-plane orientation at AOI close to 45° a strong frequency shift with rotation is observed at smaller AOI. Similarly the strength of the SPR also changes with the in-plain orientation. In combination at 42° AOI a strong resonance at 860 nm is observed. This resonance vanishes if the sample is rotated by 90°.

O 36.20 Tue 18:15 Poster B2

Photothermal Microscopy in Liquid Crystals — •André Heber, Markus Selmke, Marco Braun, and Frank Cichos — Molecular Nanophotonics Group, University of Leipzig, Linnéstraße 5, D - 04103 Leipzig

A weakly fluorescent nano-particle that resonantly absorbs light dissipates its excitation energy into the environment as heat. The resulting temperature profile creates a refractive index profile around the particle which affects the scattering of a second off-resonant laser beam. This principle called photothermal contrast is used for correlation spectroscopy, imaging and absorption spectroscopy of absorbing nano-particles such as metallic nano-particles, quantum dots and single molecules.

Here we employ the technique to study single gold nano-particles in the uniaxial liquid crystal 8CB. It is anisotropic and has phase tran-

sitions at ambient temperature which are connected to large jumps in the refractive index. This can enhance the photothermal signal. But the signal depends sensitively on frequency and sample temperature due to the phase transition. The signal anisotropy can be used to measure the local orientation of nematic domains. We analyse the photothermal signal and model it analytically. The results show that photothermal microscopy is an ideal tool to study microscopic phase transitions.

O 36.21 Tue 18:15 Poster B2

Surface-enhanced infrared spectroscopy of CBP-molecules based on nanometer-sized gaps — •Christian Huck[1], Frank Neubrech[1,2], Andrea Toma[3], David Gerbert[1], Thomas Härtling[4], Enzo Di Fabrizio[3], and Annemarie Pucci[1] — [1]Kirchhoff-Institute for Physics, Heidelberg University, Germany — [2]4th Physics Institute and Research Center SCoPE, University of Stuttgart, Germany — [3]Istituto Italiano di Tecnologia (IIT), Genova, Italy — [4]Fraunhofer Institute for Non-Destructive Testing, Dresden, Germany

Infrared spectroscopy is well suited for label-free characterization of molecular species. One disadvantage of the IR-spectroscopy is the relative low IR cross-section of molecular vibrations. One possibility to overcome this limitation is the use of surface-enhanced IR spectroscopy (SEIRS), where metal nanoparticles are used to enhance the electromagnetic field in their vicinity. If the resonance frequency of such particles matches molecule-vibrations, the vibrational signal can be enhanced up to 5 orders of magnitude. Additional enhancement is theoretically predicted and can be achieved by exploiting the extraordinary field enhancement of two antennas interacting across a very small gap.

Individual nanoantenna dimers with gap sizes down to 4 nm were prepared by electron beam lithography and subsequent photochemical metal deposition. Afterwards the dimers were covered with a 5 nm layer of CBP acting as a near-field probe. Our experiments show an increasing vibrational signal enhancement for decreasing gap sizes demonstrating the additional enhancement induced by nanometer-sized gaps.

O 36.22 Tue 18:15 Poster B2

Surface plasmon polariton induced effects onto the electronic transport through gold point contacts — •Philipp Nürnberger, Daniel Benner, Johannes Boneberg, Paul Leiderer, and Elke Scheer — Department of Physics, University of Konstanz, Germany

We study the impact of cw laser illumination onto the electronic transport through gold point contacts realized by Mechanically Controllable Break-junction (MCBJ) technique. For that purpose we excite surface plasmon polaritons at a grating, milled into the leads of the constriction. The excitation is controlled by an arrangement of additional gratings framing the constriction. Finally we compare the optical signal with the electronic response of the MCBJ.

O 36.23 Tue 18:15 Poster B2

Multicolor strong-field photoemission from metal nanotips — •Lara Wimmer, Georg Herink, Katharina Echternkamp, Daniel Solli, Sergej Yalunin, and Claus Ropers — Materials Physics Institute and Courant Research Centre, University of Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

We study strong-field photoemission from plasmonic nanotips driven by ultrashort laser pulses over a large spectral range. External static and optical fields enable us to control the photoemission process in a variety of ways. In multicolor scenarios, the cross-coupling of driving pulses at different wavelengths is investigated theoretically and experimentally, and the potential for ultrafast gating and steering of electrons in nanostructures is demonstrated.

O 36.24 Tue 18:15 Poster B2

Fabrication of plasmonic gold nanostructures for SERS using electron beam lithography and shadow evaporation — •Mario Fey — Justus-Liebig-Universität, Gießen, Deutschland

Plasmonic nanostructures exhibit a high local electric field and thus can be used for enhancing Raman signals. In order to fabricate such structures a combination of electron beam lithography (EBL) with a bilayer resist (PMMA on top of a copolymer) and shadow evaporation is used. Shadow evaporation is a means of overcoming the limitation of EBL by proximity effects and allows one to obtain metal structures with intermediate gaps of a few nanometers. A bilayer resist exhibits a pronounced T-bone undercut due to the different sensitivities of PMMA and the copolymer. The undercut allows one to carry out evaporation from different angles so the gap between two nanostructures can be tuned by the evaporation angle. The metallic line and dot structures with gaps of few nanometers were coated with dye solutions and studied by Raman spectroscopy to reveal plasmonic field enhancement in the Raman process.

O 36.25 Tue 18:15 Poster B2

Resonances and radiation patterns of metal-dielectric nanoantennas — •Manuel Gonçalves and Othmar Marti — Ulm University - Institute of Experimental Physics, Ulm, Germany

Plasmonic nanoantennas have been used to enhanced near-fields and scatter light emitted by small light sources at specific directions. However their radiation patterns are much more complex than classical antennas. Recently, materials of large refractive index were proposed for building antennas using the strong directivity of spectral well separated magnetic resonance modes. Silicon is one of the preferred candidates for such applications. On the other hand, destructive interferences between plasmonic radiant modes (bright plasmons) and subradiant modes (dark plasmons), as for magnetic dipoles and electric quadrupoles, in near-field coupled particles, leads to Fano resonances.

Using finite-element method (FEM) we study systems of plasmonic and dielectric particles presenting strong directivity, required for nanoantennas. We show how the Fano resonances can arise and their sensitivity on the particle size, environment and interparticle separation.

O 36.26 Tue 18:15 Poster B2

Polarization dependence of electron emission from cross-shaped nanoantennas — •Peter Klaer[1], Keno Krewer[1], Florian Schertz[1], Gerhard Schönhense[1], Hans-Joachim Elmers[1], Xiaofei Wu[2], and Bert Hecht[2] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz, 55122 Mainz — [2]Institut für Physik, Julius-Maximillians Universität Würzburg, 97074 Würzburg

Cross shaped nanoantennas that are designed to carry angular momentum have been fabricated by focused ion beam on single-crystalline gold flake. We show that these nanoantennas can be resonantly excited by femtosecond laser pulses using the emitted electron intensity from individual antennas, as determined by a photoemission electron microscope, as a measure for the plasmonic field enhancement. The resonant wavelength scales with the size of the antennas. The sample is illuminated from the front side at grazing incidence and from the backside at normal incidence. In both geometries the photoemission intensity of some antennas shows an unexpectedly pronounced polarization dependence, which can be explained by the actual shape of the nanoantennas.

O 36.27 Tue 18:15 Poster B2

Electromagnetic field distribution around gold nanorings under excitation with cylindrical vector beams — •Julia Fulmes[1], Christian Schäfer[1], Sebastian Jäger[2], Dominik A. Gollmer[1], Andreas Horrer[1], Dai Zhang[2], Alfred J. Meixner[2], Dieter P. Kern[1], and Monika Fleischer[1] — [1]Institute for Applied Physics, Eberhard Karls University of Tübingen, Germany — [2]Institute of Physical and Theoretical Chemistry, Eberhard Karls University of Tübingen, Germany

We investigate the optical behaviour of gold nanorings (NR) with variable geometries excited with cylindrical vector beams. The flexibility of lithographical fabrication processes enables precise control over the size, shape and surface smoothing of the nanostructures. We analyze the optical properties of gold nanorings by the combination of single particle dark field spectroscopy and confocal photoluminescence (PL) imaging. By illuminating the NR with cylindrical vector beams different photoluminescence patterns can be achieved depending on the ring diameters. The resulting PL images are explained by different overlap conditions between the ring and the individual components of the electromagnetic field in the focal spot. The observed excitation efficiency of discrete plasmon modes of the ring is in good agreement with numerical calculations. By matching the rings geometry to the illumination conditions the confined electromagnetic field can be maximized, enabling interesting applications of such nano-antenna as selective electric nanosource.

O 36.28 Tue 18:15 Poster B2

Numerical investigation of laser-triggered nanometer-sized

electron sources for ultrafast low-energy electron diffraction (ULEED) and ultrafast transmission electron microscopy (UTEM) — Stefanie Strauch, Simon Schweda, Max Gulde, Reiner Bormann, •Sascha Schäfer, and Claus Ropers — Materials Physics Institute and Courant Research Centre, University of Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

Sharp metallic tips excited by ultrashort laser pulses serve as promising electron sources for both UTEM and ULEED, due to their nanometer-sized emission area and large field enhancement at the tip apex. As part of the Göttingen UTEM initiative, we study the beam characteristics of pulsed Schottky field emitters within electron microscope geometries. In order to achieve optimal temporal and spatial pulse properties, it is crucial to understand the propagation of the photoemitted electron pulse in the beam-shaping electron optics for both high and low electron energy applications. We numerically investigate the electron optical design to improve the temporal pulse width, as well as the effective source size and beam emittance, and compare our findings with experimental results.

O 36.29 Tue 18:15 Poster B2

Surface plasmon travelling on a metallic stripe with nanometric constriction — •Golaleh Ghafoori, Daniel Benner, Johannes Boneberg, Paul Leiderer, and Elke Scheer — Department of Physics, University of Konstanz, Germany

We study the propagation of surface plasmons on a 4μm wide gold stripe of thickness 100nm by FDTD (Finite Difference Time Domain) simulations. For the excitation we use an optimized grating in the stripe. The surface plasmons propagate towards and across a constriction. We study the transmission over the constriction for different constriction shapes and as a function of the polarization. These studies allow the determination of local intensities in experiments with mechanically controllable break-junctions under light irradiation.

O 36.30 Tue 18:15 Poster B2

Probing the dispersion relation of surface plasmon polaritons by photoemission electron microscopy — •Jörn Willers Radke[1], Christoph Lemke[1], Till Leissner[1], Alwin Klick[1], Jacek Fiutowski[2], Kasper Thilsing-Hansen[2], Luciana Tavares[2], Jakob Kjelstrup-Hansen[2], Horst-Günter Rubahn[2], and Michael Bauer[1] — [1]Christian-Albrechts-Universität, IEAP, Kiel — [2]Syddansk Universitet, MCI, Sønderborg

We implemented two-photon photoemission electron microscopy (2P-PEEM) as a method to experimentally determine real and imaginary part of the dispersion relation of surface plasmon polaritons (SPPs) in the red and near-infrared spectral region. In the experiment a tunable Ti:Sapphire laser system is used for SPP excitation and detection via PEEM following an approach described in [1]. A characteristic periodicity in the photoemission data provide the relevant information on the real part of the SPP dispersion relation, the imaginary part is extracted from the decay length of the SPP signal. The validity of the approach is exemplified by measurements of the dispersion relation of SPPs propagating at the interface between a gold film and homogeneous films of para-hexaphenylene (p6P) at varying thickness. Furthermore, we also present experimental data of the SPP dispersion relation measured for individual dielectric loaded SPP waveguides. The example proofs the capability of this PEEM approach to provide a comprehensive view on SPP propagation properties in the frequency domain as governed by nanoscale objects.

