O 70: Nanostructures at Surfaces: Other Aspects

Time: Wednesday 18:15–20:30 Location: Poster A

O 70.1 Wed 18:15 Poster A

Characterization of lamellar nanostructures with X-ray scattering — •Analia Fernandez Herrero, Victor Soltwisch, Mika Pflüger, Anton Haase, Michael Krumrey, and Frank Scholze — Physikalisch-Technische Bundesanstalt

The interest in the reconstruction of nanostructured surfaces has increased in the last decade. Characterizing structures of a few nm challenges the existing metrology tools. The PTB develops high accuracy scattering and reflectometry methods in a broad energy range, from EUV to hard X-rays, at several beamlines at BESSY II and the MLS. Angle resolved scatterometry is a fast and non-destructive method which enables the study of the scattered light from periodic structures. EUV scattering and grazing incidence angle X-ray scattering (GISAXS) are used to investigate structural parameters as the sidewall angle, line width and height of state-of-the-art electron beam written SiN gratings. EUV scatterometry is very sensitive to the imperfections on the structures and therefore it provides a high sensitivity to details of the line geometry. A Maxwell solver based on the finite element method gives consistent results for the reconstruction of arbitrary shape profiles.

O 70.2 Wed 18:15 Poster A

Self-metalation of phthalocyanine molecules with silver surface atoms on Ag(110) — •Lars Smykalla, Pavel Shukrynau, and Michael Hietschold — Technische Universität Chemnitz, Institute of Physics, Solid Surfaces Analysis Group, D-09107 Chemnitz, Germany

A direct reaction of molecules with the atoms from the metal surface on which they adsorb ("self-metalation") was first reported as an unwanted process but later on it was also perceived to be a new method for bottom-up synthesis of metal complexes. We report that metal-free phthalocyanine (H2Pc) molecules are able to incorporate Ag atoms from an Ag(110) surface, therefore forming silver phthalocyanine (AgPc).[1] Scanning tunneling microscopy, X-ray photoelectron spectroscopy, and Density functional theory simulations of this reaction are presented. Three different kinds of molecules were found on the surface that are assigned to H2Pc, the corresponding dehydrogenated molecules (Pc), and AgPc. The relative amounts of Pc and AgPc increase with increasing annealing temperature. Simulations of the reaction path indicate that the metalation of H2Pc is endothermic and that the metalation of the dehydrogenated Pc molecule has a significantly lower barrier and is thermodynamically favorable. Our results shows that the orientation of the substrate surface can be crucial for self-metalation reactions because it was not observed for H2Pc on Ag(111).

[1] Lars Smykalla, Pavel Shukrynau, Dietrich R. T. Zahn, and Michael Hietschold J. Phys. Chem. C, 2015, 119 (30), 17228-17234

O 70.3 Wed 18:15 Poster A

Charge detection of quantum dots in indium arsenide nanowires — •Felix Jekat[1], Kilian Flöhr[1], Sebastian Heedt[2], Marcus Liebmann[1], Stefan Trellenkamp[3], Torsten Rieger[2], Jürgen Schubert[2], Werner Prost[4], Thomas Schäpers[2], and Markus Morgenstern[1] — [1]II. Physikalisches Institut B, RWTH Aachen — [2]PGI-9, Forschungszentrum Jülich, Germany — [3]PGI-8, Forschungszentrum Jülich, Germany — [4]Center for Semiconductor Technology and Optoelectronics, University of Duisburg-Essen

InAs nanowires have been shown to be suitable as tips for scanning tunneling microscopy (STM) with similar quality compared to tungsten tips, as demonstrated by Flöhr et al. [1]. We present devices with the goal to enable time-resolved counting of single electrons directly at these InAs nanowire STM tips. Two configurations and preliminary transport measurements are presented. The first device configuration utilizes a Quantum Point Contact as charge detector, adapted from Shorubalko et al. [2]. The second device is realized by measuring the conductance variation of another nanowire placed in close vicinity to the first one. This nanowire is coupled by a floating gate to the first nanowire over a distance of several micrometers [3].

[1] K. Flöhr et al. "Scanning tunneling microscopy with InAs nanowire tips", Appl. Phys. Lett. 101, 243101 (2012) [2] I. Shorubalko et al. "Self-Aligned Charge Read-Out for InAs Nanowire Quantum Dots", Nano Lett. 8, 382 (2008) [3] Y. Hu et al. "A Ge/Si heterostructure nanowire-based double quantum dot with integrated charge sensor", Nature Nanotechnol. 2, 622 (2007)

O 70.4 Wed 18:15 Poster A

Investigation of 3D micron structures formation on polyimide and their potential for applications — •Lukas Bayer, Pierre Lorenz, Martin Ehrhardt, and Klaus Zimmer — Leibniz-Institut für Oberflächenmodifizierung e. V., Permoserstraße 15, 04318 Leipzig, Germany

Lasers have a great potential to produce micro/nano structures fabrication in a fast and cost-effective way. But new discovered or already known self-assembly processes remain unused in commercial or scientific fields. The formation and the application of micro-sized cone structures on PI, produced by laser irradiation using a KrF excimer laser (wavelength 248 nm, pulse duration 25 ns) near the ablation threshold is presented. The influence of the laser irradiation parameters on the cone properties and the density of their appearance are studied by evaluation of images after the irradiation sequence and after each laser shot. The properties of the laser-induced 3D conical surface structures, the height and the width, are analysed by optical and scanning electron microscopy (SEM). The chemical modification of the polymer surface is studied too. In conclusion of found results of the influence of the laser processing parameters to the cone pattern formation process different application will be discussed shortly. These are: application for identification in the field of security features fabrication or the process / equipment validation for laser based processes.

