O 13: Nanostructures at Surfaces 2

Time: Monday 15:00–17:30 Location: S052

O 13.1 Mon 15:00 S052

A new setup for dimensional nanometrology using soft X-rays — •Leonhard Lohr[1], Richard Ciesielski[1], Analía Fernández Herrero[2], Andreas Fischer[1], Alexander Grothe[1], Frank Scholze[1], and Victor Soltwisch[1] — [1]Physikalisch-Technische Bundesanstalt (PTB), Abbestraße 2-12, 10587 Berlin, Germany — [2]Helmholtz-Zentrum Berlin für Materialien und Energie, Albert-Einstein-Straße 15, 12489 Berlin, Germany

Measuring nanostructured surfaces on small test patterns on dies from semiconductor fabs is an important metrology challenge. The geometrical dimensions of metrology test structures, such as linear gratings, must be determined with uncertainties in the sub-nm range. By using methods such as small angle X-ray scattering or X-ray fluorescence under grazing incidence, the photon beam spot size becomes too large for sufficient accurate measurements.

We present a new setup, mounted on the soft X-ray beamline in PTB's laboratory at the electron storage ring BESSY II. This setup works with synchrotron radiation in an ultra-high vacuum and with lubricant-free mechanics. Its small and compact design enables to detect scattered monochromatic soft X-rays under angles of incidence up to 30 degrees. The setup reduces photon beam spot size and covers diffraction patterns like them from scattered hard X-rays under grazing incidence. Depending on the incident photon energy, fluorescence from small excited regions of the sample can be measured simultaneously.

We present first measurement results from small test patterns which are located by imaging the surface using a large photon beam.

O 13.2 Mon 15:15 S052

Synthesis of metal sulfide nanoribbons on graphene by self-assembly — •Xuejiao Zhang, Kelvin Anggara, Vesna Srot, Xu Wu, Peter A. van Aken, and Klaus Kern — Max Planck Institute for Solid State Research, 70569 Stuttgart, Germany

Bottom-up synthesis of nanostructures on surface have relied on the self-assembly of nanoscale building blocks. The diversity of accessible nanostructures however have been constrained by the limited choice of atomic and molecular building blocks that can be evaporated on surface. Here we bypass this limitation by using complex inorganic ions generated from electrospray ionization as building blocks to synthesize nanostructures on surfaces. We deposited HMonS3n+1** (n = 4-6) ions onto a freestanding single-layer graphene by Electrospray Ion-Beam Deposition (ESIBD), and imaged the resulting nanostructures by aberration-corrected Scanning Transmission Electron Microscopy (STEM). The molecules were observed to form anisotropic, single-layered, crystalline MoS2 nanoflakes (< 100 nm2), which in turn self-assembled into MoS2 nanoribbons extending as far as 1 μm. The first observation of such nanostructures evidences the potential of this approach to prepare previously inaccessible nanomaterials on surfaces.

O 13.3 Mon 15:30 S052

Ni kagome lattice on Pb(111) — •Gustav Bihlmayer[1], Yen-Hui Lin[2], Stefan Blügel[1], and Pin-Jui Hsu[2] — [1]Peter Grünberg Institut and Institute for Advanced Simulation, Forschungszentrum Jülich, D-52425 Jülich, Germany — [2]Department of Physics, National Tsing Hua University, Hsinchu, 30013, Taiwan

Deposition of atomically thin films on well-ordered surfaces sometimes allows realizing new structural motives that have no correspondence in the bulk phases. Here we observe that, at low temperatures, submonolayer growth of Ni on a Pb(111) substrate leads to well-ordered, hexagonal islands. In scanning tunneling microscopy (STM) two types of edges with very different apparent height and scattering properties are observed. From density functional theory (DFT) calculations and STM images with atomic resolution we conclude that the Ni atoms form a kagome lattice and the islands show saw-tooth edges. Comparison of STM and DFT data suggests that some Ni atoms are incorporated in the subsurface layer and give rise to the low observed height of the islands and the strong difference observed at their edges. From the DFT calculations we conclude that the Ni island is non-magnetic and the electronic structure shows some characteristics of the kagome lattice, i.e. flat bands also visible in scanning tunneling spectra.

