MM 65: Nanomaterials - II

Time: Thursday 17:30–19:00 Location: IFW D

MM 65.1 Thu 17:30 IFW D

3D X-ray Diffraction Microscopy (3DXRD) using high resolution X-ray nanodiffraction — •Hergen Stieglitz[1], Johan Hektor[2], Anton Davydok[1], Christina Krywka[1], and Martin Müller[1] — [1]Helmholtz-Zentrum Geesthacht, Geesthacht, Germany — [2]DESY, Hamburg, Germany

The existing technology called 3DXRD is a well-established technique to map the grain structure of polycrystalline systems (e.g. metals). This technology is based on reconstruction algorithms which trace the positions of multiple Bragg-Peaks as a function of the rotation angle during sample rotation. These algorithms rely on that the diffraction spots do not overlap. Therefore there is a limit on the maximum number of grains, or equivalently, the smallest grain size that can be mapped.

The newly implemented nano grain mapping experiment at the beamline P03 (PETRA III) is based on scanning 3DXRD and utilizes a nano-focused X-ray synchrotron beam to examine very fine-grained systems. With respect to the small beam size of about 250 nm cross section, the precise positioning of the sample becomes more important to secure a constant gauge volume. Otherwise some grains may be outside the gauge volume in some scans, therefore they cannot be traced and produce mistakes while reconstructing.

To meet this challenge a stable and wobble-free rotation stage is in operation to ensure a constant gauge volume. A laser interferometer based feedback loop compensates the runout of the sample during rotation. Results of the very first experiments will be shown.

MM 65.2 Thu 17:45 IFW D

Epitaxial NbP and TaP Weyl Semimetal thin films - a new playground for topological heterostructures — •Amilcar Bedoya Pinto, Avanindra Kumar Pandeya, Defa Liu, Hakan Deniz, Kai Chang, Hengxin Tan, Hyeon Han, Jagannath Jena, Ilya Kostanovskiy, and Stuart Parkin — Max Planck-Institute of Microstructure Physics, Weinberg 2, 06120 Halle (Saale), Germany

Weyl Semimetals (WSMs), a recently discovered topological state of matter, exhibit an electronic structure governed by linear band dispersions and degeneracy (Weyl) points leading to rich physical phenomena, which are yet to be exploited in thin film devices. While WSMs were established in the monopnictide compound family several years ago, the growth of thin films has remained a challenge. Here, we report the growth of epitaxial thin films of NbP and TaP by means of molecular beam epitaxy. Single crystalline films are grown on MgO (001) substrates using thin Nb (Ta) buffer layers, and are found to be tensile strained (1%) and with slightly P-rich stoichiometry with respect to the bulk crystals. The resulting electronic structure exhibits topological surface states characteristic of a P-terminated surface and linear dispersion bands featuring a Fermi-level shift of -0.2 eV with respect to the Weyl points. The growth of epitaxial thin films allows the use of strain and controlled doping to tune the electronic structure of Weyl Semimetals on demand, paving the way for the rational design and fabrication of electronic devices ruled by topology.

MM 65.3 Thu 18:00 IFW D

Defect and interlayer engineering in transition metal dichalcogenides for enhancing potassium storage — •Yuhan Wu, Chenglin Zhang, and Yong Lei — Institut für Physik & IMN MacroNano, Technische Universität Ilmenau, 98693, Ilmenau, Germany

The role of the defect and interlayer engineering in two-dimensional transition metal dichalcogenides is explored for potassium storage. Molybdenum disulfide was selected as an example; the expanded interlayer spacing and defects in the basal planes are used as the anode of potassium-ion battery with voltage window of 0.5*2.5 V, which ensure the intercalation reaction rather than a conversion reaction takes place to store K-ions in the van der Waals gaps. In comparison to the defect-free counterpart with pristine interlayer spacing, the MoS2 nanoflowers showed enhanced potassium storage performance. Kinetic analysis verifies that the K-ion diffusion coefficient and surface charge storage are both enhanced. The collective effects of expanded interlayer spacing and additionally exposed edges induced by the in-plane defects enable facile potassium ion intercalation, rapid potassium ion transport and promoted surface K-ion adsorption at the same time.