[1] Kubo et al., Nano Lett. 7(2), p. 470 (2007)

O 36.31 Tue 18:15 Poster B2

Radiative heat transfer at the nanoscale between artificial structures — •Maria Tschikin[1], Philippe Ben-Abdallah[2], and Svend-Age Biehs[1] — [1]Carl von Ossietzky Universität, Institute of Physics, 26111 Oldenburg, Germany — [2]Carl von Ossietzky Universität, Institute of Physics, 26111 Oldenburg, Germany

The radiative heat flux for separation distances smaller than the thermal wavelength $\lambda_{\mathrm{th}} = \hbar c/(k_{\mathrm{B}}T)$ can be much larger than the black body limit due to the contribution of evanescent modes. Here we show that the inclusion of losses and evanescent contributions (in particular surface mode contributions) in the definition of the thermal conductance for photonic crystals is of fundamental importance. On the other hand we show that for hyperbolic materials like nanowire materials the dominant heat flux channel is provided by a broad band of frustrated modes rather than by surfaces modes. Finally, such artificial materials can be described by means of the effective medium theory in the long wavelength limit. We study the validity of the effective description for near-field radiation by comparing the effective calculation with exact results for layered media.

O 36.32 Tue 18:15 Poster B2

Single Molecule Junctions in Strong Optical Fields — •Hai Bi, Yuxiang Gong, Daniel Gerster, Joachim Reichert, and Johannes V. Barth — Physik Department E20, TUM, Garching

In order to advance the development of unimolecular electronic devices, it is mandatory to improve understanding of electron transport in single molecules, integrated in well-dependent environment. In this respect, multi-parameter studies are required to provide more information on such systems. Here we present a method which allows us to investigate single molecule junctions in strong optical fields. The molecules are self-assembled on a planar metal substrate and contacted by a gold-covered glass tip previously introduced for scanning near-field optical microscopy. The molecules are exposed to a photon flux guided through the tetrahedral tip that at the same time provides the electrical contact. The photon flux in the molecular junctions could be determined by photocurrent measurement of single photoactive proteins [1] and reveals significant field enhancements effects at the apex of the apertureless tip. This method can be employed to investigate a variety of nearly unexplored properties in single molecule junctions such as photoconductance and photocurrent generation and allows more over for an optical characterization of the molecular junctions by vibrational spectroscopic means as well.

[1] Daniel Gerster et al., Nature Nanotech. 7, 673-676 (2012)

O 36.33 Tue 18:15 Poster B2

Integration of a QCL in a SEIRA setup — •Anton Hasenkampf, Niels Kröger, Annemarie Annemarie Pucci, and Wolfgang Petrich — Kirchhoff-Institute for Physics Im Neuenheimer Feld 227 D-69120 Heidelberg

The main tool for surface-enhanced infrared absorption (SEIRA) for 60 years was the Fourier transform infrared (FTIR) spectrometer with a globar source. It allows spectroscopy of a sample with a spectral band width of 750 nm-100 000 nm. The disadvantage of this system is very low intensity of the used globar light source. This usually is compensated by long measurement times. In this work, we present an approach to combine a laser scanning microscopy setup with an external cavity quantum cascade laser (QCL) with grating in Littrow configuration. This enables a spectral measurement in the range of 7000 to 9000 nm. The 10^9 times higher spectral intensity compared to a globar can be used to reduce measurement time drastically and allows detection with a deuterated triglycine sulfate (DTGS). Since the spectral band width is limited, applications of the method are beyond broadband spectroscopy.

O 36.34 Tue 18:15 Poster B2

Ultrafast local dynamics of two-dimensional light modes — •David Leipold and Erich Runge — Institut für Physik, Technische Universität Ilmenau, Germany

The phenomenon of localization of waves by multiple coherent scattering attracts the interest of physical research for more than half a century. Anderson localization of matter waves is well established and a major building block of solid state physics. In contrast, the localization of classical waves – particularly light waves – is notoriously hard to observe and controversially discussed.

In this contribution, we present calculations considering the localized light field in ZnO nano-needle arrays. In particular, we investigate the influence of radiative losses on the formation of localized modes.

We compare results from numerical 2D solutions of Maxwells equations with open in-plane boundary conditions to 3D calculations including the finite needle-length and a rough substrate. The latter closely reproduce experimental findings[1] and have losses only in the out-of-plane directions. In the former, translational invariance in the out-of-plane directions suppresses these losses. Instead, losses in the in-plane directions are induced by open in-plane boundaries.

We find that modes showing mixed localized and lossy character form in the 2D case and can be distinguished by their lifetime and overlap with the vacuum region. These modes are similar to those found in the 3D calculations[1].

[1] M. Mascheck, *et al.*, Nature Photonics **6**, 293 (2012)

O 36.35 Tue 18:15 Poster B2

Observing the localization of light in space and time by ultrafast second-harmonic microscopy — M. Mascheck[1], S.

Schmidt[1], M. Silies[1], T. Yatsui[2], K. Kitamura[2], M. Ohtsu[2], •D. Leipold[3], E. Runge[3], and C. Lienau[1] — [1]Carl von Ossietzky Universität, Oldenburg, Germany — [2]School of Engineering, University of Tokyo, Japan — [3]Technische Universität Ilmenau, Germany

Anderson localization of light waves is notoriously hard to observe and controversially discussed for many decades. We present a method to investigate the degree of localization of the near-field of visible light in random arrays of vertically aligned ZnO nano-needles in space and time[1]. The second-harmonic emission of the needle array exhibits strong spatial fluctuations due to the presence of strong localization-induced hot-spots in the near-field intensity. We spatially resolve the second harmonic intensity with a tightly focused optical scanning-microscope setup.

In order to study the finite lifetime of the localized modes, the microscope is coupled to an interferometric frequency-resolved autocorrelation (IFRAC) setup. Combining both, the microscope focus and IFRAC with ultrashort laser pulses, we observe the localized light field with a spatial resolution better than 0.5μm and a temporal resolution better than 6 fs. We present measurements indicating hot-spot sizes smaller than the microscope resolution and mode lifetimes of 15 fs. In addition, 3D-FDTD calculations which are in well agreement with the experiment are presented[1].

[1] M. Mascheck *et al.*, Nature Photonics **6**, 293 (2012)

O 36.36 Tue 18:15 Poster B2

Simulation of antenna arrays for surface enhanced infrared spectroscopy — •Tobias W. W. Mass, Ann-Katrin U. Michel, Jon Mattis Hoffmann, and Thomas Taubner — 1st Institute of Physics, RWTH Aachen University, Sommerfeldstraße 14, 52074 Aachen, Germany

Metallic nanoantennas efficiently couple light into a region of subwavelength size. Antenna arrays designed for surface enhanced infrared spectroscopy (SEIRS) enable the detection of molecular vibration with high sensitivity [1]. Simulations are a useful tool to examine antenna coupling effects, which are crucial for plasmon resonance optimization [2]. Our simulation based investigations are concerned with square nanorod and hexagonal arranged triangle arrays having their plasmon resonances in the mid infrared region. Understanding the antenna coupling is important to predict the resonance position as well as the resonance width [3]. Therefore, analytic dipole approximations and numerical FDTD simulations are performed to explore the influence of coupling effects for different antenna lengths, array periodicities and substrate or cover material refractive indices. Experimental comparison is realized by FTIR measurements of e-beam and nanosphere lithography fabricated samples.

[1] Adato et al. *PNAS* **2009** 106(46), 19227-19232.
[2] Libermann et al. *Opt. Express* **2012** 20(11), 11953-11966.
[3] Adato et al. *Opt. Express* **2010** 18(5), 4526-4537.

O 36.37 Tue 18:15 Poster B2

Selective photo-induced metal deposition for fabrication of nanometer-sized gaps between infrared nanoantenna dimers — •Jochen Vogt[1], Frank Neubrech[1,2], Julia Katzmann[3], Thomas Härtling[3], Andrea Toma[4], Enzo Di Fabrizio[4], and Annemarie Pucci[1] — [1]Kirchhoff-Institute for Physics, Im Neuenheimer Feld 227, Heidelberg, Germany — [2]4th Physics Institute and Research Center SCoPE, University of Stuttgart, Stuttgart, Germany — [3]Fraunhofer Institute for Non-Destructive Testing, Dresden, Germany — [4]Istituto Italiano di Tecnologia (IIT), Genova, Italy

Excited metallic nanostructures separated by gaps in the nanometer range exhibit high confinement of electromagnetic fields. Resonant in the infrared, they are well suited for Surface-Enhanced Infrared Spectroscopy (SEIRS) of adsorbed molecules. In the standard electron beam lithographic fabrication process, limitations due to secondary electron effects cause the gap sizes of the initial dimers to be not smaller than approximately 10nm. In our approach, we apply the method of photo-chemical metal deposition in order to achieve further gap narrowing. The gold dimers on the substrate are covered with a gold salt solution and exposed to a focused laser beam. In our sample design, unwanted lateral growth of the dimer arms is prevented by an organic film covering the dimers in such an alignment, that spatially selective photo-chemical growth is enabled. After the growth procedure, the shielding film was removed and IR spectroscopy to determine optical properties of the dimers as well as SEIRS measurements of organic molecules were performed.

O 36.38 Tue 18:15 Poster B2

Anomalous Light Scattering by a Charged Dielectric Particle — •Rafael Leslie Heinisch, Franz Xaver Bronold, and Holger Fehske — Institut für Physik, Universität Greifswald

We study for a dielectric particle the effect of surplus electrons on the anomalous scattering of light arising from the transverse optical phonon resonance in the particle's dielectric function. Excess electrons affect the polarizability of the particle by their phonon-limited conductivity, either in a surface layer (negative electron affinity) or the conduction band (positive electron affinity). We show that surplus electrons shift an extinction resonance in the infrared. This offers an optical way to measure the charge of the particle and to use it in a plasma as a minimally invasive electric probe.

O 36.39 Tue 18:15 Poster B2

Laser-triggered electron emission from a Schottky emitter assembly — •Reiner Bormann, Stefanie Strauch, Max Gulde, Simon Schweda, Sascha Schäfer, and Claus Ropers — Materials Physics Institute and Courant Research Centre, University of Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

Laser-triggered electron emission form sharp metal tips offers great potential for future pulsed high-brightness electron sources in ultrafast transmission electron microscopy (UTEM). However, their implementation in the advanced electron optics setup of an electron microscope is challenging. As part of the Göttingen UTEM initiative, we investigate the laser-induced electron emission characteristics of a Schottky emitter as utilized in commercial transmission electron microscopes. Specifically, we focus on the angular emission pattern and energy spread of the photoemitted electrons depending on the laser fluence, pulse duration and photon energy.