O 13.4 Mon 15:45 S052

DNA origami as reference systems for nano-metrology — •Ziba Akbarian[1,2], Birka Lalkens[1,2], Michelle Weinert[3], Ingo Busch[3], Harald Bosse[3], and Uta Schlickum[1,2] — [1]Technische Universität Braunschweig, Braunschweig, Germany — [2]Laboratory for Emerging Nanometrology (LENA), Braunschweig, Germany — [3]Physikalisch Technische Bundesanstalt (PTB), Braunschweig, Germany

A key aspect of quantitative measurements is the traceability of all measurements to the international system of units (SI). DNA origami is capable of being traced back to SI units thanks to its precisely defined internal structures in 2D and 3D. Here, we will describe the possibilities of building reference systems for calibrating scanning probe instruments with μm resolution only that can be traced back to atomically precise structures. In order to accomplish this goal, we plan to fabricate DNA origami structures that include marks at well-defined positions to obtain measurable protrusions within the internal structures. The controlled fabrication of DNA origami structures that do not distort upon adsorption onto surfaces, in both liquid and air conditions will be surveyed as the first step in this research.

O 13.5 Mon 16:00 S052

How covalent chemistry affects the surface dipole of metallic nanostructures — Rustem Bolat[1,2], •Jose M. Guevara[1], Marvin Knol[1,2], Philipp Leinen[1], Ruslan Temirov[1,2,3], Oliver T. Hofmann[4], Reinhard J. Maurer[5], F. Stefan Tautz[1,2], and Christian Wagner[1,2] — [1]Forschungszentrum Jülich, Germany — [2]RWTH Aachen University, Germany — [3]Universität zu Köln, Germany — [4]Graz University of Technology, Austria — [5]University of Warwick, UK

Scanning probe experiments often encounter nanostructures of under-coordinated metal atoms, either as the investigated system or at the tip apex. While the electrostatic properties of extended planar surfaces are textbook material, the interaction of metal adatoms with the surface and with each other opens an interesting playground in which our intuition for the covalent chemistry of such metal structures is limited.

Here we investigate Ag and Au adatoms, monoatomic chains and small clusters, on the Ag (111) surface using quantum dot microscopy. We image the electrostatic potential above these nanostructures and quantify the respective surface dipoles. The two species of adatoms behave antagonistic, as the surface dipoles are positive for Ag and negative for Au structures. The measured dipoles are in excellent agreement with density functional theory calculations. We disentangle the influence of individual adatom-surface and adatom-adatom bonds down to individual atomic orbitals.

O 13.6 Mon 16:15 S052

Gold nanostructures with varying physicochemical surrounding examined with surface second harmonic generation circular dichroism spectroscopy — •Natalie Fehn[1], Ehsan Vahidzadeh[2], Karthik Shankar[2], Ueli Heiz[1], and Aras Kartouzian[1] — [1]Physical Chemistry, Department of Chemistry and Catalysis Research Center, Technical University of Munich — [2]Electrical and Computer Engineering Deptartment, Faculty of Engineering, University of Alberta

The sophisticated second-order spectroscopic methods of surface second harmonic generation (s-SHG) and s-SHG circular dichroism spectroscopies (s-SHG-CD) provide additional and complementary structural information in regards to their linear counterparts, absorbance and CD spectroscopy. Because of their surface sensitivity, s-SHG and s-SHG-CD represent an excellent choice for the investigation of molecular thin films and supported plasmonic structures, such as nanoparticles and clusters. We are especially interested in the interaction of such nanostructures with their surroundings, e.g. chiral molecule adsorbates or oxide layers, with the goal of observing a chiral response from the originally achiral particles. Those particles may then serve as catalysts in asymmetric heterogeneous catalysis. This contribution will focus on our research with emphasis on supported gold nanostructures.

O 13.7 Mon 16:30 S052

Elucidating the chirality of polycrystalline films with fundamental and SHG-CD — •Kevin Liang[1], Florian Ristow[2], Jakob Scheffel[2], Natalie Fehn[1], Reinhard Kienberger[2], Ueli

Heiz[1], Aras Kartouzian[1], and Hristo Iglev[2] — [1]Physical Chemistry, Department of Chemistry and Catalysis Research Center, Technical University of Munich — [2]Physics Department E11, Technical University of Munich

Preferential desorption of enantiomers of 1,1'-Bi-2-naphthol (BINOL) has been observed, depending on the handedness of circularly polarised light, which is of interest for enantioenrichment processes. Therefore, characterisation of the enantiomeric excess of the sample and the understanding of its chirality is key. However, that requires further studies and greater clarification to be carried out and obtained, respectively. This contribution discusses the optical properties of BINOL thin films with fundamental and second harmonic generation (SHG) circular dichroism spectroscopy (CD) with different sample preparation methods, enantiomeric compositions and under varying experimental conditions. Depending on the previous conditions mentioned, the observed CD and anisotropy (g) value can be even of opposite sign for the same thin film.