MM 65.4 Thu 18:15 IFW D

Atom Probe Tomography of self-assembled Monolayers — •Helena Solodenko and Guido Schmitz — Institute for Material Science, Heisenbergstr. 3, 70569 Stuttgart

In order to achieve molecular heterogeneous catalysis in confined geometries, catalyst molecules are linked to nanometer-sized pores within a matrix. The linkage of catalyst to the pores is crucial and therefore this project focuses on this aspect. We utilize simple model molecules which form by self-organization, so-called self-assembled monolayers (SAM), and investigate them by atom probe tomography (APT). This technique excels at chemical sensitivity and provides furthermore three-dimensional spatial information of the probed samples. The goal is to achieve physical understanding of field desorption of organic molecules under high electric fields. Experiments are conducted by preparation of nanometer-sized metallic needles, which are cleaned by field-evaporation and then coated by dipping in the according solution of thiol-based SAMs for several hours. The resulting monolayer has a thickness of less than two nanometers and is analyzed by laser-assisted APT. The carbon chains break under the influence of the high electric fields and corresponding molecular fragments are detected by time-of-flight mass spectrometry. The reconstruction reveals an ordered evaporation sequence of the molecule chain down to the substrate and provides information of surface coverages of the SAMs. Furthermore, SAMs of phosphonic acids are used, which bind to oxide materials like SiO2, Al2O3 and their evaporation behavior is compared to thiol-based SAMs.

MM 65.5 Thu 18:30 IFW D

A plasmonic absorber based on the multi-order square array of gold nanocylinders — •Zhi-Hang Wang[1], Yudie Huang[1], Peng Xie[2], Jiaxu Chen[1], Fanzhou Lv[1], Shiyao Jia[1], Yi Wang[1], Wei Wang[2], and Wenxin Wang[1] — [1]Photonic Materials Group, College of Physics and Optoelectronic Engineering, Harbin Engineering University, Harbin, China — [2]College of Physical Science and Technology, Sichuan University, Chengdu, China

Plasmonic structures are known to have strong confinement for incident light at the nanoscale. Here, a plasmonic absorber based on a sandwich nanostructure consisting of multi-order square array of 'gold cylinders- dielectric space-gold resisting layer' is studied. Thanks to the numerical simulation by FDTD, longitudinal modes at the lateral surface of gold nanocylinders and the hybrid plasmon modes at the interfaces between gold and the dielectric space are demonstrated. Furthermore, simultaneously existing of the longitudinal modes and the hybrid plasmon modes arise the plasmon-plasmon coupling at 0.9 μm and 1.4 μm. These distinctive plasmon-plasmon coupling modes result in the anti-cross splitting phenomena in the dispersion diagrams. Finally, the simulated numerical performance is designed to be verified by the experimental measurements. This work demonstrates the sandwich structure based on multi-order square array of nanocylinders-dielectric space-gold resisting layer has good potential in the field of manipulating light at nanoscale with a low-cost, large-area sample fabrication process, which opens up many promising applications such as optical absorption and strong plasmon-plasmon interaction.

MM 65.6 Thu 18:45 IFW D

The Special Role of Oxygen in the Growth of Oxide-based Compound Nanowires: Experiments and Simulation — •Jasmin-Clara Bürger, Sebastian Gutsch, and Margit Zacharias — Department of Microsystems Engineering - IMTEK, Laboratory for Nanotechnology, University of Freiburg, Georges-Köhler-Allee 103, 79110 Freiburg, Germany

The growth of oxide-based compound nanowires allows for a huge field of applications due to their unique properties. However, systematic studies on the growth of SnO2 nanowires and the influences of the individual growth parameters on the resulting structures are rare. Especially for the usage in applications, a controlled and reliable growth process and the understanding of its manipulation are becoming necessary for a purposive resulting morphology. Particularly, the VLS growth and allied methods supported by a carbothermal reduction in a horizontal tube furnace are possessing a high sensitivity to a large quantity of influencing parameters. Recently, we reported on the inhibition of the NW growth provoked by a high oxygen concentration

and the timing of the oxygen inflow due to the formation of an oxidic shell.[1] Neither oxygen nor SnO2 are soluble in the Au catalyst particle. Nevertheless, we showed that the oxygen inflow is necessary to grow these NWs.[1] Therefore, a control of the Sn/O ratio at the sample sites becomes mandatory.[1] We support our experiments with numerical simulations.

[1] J.-C. Bürger et al., J. Phys. Chem. C 122 (2018) 24407-24414