O 36.40 Tue 18:15 Poster B2

Ultrafast Photon and Electron Emission Induced at Nano-Structured Gold Tips — •Benjamin Schröder[1], Murat Sivis[1], Matthias Duwe[1], Philipp Kloth[2], Martin Wenderoth[2], and Claus Ropers[1] — [1]Materials Physics Institute and Courant Research Centre, University of Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen — [2]IV. Physikalisches Institut, University of Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

Surface-plasmon-polaritons (SPPs) can be resonantly excited on metallic tapers by grating-coupling [1]. In this process, SPPs propagate towards the apex of the taper and converge in a localized hot spot with small nanometric dimensions. This type of evanescent apex excitation scheme provides a unique source for scanning probe applications at greatly reduced far-field background [2]. In this contribution, we study the excitation of SPPs on structured gold tips driven by broadband titanium:sapphire laser pulses. The spectral characteristics of the light emitted from the apex are evaluated as a function of angle of incidence, and a clear resonant behaviour is identified. We also examine nonlinear photoemission from such tips [3] and demonstrate that they are compatible with atomically resolving scanning tunnelling microscopy.

[1] C. Ropers et al., Nano Lett. 7, 2784 (2007)
[2] D. Sadiq, et al., Nano Lett. 11, 1609 (2011)
[3] R. Bormann, et al., Phys. Rev. Lett. 105, 147601 (2010)

O 36.41 Tue 18:15 Poster B2

Multi-photon photoelectron microscopy study of plasmonic silver structures and their interaction with porphyrin molecules — •Klaus Stallberg[1,3], Gerhard Lilienkamp[1], Herbert Pfnür[2,3], and Winfried Daum[1,3] — [1]Institute of Energy Research and Physical Technologies, TU Clausthal, Leibnizstr. 4, 38678 Clausthal-Zellerfeld — [2]Institut für Festkörperphysik, Leibniz Universität Hannover, Appelstr. 2, 30167 Hannover — [3]NTH School for Contacts in Nanosystems

Localized surface plasmons (LSPs) in metallic nanostructures provide strong field enhancement upon resonant irradiation with light of appropriate wavelength and thus strongly increase the efficiency of nonlinear optical processes such as multi-photon absorption. Moreover, previous studies in the frequency and time domain showed strong coupling of molecular excitations in light-absorbing molecules with surface plasmons of metallic surfaces and plasmonic nanostructures. In this contribution we apply energy-resolved photoelectron emission microscopy (PEEM) with short laser pulse excitation to study the role of plasmonic enhancement for two-photon photoemission from porphyrin molecular layers (Mg:TPP). As substrates for our experiments we use different silver structures epitaxially grown on Si(111)-(7x7) and

Si(100)-(2x1) substrates. Variation of the structure size allows for a tuning of the LSP resonance to match the absorption band of the porphyrin molecules. The effect of plasmonic enhancement in two-photon photoemission from these systems is studied in detail by variation of the photon excitation energy.

O 36.42 Tue 18:15 Poster B2

Theory for Multidimensional Coherent Spectroscopy of Plasmon Assisted Multi-Photon-Photoemission — Martin Aeschlimann[1], Tobias Brixner[3], Matthias Hensen[2], Christian Kramer[3], Pascal Melchior[1], Walter Pfeiffer[2], •Martin Piecuch[1], Christian Schneider[1], Christian Strüber[2], and Philip Thielen[1] — [1]Fachbereich Physik and Research Center OPTIMAS, Technische Universität Kaiserslautern, Erwin-Schrödinger-Str. 46, 67663 Kaiserslautern, Germany — [2]Fakultät für Physik, Universität Bielefeld, Universitätsstr. 25, 33615 Bielefeld, Germany — [3]Institut für Physikalische und Theoretische Chemie, Universität Würzburg, Am Hubland, 97074 Würzburg, Germany

The recently demonstrated coherent 2D nanoscopy [1] allows for multidimensional coherent spectroscopy with sub-diffraction spatial resolution. In a first application the local hybridization of plasmon modes was investigated on a corrugated silver film [1]. The complete interpretation of multidimensional spectra requires a suitable model for the excitation process. Here we present a model for plasmon assisted multiphoton photoemission in which both, collective and single particle excitations are treated as quantum excitations. Based on this, coherent 2D spectra are simulated and the concept of phase cycling is applied to identify particular quantum mechanical pathways through an appropriate linear combination of detectable photoemission signals. The resulting two dimensional photoemission spectra grant direct access to the coupling parameter of the system under investigation.

[1] Aeschlimann et al., *Science* 333 (6050), 1723-1726 (2011)

O 36.43 Tue 18:15 Poster B2

Light intensity modulation in tailored magneto-plasmonic crystals by a novel longitudinal magneto-photonic effect — V.I. Belotelov[1,2], L.E. Kreilkamp[3], •M. Jäckl[3], I.A. Akimov[3], A.N. Kalish[1,2], D.A. Bykov[4], S. Kasture[5], Achanta Venu Gopal[5], M. Nur-E-Alam[6], M. Vasiliev[6], L.L. Doskolovich[4], D.R. Yakovlev[3], K. Alameh[6], A.K. Zvezdin[2], and M. Bayer[3] — [1]Lomonosov Moscow State University, 119991 Moscow, Russia — [2]Prokhorov General Physics Institute, Russian Academy of Sciences, 119991 Moscow, Russia — [3]Experimental Physics 2, TU Dortmund University, D-44221 Dortmund, Germany — [4]Image Processing Systems Institute, Russian Academy of Sciences, 443001 Samara, Russia — [5]Tata Institute of Fundamental Research, 400005 Mumbai, India — [6]Electron Science Research Institute, Edith Cowan University, 6027 Joondalup, WA, Australia

We present our study on a novel magneto-optical phenomenon observed in a hybrid metal-dielectric structure consisting of a one-dimensional gold grating on top of a magnetic waveguide layer. When a magnetic field is applied perpendicularly to the grating slits the field distribution of its optical modes and thus the mode excitation conditions are changed. Under those conditions two principal modes of the magnetic layer – TM- and TE-modes – acquire additional field components and thus turn into quasi-TM and quasi-TE-modes, respectively. In the optical far-field this modification of the modes manifests itself in the distinct alteration of the optical transmission or reflection coefficients when the structure becomes magnetized.

O 36.44 Tue 18:15 Poster B2

Dark-field spectroscopy and simulation of plasmonic modes in single nanostructures — •Andreas Horrer, Christian Schäfer, Dominik A. Gollmer, Julia Fulmes, Dieter P. Kern, and Monika Fleischer — Institute for Applied Physics, Eberhard Karls University of Tuebingen, Auf der Morgenstelle 10, 72076 Tuebingen, Germany

Due to their strongly localized electrical fields and sharp resonances in the optical or infrared range, plasmonic nanostructures provide a promising platform for many applications, for example the detection of molecules with high sensitivity. For such applications it is crucial to be able to fabricate structures with well-defined sizes and shapes in a controlled manner and to understand their plasmonic resonances. Dark-field spectroscopy, where scattered light from individual nanoparticles can be detected in the far field, is a highly useful method for the study of the plasmonic modes of such structures. Different plasmonic nanostructures like gold nanocones, nanotriangles or nanodiscs were fabricated with varying sizes and aspect ratios and the optical properties of single structures were investigated by dark-field spectroscopy. For the characterization of the plasmonic modes of the nanostructures the spectra were compared to the results of finite element method based simulations of the structures in differently polarized electromagnetic fields. An overview over different structures, their spectral properties and corresponding numerical simulations will be presented.

O 36.45 Tue 18:15 Poster B2

ToF-PEEM for Probing and Control of Nanoplasmonic Optical Fields at Ultrahigh Spatiotemporal Resolutions — •Soo Hoon Chew[1,2], Alexander Gliserin[1,2], Matthias Kübel[2], Huanglei Bian[1], Kellie Pearce[1,2], Christian Späth[1], Florian Schertz[3], Jürgen Schmidt[1], Matthias Kling[2], and Ulf Kleineberg[1] — [1]Faculty of Physics, Ludwig Maximilian University of Munich, Germany — [2]Max Planck Institute of Quantum Optics, Germany — [3]Institute of Physics, University of Mainz, Germany

The attosecond plasmonic field microscope was developed to study the plasmonic dynamics in nanostructured surfaces with attosecond temporal and nanometer spatial resolution. We obtained a spatial resolution of 200 nm from imaging the gold nanostructures using time-of-flight-photoemission electron microscopy (ToF-PEEM) in combination with extreme ultraviolet attosecond pulses from a high harmonic generation source. We find that energy-filtered imaging could reduce the chromatic aberrations and the primary electrons are not affected by the space charge problem. Recently, strong carrier-envelope phase (CEP) effects are shown to be important in controlling electron motion in the matters. In order to investigate and control CEP effects on plasmonic nanostructures for every single laser shot, the phase-tagged ToF-PEEM has been developed. First experiments measuring CEP dependence on single gold nanoparticles have been performed with 10 kHz few-cycle laser pulses. These experiments demonstrate first steps toward the temporal characterization and CEP control of nanoplasmonic fields in a femtosecond optical-pump/attosecond XUV-probe scheme.

O 36.46 Tue 18:15 Poster B2

Spatiotemporal characterisation of nanofabricated silver plasmonic waveguides using 2P-PEEM — •Kellie Pearce[1,2], Christian Späth[1], Soo Hoon Chew[1,2], Sebastian Nobis[1], Anika Spreen[1], Jürgen Schmidt[1], and Ulf Kleineberg[1] — [1]Department of Physics, Ludwig Maximilian University of Munich, Garching, Germany — [2]Max Planck Institute of Quantum Optics, Garching, Germany

We characterise the static and dynamic properties of plasmonic waveguides and nanostructures using two-photon photoemission electron microscopy (2P-PEEM). The influence of the size, shape, and length of nanolithographically fabricated silver arrow-like waveguides on the surface plasmon excitation, propagation and focussing is investigated. In addition, we examine the polarization dependence of hotspots in coupled structures such as silver bow ties and chemically-synthesised gold nanospheres. Characterisation is performed as a first step towards time-resolved measurements using 10kHz few-cycle laser pulses.

O 36.47 Tue 18:15 Poster B2

Calculation of gold nanoparticle-enhanced up-conversion intensity of Er^{3+} ions — •Deepu Kumar[1], Florian Hallermann[1], Stefan Fischer[2], Alexander Sprafke[3], Jan Christoph Goldschmidt[2], and Gero von Plessen[1] — [1]Intitute of Physics (1A), RWTH Aachen University, 52056 Aachen, germany — [2]Fraunhofer ISE, Heidenhofstr. 2, 79110 Freiburg, Germany — [3]μMD Group, Institute of Physics, Martin-Luther University Halle-Wittenberg, 06120 Halle, Germany

The current generation process in conventional solar cells does not have any contribution from photons with energies lower than the silicon band gap (1.12 eV). Up-conversion processes, such as the excitation of electrons via sequential absorption of infrared photons in rare-earth ions, may be suited to exploit the near-infrared region of the solar spectrum. These processes lead to the conversion of two or more photons with low energy into one sufficiently high-energy photon that can be absorbed in silicon. We calculate the intensity enhancement of the up-conversion photoluminescence from a thin planar layer of Er^{3+} ions induced by a nearby gold nanosphere. We discuss the roles of the various excitation and decay processes involved in this enhancement.