O 70.5 Wed 18:15 Poster A

Different tip functionalizations in scanning probe microscopy — •Philipp Scheuerer und Jascha Repp — Universität Regensburg, Fakultät für Physik, Universitätsstraße 31, 93053 Regensburg

Recently AFM measurements with CO functionalized tips gained a lot of interest since such tips allow to resolve the chemical structure of individual molecules adsorbed on surfaces. The origin of this enhanced resolution is Pauli repulsion [1]. Moreover, it was found that the CO can bend sideways due to tip-sample forces which gives rise to additional contrast sharpening [2].

However, this bending can be a drawback as it causes image distortions. CO functionalized tips have been widely applied not only in AFM but also for KPFS measurements. Up to now, only some other small molecules and atoms were tried to functionalize the tip apex. However there is no alternative that reduces drawbacks like bending and gives a resolution comparable to CO functionalized tips.

We functionalized the tip with several different types of individual molecules to find out whether some of them provide interesting imaging properties.

[1] L. Gross, F. Mohn, P. Moll, N.and Liljeroth, and G. Meyer. Science, 325, 1110 (2009).

[2] P. Hapala, G. Kichin, C. Wagner, F. S. Tautz, R. Temirov, and P. Jelínek. Physical Review B, 90, 085421 (2014).

O 70.6 Wed 18:15 Poster A

Quantifying the contrast mechanisms of a scanning electron microscope by an integrated AFM system — •Frank Hitzel[1], Nils Anspach[1], Kerstin Sempf[2], and Peter Gnauck[3] — [1]Semilab Semiconductor Physics Laboratory Co. Ltd., Budapest, Hungary — [2]Fraunhofer Institute for Ceramic Technologies and Systems, Dresden, Germany — [3]Carl Carl Zeiss Microscopy GmbH, Oberkochen, Germany

The Scanning Electron Microscope (SEM) is a powerful tool to obtain information about sample surface properties like morphology, material type, crystal orientation, conductivity and much more. At low acceleration voltages, secondary electrons are influenced by many different effects, and the resulting images represent a mixture of different contrast sources, which often cannot be distinguished by the SEM related methods themselves.

In such cases, the combined SEM/AFM tool from Carl Zeiss and Semilab goes a step further: Due to the different imaging mechanism, the AFM is able to distinguish between real topography, work function, and conductivity and obtains absolute values for each of them. Especially for samples with strong morphology, the combined SEM/AFM is

the only tool permitting full electrical characterization of areas, which have to be located by the detection mechanism of the SEM.

We will present examples in which this unique approach has led to a much better understanding of the investigated sample properties. Examples from the fields of ceramics (SiC), organic electronics, Li batteries and semiconductors will be shown.

O 70.7 Wed 18:15 Poster A

Shifting the voltage drop in electron transport through a single molecule — •Sujoy Karan[1,2], David Jacob[3], Michael Karolak[4], Christian Hamann[1], Yongfeng Wang[1], Alexander Weismann[1], Alexander I. Lichtenstein[5], and Richard Berndt[1] — [1]Institut für Experimentelle und Angewandte Physik, Christian-Albrechts-Universität zu Kiel, 24098 Kiel, Germany — [2]Institut für Experimentelle und Angewandte Physik, Universität Regensburg, 93053 Regensburg, Germany — [3]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, 06120 Halle, Germany — [4]Institut für Theoretische Physik und Astrophysik, Universität Würzburg, Am Hubland, 97074 Würzburg, Germany — [5]I. Institut für Theoretische Physik, Universität Hamburg, 20355 Hamburg, Germany

A Mn-porphyrin was contacted on Au(111) in a low-temperature scanning tunneling microscope (STM). Differential conductance spectra show a zero-bias resonance that is due to an underscreened Kondo effect according to many-body calculations. When the Mn center is contacted by the STM tip, the spectrum appears to invert along the voltage axis. A drastic change in the electrostatic potential of the molecule involving a small geometric relaxation is found to cause this observation.

O 70.8 Wed 18:15 Poster A

Controlling and monitoring the local charge distribution of a nanoscaled space charge region — •Katharina Kaiser, Philipp Kloth, and Martin Wenderoth — IV. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

Using a low temperature Scanning Tunneling Microscope in combination with optical excitation we have investigated the interplay and dynamics of free and bound charge carriers inside a nanoscaled space charge region (SCR) at the GaAs(110) surface [1]. This approach allows us to actively modify the local charge distribution at the surface by changing the optical excitation density and the tunnel current and to control charge fluctuations.

One central part is the capture process of photo-generated minority charge carriers in the presence of locally fixed dopant atoms within the space charge region. By establishing a quantitative model, we are able to extract key quantities like the diffusive or field driven capture rate of photo-generated holes. The analysis of the noise of the tunnel current provides access to the temporal charging and discharging process of dopant atoms inside the SCR, showing that the presence of photo-generated charge carriers changes the noise of the system significantly.

[1] Kloth et al., Nat. Comm. (2015)