O 13.8 Mon 16:45 S052

AFM studies of ion-exchange treated glass surfaces — •Fabian Höhn[1,3], Fabian Ullmann[1,3], Norbert Arndt-Staufenbiel[2], and Stefan Krischok[1,3] — [1]Institute of Physics, TU Ilmenau, Weimarerstraße 25, 98693 Ilmenau, Germany — [2]Fraunhofer Institute for Reliability and Microintegration, Gustav-Meyer-Allee 25, 13355 Berlin, Germany — [3]Center of Micro-and Nanotechnologies, TU Ilmenau, Gustav-Kirchhof-Straße 7, 98693 Ilmenau, Germany

There is a big difference between the bond strength of glass and its respective tensile strength. The reason for this discrepancy is assumed to be so-called "microcracks", this surface damage is considered to massively reduces the tensile strength. We assume that these damages widen by stretching the surface and become thus more visible. Another point that will be investigated, regarding this matter, is micro waveguides in glass. These are created by silver ion exchange in glass. It is assumed that the mentioned surface damages are a cause for reduced quality of these waveguides. For this purpose, we examine the difference in topography between untreated Gorilla V1 glass from Corning, a sample stretched using the three-point method and a sample in which a silver ion exchange was carried out on the surface. The difference in topography is first described qualitatively and then determined quantitatively with roughness parameters. Finally, a comparison of the three samples should provide an insight into the topography of glasses under stress and a contribution to the optimization of the mentioned waveguides.

O 13.9 Mon 17:00 S052

Processing copper surfaces with ultrashort laser pulses to reduce secondary electron yield — •Elena Bez[1,2], Marcel Himmerlich[1], Ana Karen Reascos Portilla[1], Pierre Lorenz[3], Klaus Zimmer[3], Mauro Taborelli[1], and André Anders[2,3] — [1]CERN, European Organization for Nuclear Research, 1211 Geneva 23, Switzerland — [2]University of Leipzig, Linnéstr. 5, 04103 Leipzig, Germany — [3]Leibniz Institute of Surface Engineering (IOM), Permoserstr. 15, 04318 Leipzig, Germany

Ultrashort-pulse laser processing in air is employed to engrave micro- and nanostructures on copper surfaces aiming to reduce secondary electron emission. Parameters such as the laser power and scanning speed are varied to investigate their influence on the resulting structures. The morphology, as well as the chemical composition of the laser-treated surfaces, are analyzed by scanning electron microscopy (SEM) and X-ray photoelectron spectroscopy (XPS), respectively. At low power and high scanning speed, only slight changes to the surface topography occur, whereas compact, cauliflower-like nanostructures and micrometer deep trenches are generated at high power and low scanning speed. The higher the accumulated laser fluence, the more material is ablated and the more oxidized particles are redeposited. A clear correlation exists between the accumulated fluence for processing with 355, 532 and 1064 nm photons, and the resulting secondary electron yield of the surface. Its maximum can be reduced from 2.2 to 0.7. Mastering these dependencies helps to develop a system that enables laser processing of beam pipes of selected magnets in the Large Hadron Collider.

O 13.10 Mon 17:15 S052

Highly ordered three-dimensional Ni-TiO2 nanopore arrays as sodium-ion battery anodes — •Mo Sha, Huaping Zhao, and Yong Lei — Fachgebiet Angewandte Nanophysik, Institut für Physik & IMN MacroNano, Technische Universität Ilmenau, 98693 Ilmenau, Germany

Sodium-ion batteries (SIBs) represent an effective energy storage technology with potentially lower material costs than lithium-ion batteries. Here, we show the electrochemical performance of SIBs with electrode design at the nanoscale. Highly ordered three-dimensional (3D) self-supported Ni-TiO2 nanopore arrays (NiNPA@TiO2) with highly oriented nanoporous structures are fabricated using nanoimprited AAO templating technique and applied as nanostructured anodes for SIBs applications. Their large specific surface area can ensure a high capacity, and their highly oriented and stable nanoporous structure can facilitate ion transport. The NiNPA@TiO2 nanoarrays delivered a reversible capacity of 240 mAh g-1 after 100 cycles at the current density of 50 mAh g-1 and were able to retain a capacity of 105 mAh g-1 at the current density as high as 5 A g-1. Their large active sites, high ion accessibility, fast electron transport, and excellent electrode integrity were shown as great merits to obtain the presented electrochemical performance. Not limited to the SIBs electrodes, the highly ordered 3D heterostructured nanoarrays as a promising electrode design for other electrochemical energy conversion and storage devices.