O 36.48 Tue 18:15 Poster B2

Fabrication and investigation of plasmonic nano gratings

for photovoltaic devices — •Felicitas Walter, Dominik A. Gollmer, Christopher Lorch, Jiri Novak, Frank Schreiber, Dieter P. Kern, and Monika Fleischer — Institute for Applied Physics, Eberhard Karls University, 72076 Tübingen, Germany

The emerging field of plasmonics has brought about methods for guiding and localizing light at the nanoscale. Now the attention of researchers in this field has turned towards applications, where design approaches based on plasmonics can be used e.g. to improve absorption in photovoltaic devices. In this context we combine organic photovoltaics with plasmonic gold structures. It is our goal to increase the efficiency of such devices by the optical near field enhancement and scattering at the structured interfaces. Plasmonic gold structures are fabricated using the serial procedure of electron beam lithography, with which we have great flexibility regarding size and shape. First line gratings were fabricated, where we varied the periodicity and the line width. In addition, dot gratings with varying radii and periodicity were produced. For testing these gratings can be covered with organic layers relevant for photovoltaics. The optical properties of the structures are studied without and with such layers. Here we will present scanning electron micrographs of the gold structures and optical transmission spectra of these structures without and with added organic thin films.

O 36.49 Tue 18:15 Poster B2

Fabrication of nanoscaled plasmonic structures for Photoelectron emission microscopy (PEEM) by electron beam lithography — •Christian Späth, Anika Spreen, Soo Hoon Chew, Kellie Pearce, and Ulf Kleineberg — Ludwig-Maximilians-Universität München, Department für Experimentalphysik und Laserphysik, Coulombwall 1, 85748 Garching

To support experiments in the field of ultrafast nano-optics and plasmonics the fabrication of metallic nanostructures of various sizes and shapes by electron beam lithography is an important prerequisite.

We report on our latest results in the development process of nanoantennas for local optical field enhancement by localized surface plasmons (LSP) and tapered plasmonic waveguides for transportation and possible control of surface plasmon polaritons (SPP). Waveguides with different geometries with respect to size, tip shape, incoupling grating periods have been written in PMMA bilayer resist systems on Si (100) wafer and have subsequently been metal coated with ultrathin Ag or Au layers and finalized by lift-off; similarly with all nanoantennas, e.g. bow ties, ellipsoids and gratings in different sizes and arrangements.

The topography of these structures has been analyzed by means of atomic force and scanning electron microscopy and the spatiotemporal plasmonic properties of the nanosamples have been investigated by nonlinear laser photoelectron emission microscopy. Furthermore we plan to utilize different substrate materials such as diamond like carbon (DLC) or indium zinc oxide (InZnO) to improve image contrast during PEEM experiments.

O 36.50 Tue 18:15 Poster B2

Infrared spectroscopy of phase transitions in metal nanosystems — •Fabian Hötzel[1], Chung Vu Hoang[1,2], Tadaaki Nagao[2], Robert Lovrinčić[1,3], and Annemarie Pucci[1] — [1]Kirchhoff Institute of Physics , Heidelberg University, Heidelberg, Germany — [2]National Institute for Materials Science, Tsukuba, Japan — [3]Weizman Institute of Science, Rehovot, Israel

Metals show strong plasmonic effects in the infrared, which enables contact-free conductivity studies. Contribution from relaxation processes and band structure can be separately derived from spectral information. Even more, polarization dependent studies may reveal anisotropic behaviour. We present and explain examples with phase transitions as such between different metallic structures and a Peierls-type transition. This contribution is related to DFG-FOR 1700.

O 36.51 Tue 18:15 Poster B2

Characterization of Horizontally-aligned Carbon Nanotubes: Impact of Tip-induced Strain and Bias Voltage — •Parisa Bayat[1], Raul D. Rodriguez[1], Alexander Villabona[1], Sascha Hermann[2], Stefan E. Schulz[2], and Dietrich R.T. Zahn[1] — [1]Semiconductor Physics, TU Chemnitz — [2]ZfM, TU Chemnitz

Carbon nanotubes (CNTs) have attracted huge attention in the area of nanotechnology since the seminal work of Iijima in 1991. Several interesting examples of the advantages of CNTs like their high carrier mobility, remarkable thermal conductivity and significant mechanical strength have been demonstrated. The focus of this work is on the electrical properties of semiconducting single wall CNTs (SWCNTs) horizontally aligned between two pre-structured palladium electrodes in a field-effect transistor configuration. In this work we aim at investigating the role of tip-induced deformation of the SWCNTs by the AFM tip and the effect of bias voltage. Atomic force microscopy (AFM) in force spectroscopy mode, current sensing AFM, Kelvin force microscopy, and (tip enhanced) Raman spectroscopy are employed for the characterization. It was reported that the band structure of a carbon nanotube can be dramatically altered by mechanical strain reflected in examples such as the metallization of SWCNT by locally applying pressure. Theoretical works predict that band gap changes can range between +/-100 meV per 1% stretch, depending on CNT chirality. Our work aims at evaluating and verifying these predications. DFG-Research Unit 1713 "Sensoric Micro- and Nanosystems" SMINT is acknowledged for financial support.

O 36.52 Tue 18:15 Poster B2

Characterisation of Boron-doped Silicon Nanowires — •Stefan Weidemann[1], Peter Schäfer[2], Stefan Kowarik[2], Klaus Rademann[3], and Saskia F. Fischer[1] — [1]Novel Materials, Humboldt-Universität zu Berlin, 10099 Berlin, Germany — [2]Coherent Optics with X-rays, Humboldt-Universität zu Berlin, 10099 Berlin, Germany — [3]Nanostructured Materials, Humboldt-Universität zu Berlin, 10099 Berlin, Germany

Nanostructures of silicon reveal new intrinsic properties like decreased thermal conductivity [1]. To date, it remains a challenge to measure simultaneously thermal and electronic transport properties of individual silicon nanowires. Here, we prepare silicon nanowires by metal-assisted chemical etching (MACE)[2] with solid, rough and porous surfaces in dependence of the boron doping concentration (resistivities of ρ <10 mΩcm, ρ =14-23 Ωcm, ρ >1 kΩcm).

Nanowire lengths up to 110 μm (undoped Si, ρ >1 kΩcm), 90 μm (medium doped Si, ρ=14-23 Ωcm) and about 30 μm (highly doped Si, ρ<10 mΩcm) are achieved. Fabrication on wafer scale is possible. Surface and structural properties of both nanowire ensembles and individual nanowires are investigated by electron microscopy and x-ray diffraction. Single nanowires are investigated with respect to their thermoelectrical properties.

[1] A. I. Hochbaum *et al.*, Nature 451, 163 (2008)
[2] Z. Huang *et al.*, Adv. Mater. 2011, 23, 285-308

O 36.53 Tue 18:15 Poster B2

Mesoporous Silicon Nanowire Characterisation by Nitrogen Gas Adsorption — •Stefan Weidemann[1], Dirk Wallacher[2], and Saskia F. Fischer[1] — [1]Novel Materials, Humboldt-Universität zu Berlin, 10099 Berlin, Germany — [2]Department Sample Environments, Helmholtz-Zentrum Berlin, 14109 Berlin, Germany

Silicon nanowires produced by metal-assisted chemical etching have different surface morphologies in dependence of the doping concentration[1]. Solid, rough and porous nanowire surfaces can be prepared. While the formation mechanism of rough surfaces is still unclear we investigate the surface texture of mesoporous silicon nanowires by nitrogen gas adsorption.

We fabricated silicon nanowire ensembles of undoped Si (resistivity ρ>1 kΩcm), medium boron doped Si (ρ=14-23 Ωcm) and highly boron doped Si (ρ<10 mΩcm) and determined surface properties like pore diameter, pore volume and sample surface area. We discuss for samples of different preparation parameters such as etching time and etchant concentration how the pore formation is affected and determine the mean poresize distribution on highly doped nanowires.

[1] A. I. Hochbaum *et al.*, Nano Lett., Vol. 9, No. 10, 2009

O 36.54 Tue 18:15 Poster B2

Scanning tunneling microscopy of reconstructions including nanoline structures on the $SrTiO_3$(001) surface — •Ines Weidle, Jochen Settelein, Julian Aulbach, Jörg Schäfer, Michael Sing, Lenart Dudy, and Ralph Claessen — Physikalisches Institut, Universität Würzburg, 97074 Würzburg, Germany

The surface of cleaved $SrTiO_3$ hosts a two-dimensional electron gas which has recently attracted much attention as a model system for low-dimensional metals. On the other hand the surface of this oxide is known to exhibit a multitude of reconstructions. Among these reconstructions produced by a sequence of sputtering and annealing cycles, there are self-assembled nanoline-like structures of reduced titanate. These nanowires may have potential interest for (quasi-) one-dimensional physics of the electronic structure. We have explored the fabrication of these reconstructions on Nb-doped $SrTiO_3$ and present

our scanning tunneling microscopy (STM) measurements on nanoline structures.

A systematic study of the evolution of the various reconstructions has been performed as a function of the annealing treatment. After annealing, the STM images show widespread formation of a c(4 × 2) reconstruction. Subsequent annealing treatment promotes the occurrence of so-called dilines in (6 × 2) reconstruction. Their density can be increased upon further temperature treatment. The presentation discusses the various surface phases observed and provides a comparison with the pertinent literature.

O 36.55 Tue 18:15 Poster B2

Polystyrene spheres assisted anodization method for the preparation of size-controlled pore diameter and separation in the AAO template — •Yaoguo Fang[1], Kin Mun Wong[1], Liaoyong Wen[1], Yan Mi[1], Gerhard Wilde[2], and Yong Lei[1] — [1]H1107 Heliosbau, Technische Universität Ilmenau, Prof. Schmidt Str. 26, 98693 Ilmenau, Germany — [2]Heisenbergstr. 11 48149 Münster, Germany

Abstract We propose a method where the size of the pores in the anodic aluminum oxide (AAO) template can be precisely controlled with the use of the regular arrays of polystyrene (PS) spheres as a mask. A monolayer of PS spheres was first prepared on the bare aluminum foil and the silica sol was introduced into the spaces between the PS spheres. This was followed by removing the PS spheres with toluene and consequently highly ordered arrays of micro-bowl structures are fabricated on the Al foil. With the use of the PS spheres, the center of the bowl structures on the Al surface are not covered by the silica gel due to contact between the bottom of the PS sphere and the Al surface during the silica sol infiltration. With the use of the PS spheres, most of the Al surface will be covered by the silica sol and the pores can only be formed at the center of highly ordered arrays of micro-bowl structures by the normal two-step anodization procedure. Importantly, with the use of the smaller PS spheres, smaller pore diameters (less than 10 nm) in the AAO template can be obtained. In addition, the separation between the pores can be adjusted with the different sizes of the PS spheres.

O 36.56 Tue 18:15 Poster B2

Polystyrene spheres assisted anodization method for the preparation of size-controlled pore diameter and separation in the AAO template — •Yaoguo Fang[1], Kin Mun Wong[1], Liaoyong Wen[1], Yan Mi[1], Gerhard Wilde[2], and Yong Lei[1] — [1]H1107 Heliosbau, Technische Universität Ilmenau, Prof. Schmidt Str. 26, 98693 Ilmenau, Germany — [2]Institut für MaterialPhysik, Westfälische Wilhelms-Universität Münster, 48149 Münster, Germany

Abstract We propose a method where the size of the pores in the anodic aluminum oxide (AAO) template can be precisely controlled with the use of the regular arrays of polystyrene (PS) spheres as a mask. A monolayer of PS spheres was first prepared on the bare aluminum foil and the silica sol was introduced into the spaces between the PS spheres. This was followed by removing the PS spheres with toluene and consequently highly ordered arrays of micro-bowl structures are fabricated on the Al foil. With the use of the PS spheres, the center of the bowl structures on the Al surface are not covered by the silica gel due to contact between the bottom of the PS sphere and the Al surface during the silica sol infiltration. With the use of the PS spheres, most of the Al surface will be covered by the silica sol and the pores can only be formed at the center of highly ordered arrays of micro-bowl structures by the normal two-step anodization procedure. Importantly, with the use of the smaller PS spheres, smaller pore diameters (less than 10 nm) in the AAO template can be obtained. In addition, the separation between the pores can be adjusted with the different sizes of the PS spheres.

O 36.57 Tue 18:15 Poster B2

Polystyrene spheres assisted anodization method for the preparation of size-controlled pore diameter and separation in the AAO template — •Yaoguo Fang[1], Kin Mun Wong[1], Liaoyong Wen[1], Yan Mi[1], Gerhard Wilde[2], and Yong Lei[1] — [1]Fachgebiet 3D-Nanostrukturierung, Institut für Physik & IMN MacroNano (ZIK), Institute for Physics and IMN MacroNano (ZIK),Technische Universität Ilmenau, Prof. Schmidt Str. 26, 98693 Ilmenau, Germany — [2]Institut für MaterialPhysik, Westfälische Wilhelms-Universität Münster, 48149 Münster, Germany

We propose a method where the size of the pores in the anodic aluminum oxide (AAO) template can be precisely controlled with the use of the regular arrays of polystyrene (PS) spheres as a mask. A monolayer of PS spheres was first prepared on the bare aluminum foil and the silica sol was introduced into the spaces between the PS spheres. After removing the PS spheres, highly ordered arrays of micro-bowl structures are fabricated on the Al foil. With the use of the PS spheres, the center of the bowl structures on the Al surface are not covered by the silica gel due to contact between the bottom of the PS sphere and the Al surface during the silica sol infiltration. Therefore most of the Al surface will be covered by the silica sol and the pores can only be formed at the center of highly ordered arrays of micro-bowl structures by the normal two-step anodization procedure. Importantly, with the use of the smaller PS spheres, smaller pore diameters(less than 10nm)in the AAO template can be obtained. In addition, the separation between the pores can be adjusted with the different sizes of the PS spheres.

O 36.58 Tue 18:15 Poster B2

New approach to the fabrication of ssDNA/oligo(ethylene glycol) monolayers and complex nanostructures — •M Nuruzzaman Khan[1], Vinalia Tjong[2], Ashutosh Chilkoti[2], and Michael Zharnikov[1] — [1]Angewandte Physikalische Chemie, Universität Heidelberg, 69120 Heidelberg, Germany — [2]Department of Biomedical Engineering, Duke University, N C 27708-0300, USA

Immobilization of single stranded DNA (ssDNA) on solid support is an important issue for binding and detection of the complementary DNA target as well as for the recognition of DNA binding proteins. Here we present a universal two-step approach to fabricate mixed monomolecular films comprising thiolated ssDNA and oligo(ethylene glycole) substituted alkanethiolates (OEG-AT) which exhibit biocompatible properties providing a suitable matrix for the ssDNA . At first, the primary OEG-AT monolayer was irradiated with electrons to create defects in a controlled fashion. In the second step, a defect-promoted exchange between the molecules in the monolayer and ssDNA species in solution occurred, with the extent depending on the irradiation dose. The approach was combined with E-beam lithography, which allowed us to fabricate versatile ssDNA patterns of any required shape imbedded in the protein-repelling matrix. Further, applying surface initiated enzymatic polymerization, we succeeded to amplify the above ssDNA/OEG-AT patterns in the z-direction in a controlled fashion. Both ssDNA pattern and related 3D nanostructures can be widely used as versatile nanofabrication platform in such important fields as bio-engineering, bio-technology, and sensor fabrication.

O 36.59 Tue 18:15 Poster B2

Fabrication of iron nanostructures on various surfaces via focused electron beam induced processing in UHV — •Fan Tu, Florian Vollnhals, Martin Drost, Esther Carrasco, Matthias Franke, Hans-Peter Steinrück, and Hubertus Marbach — Lehrstuhl für Physikalische Chemie II, Friedrich-Alexander Universität Erlangen-Nürnberg, Egerlandstr.3, D-91058, Erlangen, Germany

Focused electron beams are well suited to manipulate matter on the nanoscale. In our 'surface science approach' to focused electron beam induced processing (FEBIP) we either deposit fragments of adsorbed precursor molecules or directly change the properties of a substrate itself. With the focused electron beam induced surface activation (EBISA) we recently explored a novel technique in which oxide surfaces, e.g. of SiOx and TiO2 substrates can be chemically activated on the nanoscale after local electron beam irradiation [1,2]. These activated region can be later on developed with Fe(CO)5 resulting in pure iron nanostructures. With this contribution we considerably expand the EBISA technique to adsorbed organic films on metal substrates and well-defined oxide reconstructions both on metal substrates. This work was supported by the DFG via grant MA 4246/1-1.

[1] M.M. Walz et al., Angw. Chem. Int. Ed., 49 (2010), 4669;
[2] M.M. Walz et al., Appl. Phys. Lett., 100(2012), 053118

O 36.60 Tue 18:15 Poster B2

Quantum-Well-States with non-vanishing momentum component in Cu/Co/Cu(100)-Systems — Philipp Kloth, Martin Wenderoth, •Philip Willke, Henning Prüser, and Rainer G. Ulbrich — IV. Phys. Inst., Georg-August-Universität, Göttingen

Quantum-well-states can form in metallic heterostructures and have been investigated by several methods, for example photoemission [1] and STM [2]. We report the formation of quantum-well-states above the Fermi energy for a Cu/Co/Cu(100)-layer system using low-temperature scanning tunneling spectroscopy. These states emerge

from a stationary point at the Fermi surface with a non-zero parallel momentum component. We show that the preparation method of the metallic heterostructures is a crucial parameter for the formation of these states. By comparing our results with a transfer matrix simulation in combination with a tight-binding band structure calculation, a cross-over between resonance states and bound states can be identified. This results in a phase shift of the energetic dispersion of these states with varying the confinement thickness. Furthermore, these states seem to dominate the density of states of copper compared to the more prominent well-states in this system with no parallel wave vector component.

We acknowledge the financial support by the DFG SFB 602 Project A3.

[1] J.E. Ortega, F.J. Himpsel, G.J. Mankey, and R.F. Willis, Phys. Rev. B 47, 1540-1552 (1993)

[2] M. Becker and R. Berndt, Phys. Rev. B 81, 205438 (2010)

O 36.61 Tue 18:15 Poster B2

PTCDA adsorption on KCl and NaCl(100) surfaces studied from first principles — •Hazem Aldahhak, Wolf Gero Schmidt, and Eva Rauls — Theoretische Physik, Universität Paderborn

In recent years, various highly regular supramolecular architectures of self-organized molecules on crystals have been designed and used in the bottom-up device technology.

In the past, metal surfaces have frequently been used as substrate. However, metal substrates induce screening and quenching effects and thus hamper the detailed spectroscopy of the adsorbed overlayer. In contrast, molecular adsorption on ionic crystals like sodium or potassium chloride opens the possibility to study electronically decoupled molecules.

Here we present density-functional theory calculations on the adsorption of PTCDA on KCl and NaCl (100) surfaces. Thereby the adsorption on flat surfaces as well as stepped substrates steps is investigated. Experimentally, both flat-lying (P-type) as well as standing molecules (S-type) are observed depending on the preparation conditions. In order to understand and rationalize the adsorption mechanisms leading to the formation of these structures, a large variety of interface geometries was studied and analyzed with respect to the contribution of ionic, covalent and van-der-Waals interactions between adsorbates and substrates. The influence of the substrate and bonding mechanism on the molecular electronic structure is investigated in detail and compared with the experimental data available.

O 36.62 Tue 18:15 Poster B2

Irradiation of graphene on calcium fluoride with highly charged ions — •Philipp Ernst, Jakob Krämer, Roland Kozubek, Johannes Hopster, and Marika Schleberger — Fakultät für Physik, Universität Duisburg-Essen, 47048 Duisburg, Germany

We have irradiated CaF_2 and graphene on CaF_2 with slow (E_{kin}=260 keV) highly charged ions ($^{129}Xe^{35+}$), which leads to defects on the surface in the nm-range. The topography of the sample is analyzed using an atomic force microscope (AFM) in contact- and tapping-mode. Two different types of masks were designed to compare irradiated areas on CaF_2 with unirradiated areas. Thus, it is possible to distinguish between small clusters most likely due to sputtering and defects directly created by HCI impact. We show, that AFM operating parameters have to be carefully chosen to perform a quantitative analysis of irradiation induced defects. The uncovered CaF_2 surface shows the well known hillocks induced by individual HCI impacts. The defects on graphene appear as regions of increased friction. By flipping the graphene flake with the AFM tip, the CaF_2 substrate below could be studied. There, the diameter of the hillocks are significantly smaller (7-8 nm) than on the uncovered sections of CaF_2 (15-40 nm).

O 36.63 Tue 18:15 Poster B2

Electronic characterization and ion induced modification of single layer MoS2 sheets — •Kolyo Marinov[1], Oliver Ochedowski[1], Nils Scheuschner[2], Ulrike Hutten[1], Janina Maultzsch[2], and Marika Schleberger[1] — [1]Universität Duisburg-Essen, Duisburg, Germany — [2]Technische Universität Berlin, Berlin, Germany

Ultrathin sheets of layered transition metal dichalcogenides like MoS2 have drawn much interest recently. While graphene lacks a band gap which complicates its integration in future semiconducting devices, MoS2 shows a transition from an indirect towards a direct band gap semiconductor in the case of single layer MoS2 sheets. It has already been demonstrated that the electron mobility matches Si and high on/off ratios of MoS2 devices can be achieved. We will present Kelvin probe force microscopy and *-photoluminescence data of single layer MoS2 exfoliated on SrTiO3. Our data shows a possible charge transfer and shift in the work function induced by the substrate. Furthermore, it will be shown how swift heavy ion irradiation can be used to taylor thin MoS2 sheets by creating rifts in the MoS2 sheet along the ion trajectory or creating folded MoS2 sheets which exhibit closed bilayer edges.

O 36.64 Tue 18:15 Poster B2

Automated spray coating process for the synthesis of extensive artificial opals — •Daniela Schneevoigt[1], Alexander Sprafke[1], and Ralf Wehrspohn[1,2] — [1]Martin-Luther-Universität, Halle-Wittenberg, Deutschland — [2]Fraunhofer IWM, Halle, Deutschland

3D photonic crystals such as artificial opals are a promising material class for the use in advanced light management concepts for solar cells [1]. To be able to integrate such concepts within the photovoltaic industry a low-cost and large-scale technique to produce photonic crystals of high quality is needed.

Here, we report on the successful implementation of an automated process for a spray induced self-assembly of 3D artificial opals. In contrast to previous work, non-porous substrates, such as glass or Si wafers are used. To achieve artificial opals of high quality, process parameters such as the solid content of the dispersion, the substrate material and the dispersion agent have to be adjusted. Most important is the understanding of the drying process, which is strongly affected by the choice of the aforementioned parameters. Therefore an extensive investigation of the influence of these parameters on the spray coating process was carried out in order to achieve a more precise understanding of the crystallization mechanism and to gain a better control over the fabrication process of artificial opals by spray coating.

[1] Sprafke, A., Wehrspohn, R., Light trapping concepts for photon management in solar cells. Green, 2(4): 177-187, (2012).

O 36.65 Tue 18:15 Poster B2

Are there coherent phonon signatures of a photoinduced, meta-stable state in *1T*-TaS_2? — •Manuel Ligges[1], Simon Freutel[1], Isabella Avigo[1], Ljupka Stojchevska[3], Laurenz Rettig[1], Tomaz Mertelj[3], Ping Zhou[1], Dragan Mihailovic[3,4], Lutz Kipp[2], Kai Rossnagel[2], and Uwe Bovensiepen[1] — [1]Univ. Duisburg-Essen, Germany — [2]Christian-Albrechts-Univ. zu Kiel, Germany — [3]Complex Matter Dept., Jozef Stefan Institute, Ljubljana, Slovenia — [4]CENN Nanocentre, Ljubljana, Slovenia

1*T*-TaS_2 is a layered transition metal-dichalgoenide that exhibits a manifold of electronic and structural phases, giving rise to a complex interplay between electronic correlation effects and structural modifications. Of particular interest is the photo-induced melting of the Mott-Hubbard phase that is associated with a partial removal of commensurate charge-density wave (CCDW) order. We performed pump-probe photoemission experiments in which coherent phonon signatures associated with the amplitude mode of this CCDW are observed. Upon strong (a few mJ/cm^2) infrared few-pulse pre-excitation of the material before the pump-probe experiments, severe changes in the vibrational spectrum can be observed that persist on very long timescales (> hrs). The signature observed before this intense excitation (2.4 THz) splits up into a 2.4 THz and a 2.5 THz component with comparable amplitude. We will discuss meta-stable configurations of the CCDW ordered state as a potential origin of this observation. We acknowledge financial support by the Deutsche Forschungsgemeinschaft through BO 1823/2, /4 and the European Union under grant agreement 280555 within FP7.

O 36.66 Tue 18:15 Poster B2

Microscopic and spectroscopic studies of epoxy-steel interfaces — •Henning Munkert[1], Lienhard Wegewitz[1,2], Florian Voigts[3], Heinz Palkowski[2,4], and Wolfgang Maus-Friedrichs[1,2] — [1]Institut für Energieforschung und Physikalische Technologien, TU Clausthal — [2]Clausthaler Zentrum für Materialtechnik, TU Clausthal — [3]Institut für Elektrochemie, TU Clausthal — [4]Institut für Metallurgie, TU Clausthal

Deformable sandwich sheet materials produced as raw materials and formed afterwards to complex geometries require a good bonding to guarantee a stable shear transfer between the single layers. However, due to the deformation, failures by delamination often occur between the epoxy and the metal. The aim of our work is to understand the

basic effect of the interfaces' bonding behavior in selected preparation steps of the system. It is shown how surfaces change topographically as well as in their chemical composition, if epoxy and steel layers get into contact with each other: The interaction between the two materials results in various functional carbon groups like C-C, C-O and C=O and in the reduction of iron according to the different preparation steps. These effects are studied with Atomic Force Microscopy (AFM) and X-ray Photoelectron Spectroscopy (XPS).

O 36.67 Tue 18:15 Poster B2

Surface alteration during the corrosion of sodium silicate glasses — •Melanie Dathe and Hans Roggendorf — Martin-Luther-Universität Halle-Wittenberg, Institut für Physik

The dissolution of sodium silicate glasses is a standard method for the production of soluble glass (waterglass). Therefore, the processes of the dissolution of sodium silicate glasses are investigated. The composition of the sodium silicate glasses investigated here was $Na_2O \cdot x\ SiO_2$, with x=2 and 3.3. The dissolution of the glass can be regarded as an extreme case of glass corrosion. During this process, layer formation arises at the surface, ion exchange occurs as well as dissolution of the altered surface. These changes at the interface glass - corrosion media were first observed with in-situ microscopy. Corrosion tests were executed under static and dynamic test conditions, in order to gain information about the dependence on time, temperature and ratio of sample surface to solution volume. The developed layers were analysed after the corrosion tests with scanning electron microscopy with energy dispersive analysis in order to gain elemental concentration profiles. Raman microscopy and infrared reflexion spectroscopy were used for identification of water species and their amounts. Besides layer characterisation, the gained corrosion values (pH value, concentration of dissolved species in the solution) were compared with established corrosion models.

O 36.68 Tue 18:15 Poster B2

Adsorption of tetrahydrofuran on the Si(001) surface studied by means of STM and XPS — •Marcel Reutzel[1], Gerson Mette[1], Michael Dürr[1,2], Ruben Bartholomäus[3], Ulrich Koert[3], and Ulrich Höfer[1] — [1]Fachbereich Physik und Zentrum für Materialwissenschaften, Philipps-Universität, D-35032 Marburg — [2]Fakultät Angewandte Naturwissenschaften, Hochschule Esslingen, D-73728 Esslingen — [3]Fachbereich Chemie, Philipps-Universität, D-35032 Marburg

A promising possibility to compete with the challenges of miniaturization in semiconductor device physics is the functionalization of inorganic semiconductor surfaces with organic molecules. In this context, we have investigated the reaction of the frequently-used organic solvent tetrahydrofuran (THF) on Si(001) by means of scanning tunneling microscopy (STM) and X-ray photoelectron spectroscopy (XPS). Despite its low reactivity in solvent based organic chemistry, THF was found to exhibit a complex surface chemistry on the Si(001) surface.

At low temperatures, the STM images indicate an adsorption geometry with the THF molecule located at the lower Si dimer atom. In combination with an observed energetic shift to higher binding energies in the O(1s) XP spectra, a dative bonding between a free electron pair of the oxygen atom and the empty dangling bond surface state is suggested. At temperatures $T_s > 270$ K, an irreversible rearrangement of the THF molecules is observed. The resulting configurations bridge two dimer rows. For temperatures $T_s > 700$ K, the STM and XPS data point to the formation of silicon carbide and silicon oxide structures.

O 36.69 Tue 18:15 Poster B2

CH_4 and C_2H_4 decomposition and hydrocarbon formation on Ru(0001) — •Harald Kirsch, R. Kramer Campen, and Martin Wolf — Fritz-Haber-Institut, Faradayweg 4-6, 14195 Berlin

Interaction of CH_4 and C_2H_4 with a metal (oxide) surface may lead to the stepwise decomposition of these species and the formation of higher hydrocarbons. Understanding the details of these processes is critical to engineer desired chemistry: e.g. the oxidative coupling of CH_4 to form C_xH_y or the steam reforming of CH_4. Here we characterize the interaction of CH_4 and C_2H_4 with the Ru(0001) surface under UHV conditions using temperature programmed desorption and vibrational sum frequency spectroscopy (> 5 cm^{-1} resolution) as a function of surface temperature (100-500 K) and coverage (quantified using C+O recombinative desorption). To overcome the dissociation barrier of CH_4 on Ru(0001) we employ a molecular beam source with CH_4 seeded either in He or H_2. By investigating both CH_4 and C_2H_4 decomposition we identify novel species in the decomposition pathways of both gases: CCH_2 is observed in the sequential decomposition of C_2H_4 and CCH in the high temperature decomposition($> 350K$) of CH_4 each for the first time. By characterizing both species as a function of surface coverage and, for CH_4, as a function of carrier gas we further show how the relative stability of various double-carbon species is a function of available hydrogen adsorption sites. At coverages $< 30\%$ of a ML of carbon, the formed CCH_2/CCH species are stable up to 350K, while at $> 60\%$ ML its stable up to 500K. The results are discussed in comparison to theoretical modelling of the decomposition process.

O 36.70 Tue 18:15 Poster B2

Sabatier based CO2-Methanation of flue gas in conventional power plants — •Michael Fleige, Klaus Müller, and Dieter Schmeisser — Brandenburgische Technische Universität Cottbus, Angewandte Physik/Sensorik, Konrad-Wachsmann-Allee 17, Germany

Already discovered by Paul Sabatier in 1902 the Hydrogenation according to CO2 + 4H2 ->CH4 + 2H2O nowadays is discussed in the course of the 'Power-to-Gas' approach to utilize excess energy from renewable electricity generation in times of oversupply of electricity. We investigate the behavior of this process in a simulated flue gas atmosphere of conventional base load power plants, which could be used as constant sources of the reactant CO2. Therefore the influence of different flue gas compositions such as varying contents of nitrogen and residual oxygen are tested in a laboratory scale. The heterogeneous catalysis process is investigated with regard to conversion rates, yield and selectivity and long-term stability of the Ni-catalyst. Earlier results of stable operating conditions in a 1:1 mixture of nitrogen and reactants, which is a typical ratio for flue gas in conventional power plants, could be confirmed in a first step.

O 36.71 Tue 18:15 Poster B2

HR-EELS on powder samples — •Sebastian Frey, Martin Kroll, and Ulrich Köhler — Ruhr-Universität Bochum

High resolution electron energy loss spectroscopy is a useful tool in heterogeneous catalysis as it provides information about vibrational states of adsorbates. While HR-EELS on single crystals has found wide spread and nowadays serves as a sophisticated tool to obtain adsorbate information, most studies on oxide nanoparticles rely on infrared spectroscopy (FTIRS) as EELS requires a reflecting sample with high conductivity. In the field of heterogeneous catalysis this causes a material gap between idealized single crystalline model systems (analyzed with HR-EELS) on the one hand and real catalysts based on nanoparticles (studied with FTIRS) on the other hand.

Enabling HR-EEL Spectroscopy on nanoparticles opens up a new approach to get closer insight into the behavior of real oxide materials that are used in heterogeneous catalysis. We studied ZnO nanoparticles and their corresponding metal loads Cu and Au, which are used for methanol synthesis and CO oxidation. Our experience shows that a thoroughly sample preparation and pretreatment is vital in order to obtain reasonable results in the EELS. The nanoparticle layer has to be smooth and closed to produce adequate reflection intensity. Moreover sufficient conductivity is required to prevent surface charging. Both requirements can be met by sedimenting oxide powder on a gold plate. In the case of ZnO a clear phonon spectrum emerges which is comparable to Fuchs-Kliewer phonons present on a single crystalline surface.

O 36.72 Tue 18:15 Poster B2

Ultraviolet photoelectron spectroscopy and transmission electron microscopy of mass selected silver clusters — •Natalie Miroslawski[1], Christoph Schröder[1], Paul Salmen[1], Bernd von Issendorff[2], Wilfried Sigle[3], Peter A. van Aken[3], and Heinz Hövel[1] — [1]Fakultät Physik/DELTA, Technische Universität Dortmund, 44221 Dortmund, Germany — [2]Fakultät für Physik, Albert-Ludwigs Universität Freiburg, 79104 Freiburg, Germany — [3]MPI for Intelligent Systems, 70569 Stuttgart, Germany

Mass selected silver clusters between 55 and 923 atoms were deposited with less then 0.1eV/atom kinetic energy on Xenon and investigated with ultraviolet photoelectron spectroscopy (UPS) with a photon energy of 11.6eV. The clusters were deposited with different coverage and measured at 15K. To extract the signal of the silver clusters we measured spectra for the rare gas covered substrate before deposition and substracted them from the measurements after cluster deposition. We obtained a size dependent cluster signal for energies in the s-p-band region which are discussed in respect of free beam experiments [1].

Additionally we present transmission electron microscopy (TEM)

images of silver clusters with 923, 1100 and 2493 atoms per cluster.

[1] Oleg Kostko, *Photoelectron spectroscopy of mass-selected sodium, coinage metal and divalent metal cluster anions*, PhD-thesis, Albert-Ludwigs-Universität Freiburg (2007)

O 36.73 Tue 18:15 Poster B2

Mass selected copper clusters on rare gases(Ar/Xe): Photoelectron spectroscopy with ultraviolet light — •Paul Salmen[1], Natalie Miroslawski[1], Christoph Schröder[1], Bernd von Issendorff[2], and Heinz Hövel[1] — [1]Fakultät Physik / DELTA, Technische Universität Dortmund, 44221 Dortmund, Germany — [2]Fakultät für Physik, Universität Freiburg, 79104 Freiburg, Germany

We investigated mass selected copper clusters between 55 and 923 atoms deposited and measured at temperatures between 12 K and 15 K on several monolayers of Argon (Ar) and Xenon (Xe) using ultraviolet photoelectron spectroscopy. The rare gas was used to minimize the cluster/surface interaction and the layers were adsorbed at 30 K (Xe) and 15 K (Ar) on Copper(111) and Silver(111) surfaces. The clusters were soft landed with less than 0.1 eV per atom kinetic energy. To extract the signal of the copper clusters we measured the spectra for the rare gas covered substrate before deposition and subtracted them from measurements after the deposition. We used an Ar-gas discharge lamp ($h\nu$=11.6 eV) with a heatable LiF-window to suppress the satellite lines[1].

[1] M.Budke and M.Donath, Appl. Phys. Lett. 92, 231918 (2008); S.Suga, et al., Rev. Sci. Instruments 81, 105111 (2010)

O 36.74 Tue 18:15 Poster B2

High deposition rate of metal (oxide) nanoclusters generated in pulsed DC magnetron sputtering system — •Oleksandr Polonskyi[1,2], Tilo Peter[1], Amir Ahadi[1], Alexander Hinz[1], Thomas Strunskus[1], Vladimir Zaporojtchenko[1,3], and Hynek Biederman[2] — [1]Faculty of Engineering, Institute for Materials Science - Multicomponent Materials, Kiel University, Kaiserstr. 2, D-24143 Kiel, Germany — [2]Charles University in Prague, Faculty of Mathematics and Physics, V Holesovickach 2, 180 00 Prague 8, Czech Republic — [3]deceased

The effect of pulsing a DC magnetron discharge on deposition of metal (-oxide) nanoclusters was studied. The work is focused mainly on the deposition of Ti (TiOx) nanoclusters by means of gas aggregation cluster source based on magnetron sputtering. Argon was used as a working gas and additionally, a low concentration of oxygen was admixed, which is necessary for the cluster formation process. The discharge was excited using the combination of a DC power supply operating at constant power mode and self-constructed pulsing unit with frequency repetition up to 100 kHz. It was found that the utilization of pulsed magnetron sputtering provides an extremely high deposition rate of Ti (TiOx) nanoclusters in comparison to a continuous magnetron discharge. The influence of the discharge repetition frequency (20-100 kHz) and duty cycle (20-90%) was investigated. By adjusting the duty cycle and repetition frequency at constant power and oxygen admixture, a maximum efficiency of cluster generation and thus deposition rate can be found.

O 36.75 Tue 18:15 Poster B2

Clusters from Focused Ion Beams – High-resolution mass spectroscopy of Liquid Metal Ion Sources — •Martin Wortmann, Dirk Reuter, and Andreas D. Wieck — Ruhr-Universität Bochum, Universitätsstr. 150, 44780 Bochum

The Liquid Metal Ion Source (LMIS) is by far the most commonly used source type for Focused Ion Beam (FIB) applications. But the expected abundance of clusters from these sources also makes them a promising tool for the preparation of mass selected clusters. For the investigation of the emission characteristics, the resolution of the FIB-system-built-in mass filters is normally the limiting factor. The resolution of the commonly employed $E \times B$ – filters decreases with the mass of the clusters and therefore it has so far been impossible to measure the abundance of clusters, which are composed of more than 10 atoms.

Recently, a high resolution mass spectrometer for measuring the emission characteristics of LMIS has been built and set into operation. The resolution of the measurement setup is sufficient for accomplishing mass separation for clusters with masses above 2000 amu. Small clusters can even be analyzed regarding their composition of different isotopes. In this contribution, technical details of the mass spectrometer and results of the first measurements are presented.

O 36.76 Tue 18:15 Poster B2

Structural and Dynamical Properties of Nitrates of Alkali Metal in the Vapor-aqueous Interface — •Gang Huang — Institute for Pysics, University of Mainz,Mainz, Germany

The structure of ions at the vapor-aqueous interface, and their influence on the water's hydrogen bond network is of special interest to the atmospheric chemistry community. The use of surface specific vibrational spectroscopy techniques has permitted to elucidate some aspects of surface hydrogen bond structure for water in the presence of ions [1]. The influence of molecular ions (such as nitrate and sulfate ions) has been analyzed, but proved more elusive than that for halide solution [2].

We use ab initio molecular dynamics to analyze the structure and dynamics of the vapor-aqueous interface containing LiNO3 and to provide a microscopic interpretation of recent experimental results from the group of H. Allen. Vibrational density of states is used to extract the vibrational signatures for the ions and the surrounding water molecules. Gas phase clusters of (Alkali)NO3(H2O)n (n=3,4,5) have been used to obtain the effects of different Alkali ions on hydrogen bond network. The MD simulations were performed with the software suite CP2K.

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O 36.77 Tue 18:15 Poster B2

Synthesis of core-shell and composite nanoparticles — •Aladin Ullrich, Stefan Hohenberger, and Siegfried Horn — Lehrstuhl für Experimentalphysik II, Universität Augsburg

We have investigated the synthesis of core-shell and composite transition metal oxide nanoparticles. The particles were synthesized by thermal decomposition of metallorganic precursors in a high-boiling solvent. We synthesized particles consisting of a mixture of iron oxide and manganese oxide in a two-step synthesis.

In the first step, iron oleate and manganese oleate were used as precursors for the production of pure iron oxide and manganese oxide nanoparticles, respectively. In the second step, these particles were used as seed crystals for the growth of the respective other compound. Following this route we were able to synthesize composite particles combining iron oxide and manganese oxide. The particles were characterized by transmission electron microscopy, using the energy filtered imaging mode to visualize the elemental distribution. The composite particles found included also core-shell-systems with a size of 20 nm.

The magnetic properties of the particles were studied on a sample produced by drying a solution of hexane containing composite particles. Field cooled magnetic hysteresis measurements show an exchange bias. We suggest that this exchange bias arises from the interface between manganese oxide and iron oxide within the composite particles.

The preparation method for composite nanoparticles described here is widely applicable, e.g. it can be applied to almost all transition metal oxides.

O 36.78 Tue 18:15 Poster B2

Interaction of Metal Clusters with Organic Molecules: Absorption Spectroscopy and Current Setup of a Photoemission Electron Microscope — •Hannes Hartmann[1], Ingo Barke[1], Vladimir Popok[2], Alexandra Pazidis[1], Antje Neubauer[1], Stephan Bartling[1], Stefan Lochbrunner[1], and Karl-Heinz Meiwes-Broer[1] — [1]Institut für Physik, Universität Rostock, Universitätsplatz 3, 18051 Rostock, Germany — [2]Department of Physics and Nanotechnology, Aalborg University, 9220 Aalborg, Denmark

Clusters and nanoparticles are of significant interest for applications in catalysis. One approach is the utilization of the nanoparticles' optical properties to increase the efficiency of existing catalytic schemes. In this contribution recent results on the optical properties of a system of Ir based photosensitizers (PS) in interaction with Ag clusters are summarized in view of potential applications for photocatalytic hydrogen production. For a more detailed understanding of the coupling mechanisms between deposited clusters and organic molecules an experimental setup for photoemission electron microscopy (PEEM) is being realized. The PEEM is equipped with an imaging time-of-flight and a retarding-field energy filter. Several excitation sources can be used, including a Hg-lamp, a 266nm cw-laser, and a Ti:sapphire laser for two-photon photoemission (2PPE). In addition to standard equipments for sample preparation the chamber is attached to a clus-

ter source for in-situ deposition of mass-selected nanoparticles. The current state of design and construction of the experimental setup, as well as the results of first measurements are presented.

O 36.79 Tue 18:15 Poster B2

UV-VIS absorption and XANES of Ag clusters in matrices — •Stefanie Duffe[1], David Engemann[1], Sabrina Hoffmann[1], Christian Sternemann[1], Ralph Wagner[2], Kristina Kvashnina[3], Pieter Glatzel[3], and Heinz Hövel[1] — [1]TU Dortmund, Fakultät Physik / DELTA, Dortmund, Germany — [2]BU Wuppertal, Fachgruppe Physik-Materialwissenschaften, Wuppertal, Germany — [3]ESRF, Grenoble, France

We produce Ag clusters by supersonic nozzle expansion using THECLA, a THErmal CLuster Apparatus [1,2] which was designed to enable optical spectroscopy of clusters in a free jet and deposited on silica glass [2] or in matrices. The optical properties and the UV-VIS absorption band of Ag clusters alter significantly with size, shape, interparticle spacing and the properties of the local environment. Embedding the clusters into polydimethylsiloxane (PDMS) [3], aerogel or ionic liquids enables the investigation of a much higher amount of separated clusters which is otherwise limited by coalescence and electromagnetic coupling. We investigate the plasmon resonance of Ag clusters in PDMS or aerogel by optical spectroscopy [4]. XANES measurements at the Ag $L_{1,2,3}$-edges [5] were carried out at the synchrotron radiation sources DELTA and ESRF and were compared to FEFF calculations.

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O 36.80 Tue 18:15 Poster B2

Conductance and Relaxations of Magnetic Single-Atom Contacts — Nicolas Néel[1], Silke Schröder[2], Cesar Lazo[2], Paolo Ferriani[2], Nico Ruppelt[1], •Jörg Kröger[3], Stefan Heinze[2], and Richard Berndt[1] — [1]Institut für Experimentelle und Angewandte Physik, Christian-Albrechts-Universität zu Kiel, D-24098 Kiel, Germany — [2]Institut für Theoretische Physik und Astrophysik, Christian-Albrechts-Universität zu Kiel, D-24098 Kiel, Germany — [3]Institut für Physik, Technische Universität Ilmenau, D-98693 Ilmenau, Germany

Single-atom contacts fabricated from a Cr-covered tip of a scanning tunnelling microscope and Co and Cr atoms adsorbed to Fe double-layer islands on W(110) exhibit spin-dependent conductances. Depending on the alignment of the magnetic moments of the tip apex and the adsorbed atom the conductance varies by $\approx 40\,\%$. Consequently, these contacts represent atom-sized spin valves. Scrutinizing the spin polarization of the current through these contacts in the vicinity of the tunneling-to-contact transition reveals different geometric relaxations depending on the magnetic moment alignment. Concomitant density functional calculations trace these observations to differently strong exchange forces. The tunnelling anisotropic magnetoresistance is explored at the ultimate limit, *i. e.*, at the single-atom scale. Single Co atoms adsorbed to domains and domain walls of a ferromagnetic Fe film on W(110) exhibit an anisotropy of the magnetoresistance of up to 12 % and repeated sign changes as a function of the bias voltage. Financial support by the Deutsche Forschungsgemeinschaft through SFB 668 is acknowledged.

O 36.81 Tue 18:15 Poster B2

Highly efficient spin-resolved photoelectron spectroscopy experiment — •Moritz Plötzing, Roman Adam, Lukasz Plucinski, and Claus M. Schneider — Peter Grünberg Institut (PGI-6), Research Center Jülich, 52425 Jülich, Germany

The presented work aims for building up an energy- and spin-filtered photoemission setup enabling electron count rates high enough for pump-probe experiments using pulsed extreme ultraviolet light sources. In order to reach the needed efficiency, the experiment is equipped with a high-transmission spectrometer as well as a spin-detector based on photoelectron scattering from a thin, oxidized iron film. The latter has a figure of merit $FOM = S^2 I/I_0$ [(1)] of 2.2×10^{-3} for a measurement of both orthogonal spin directions beeing more than one order of magnitude higher compared to other commercially available spin-detectors [1]. First results using a He discharge lamp on thin Co films in-situ grown on Cu(100) verify the high scattering efficiency $I/I_0 \approx 10\%$ in spin-resolved operation mode. Additionally, the determined spin-polarization $P \approx 30\%$ in the electrons below valence band is comparable with other published data and hence confirms the expected Sherman function, too. Both together serves as a proof of the high FOM.

[(1)]: S: Sherman function, I/I_0: spin-resolved count rate normalized to count rate for incoming electrons

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O 36.82 Tue 18:15 Poster B2

Complex magnetism in the Fe monolayer on Ir(001) — •Markus Hoffmann, Maren Kaluza, Tobias Dornheim, Bertrand Dupé, Paolo Ferriani, and Stefan Heinze — Institut für Theoretische Physik und Astrophysik, Universität Kiel, 24098 Kiel

Recently, complex magnetic ground states have been reported for a number of transition-metal nanostructures on surfaces [1-4]. The driving force behind these non-collinear spin structures is a competition of exchange, Dzyaloshinskii-Moriya (DM) and higher-order spin interactions. For an Fe monolayer on Ir(111) this leads to the formation of an atomic-scale magnetic skyrmion lattice [4]. Here, we present a first-principles study of the magnetic properties of the Fe monolayer on Ir(001) based on density-functional theory using the full-potential linearized augmented plane wave (FLAPW) method. We map our total energy calculations of spin spirals to a Heisenberg model to obtain the exchange constants. By including spin-orbit coupling we also find the strength of the DM interaction and the magnetocrystalline anisotropy. We demonstrate that higher-order spin interactions are non-negligible in this system. Based on the obtained magnetic interactions, we perform Monte-Carlo simulations and simulate spin-polarized scanning tunneling microscopy images.

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O 36.83 Tue 18:15 Poster B2

Nanomagnets affected by spin-polarized tunneling and field-emission — •Johannes Friedlein, Anika Schlenhoff, Stefan Krause, Andreas Sonntag, and Roland Wiesendanger — Institute of Applied Physics, University of Hamburg

Understanding the interaction of spin-polarized electrons with magnetic solids is a key aspect in advanced spin-electronic applications. In general, a spin-polarized current affects a nanomagnet by Joule heating and magnon generation. In order to investigate similarities and differences of the interaction of tunneling and field-emitted electrons with magnetic matter on the atomic scale, we performed a combined spin-polarized tunneling microscopy (SP-STM) and spin-polarized scanning field-emission microscopy (SP-SFEM) study [1,2]. From a detailed lifetime analysis of a thermally switching nanomagnet, we extract the impact of spin-polarized tunneling and field-emitted electrons on Joule heating and spin-transfer torque. Whereas tunneling electrons carry low-energy into the magnet, high-energy field-emitted electrons are injected into the spin-dependent image potential states located in the vacuum in front of the magnet and subsequently relax into the sample [3]. We will present the experimental results in terms of current-dependent generation of Joule heating, magnons and Stoner excitations.

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O 36.84 Tue 18:15 Poster B2

High-Frequency Vibrational Modes of Cold-Deposited Copper Adatoms on Low-Index Copper Surfaces — •Jan Pischel, Olaf Skibbe, and Annemarie Pucci — Kirchhoff-Institut für Physik, Im Neuenheimer Feld 227, D-69120 Heidelberg

Vicinal low-index metal surfaces are known to give rise to vibrational modes with frequencies well above the bulk phonon band [1,2]. Low-coordinated atoms at steps and kink sites which relax with respect to their bulk position, but also with respect to their regular surface position, have been identified as originators of these high-frequency modes [2]. If the surface, the steps and the kinks are thought of as "perturbations of increasing complexity on an otherwise periodic system" [2], the next step would consequently be to investigate the vibrational properties of single adatoms.

For that purpose, we prepared copper surfaces with a well-defined degree of roughness under UHV by cold-depositing small amounts of copper on sputter-annealed low-index surfaces. Our HREEL-spectra of the rough Cu(111) and Cu(110) surfaces show indeed excitations at frequencies even higher than those observed on the vicinal surfaces. Since vibrations are playing a crucial role in the mediation of surface reactions [3], the existence of high-frequency vibrational modes on rough metal surfaces is expected to be relevant for a better understanding of catalytic reactions.

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O 36.85 Tue 18:15 Poster B2

Optimized Extreme-Ultraviolet High-Harmonic Generation Output for trARPES from Correlated-Electron Materials — •J. Urbancic[1], S. Eich[1], M. Wiesenmayer[1], A. V. Carr[2], A. Ruffing[1], S. Jakobs[1], S. Hellman[3], K. Jansen[3], A. Stange[3], M. M. Murnane[2], H. C. Kapteyn[2], L. Kipp[3], K. Rossnagel[3], M. Bauer[3], S. Mathias[1], and M. Aeschlimann[1] — [1]TU Kaiserslautern and Research Center OPTIMAS, 67663 Kaiserslautern, Germany — [2]JILA, University of Colorado and NIST, Boulder, Colorado 80309-0440, USA — [3]IEAP, University of Kiel, 24098 Kiel, Germany

Time- and angle-resolved photoemission spectroscopy (trARPES) using femtosecond laser pulses in the extreme ultraviolet (XUV) region plays a key role in the investigation of ultrafast quasiparticle dynamics in correlated-electron materials [1-4]. However, the full potential of this technique has not been achieved, i.e. all so far developed technical solutions suffered from a trade-off between photon flux, energy- and time-resolution. This was because of limitations in the intrinsic high-harmonic generation (HHG) process, and because of dispersive optical elements in the XUV-beamline that were needed to monochromatize the output of the HHG source. Here we show that using short-wavelength laser light to drive the HHG process and removing most of the dispersive elements offers an improved solution for efficient XUV trARPES with sub 30 fs time- and sub 150 meV energy-resolution.

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O 36.86 Tue 18:15 Poster B2

Thermal desorption spectroscopy of astrophysically relevant molecules on olivine and single crystal forsterite — •Tushar Suhasaria[1,2], Nadine Heming[1], Robert Frigge[1], Björn Siemer[1], and Helmut Zacharias[1,2] — [1]Physikalisches Institut, University of Münster, Germany — [2]Graduate School of Chemistry, University of Münster, Germany

Over the years, it has been known that gas-grain chemistry is responsible for molecule formation in the interstellar medium [1]. These dust grains are thought to be silicates or carbonaceous materials. In recent times more than 140 different gases have been reported in the dense regions of interstellar space [2]. At low temperatures ($\approx$ 10 K) in the ISM the icy grain mantles undergo processing and are forming molecules due to exposure to ultraviolet, x-ray, cosmic radiation and heat. Temperature programmed desorption (TPD) is the most widely used characterization technique to investigate these primary effects and provide binding energies and reaction orders .Starting at 4K we performed TPD measurements on several molecules like D_2, CO, CH_4,CO_2 and NH_3 adsorbed on single crystal forsterite ($MgSiO_4$) and olivine (Mg_x Fe_{1-x} SiO_4) surfaces. Averaging over several measurements, it is seen that D_2, CO, CH_4, CO_2 molecules have slightly greater average binding energies on forsterite than on olivine.

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O 36.87 Tue 18:15 Poster B2

Probing shallow trapped electron state and related processes of TiO_2 with UHV-IRRAS — Hikmet Sezen, •Carsten Natzeck, Chengwu Yang, Alexei Nefedov, and Christof Wöll — Institute of Functional Interfaces (IFG), Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

TiO_2 as a metal oxide material with a wide band gap has numerous attentions because of its distinct chemical and physical properties. The shallow trapped electron state of TiO_2 presenting ca. 0.12 eV below than the conduction band continuum has not been fully understood property that has a crucial rule about photo- and charge-induced catalytic reactions.[1,2] In this work, a novel system for infrared reflection absorption spectroscopy in ultrahigh vacuum ambience (UHV-IRRAS) was used that allows recording both UHV-IRRAS measurements at grazing incidence on single crystal and FTIR transmission measurements for polycrystalline powder samples. It has been shown, that with this system can probe directly population of presenting charges within band gap of TiO_2. Comparative studies of the shallow trapped related processes were performed under atomic hydrogen treatment and exciting stimuli are exposing UV light. Moreover, as well as the steady state, the rapid scan measurements have been done to follow dynamic of the related processes.

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O 36.88 Tue 18:15 Poster B2

Details in the short-time response of the photo-induced CDW phase transition of 1T-$TiSe_2$ measured with femtosecond XUV photoemission — •S. Eich[1], J. Urbancic[1], M. Wiesenmayer[1], A.V. Carr[2], A. Ruffing[1], S. Jakobs[1], S. Hellmann[3], T. Rohwer[3], M.M. Murnane[2], H.C. Kapteyn[2], L. Kipp[3], K. Rossnagel[3], M. Bauer[3], S. Mathias[1], and M. Aeschlimann[1] — [1]TU Kaiserslautern and Research Center OPTIMAS, 67663 Kaiserslautern, Germany — [2]JILA, University of Colorado and NIST, Boulder, Colorado 80309-0440, USA — [3]Institute of Experimantal and Applied Physics, University of Kiel, 24098 Kiel, Germany

We use time- and angle-resolved photoemission spectroscopy (trARPES) with sub 150 meV energy and sub 30 fs time-resolution to study the photo-induced phase transition in the charge-density wave compound 1T-$TiSe_2$ [1]. The improved energy-resolution in comparison to our previous studies does now allow us to disentangle more details in the short-time response of this charge-density wave compound to an ultrafast laser excitation.

[1] Rohwer et al., Nature 471,490 (2011)

O 36.89 Tue 18:15 Poster B2

Time-resolved desorption of Hydrogen isotopes from HOPG by femtosecond laser pulses — •Robert Frigge and Helmut Zacharias — Physikalisches Institut, Universität Münster, Germany

The desorption of atomic hydrogen isotopes from HOPG is examined after surface excitation with fs-laser pulses at $\lambda = 400$ nm. Desorbed neutral H atoms are ionized using (2+1) REMPI via the $2s \leftarrow 1s$ transition, and are detected with a time-of-flight mass spectrometer. Velocity distribution measurements result in three maxima for fast, medium and very slow desorbed hydrogen atoms. By electron scattering calculations [1] of the vibrational excitation of the H-C bond the three maxima can be identified with different adsorption potentials, depending upon the neighboring H atom position on the graphene lattice. A nonlinear fluence dependence of the desorption yield allows two pulse-correlation experiments. As a result we derive a pulse-delay dependent yield with a FWHM of between 700 fs for the fast and about 1 ps for the slow desorbing atoms . These correlation times indicate short lifetimes of the excited electrons and support a calculation in the DIMET model.

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