O 54: Nanostructured surfaces and thin films

Time: Wednesday 10:30–12:30 Location: HSZ/0201

O 54.1 Wed 10:30 HSZ/0201

Advanced Characterization of Black Silicon via AFM and XPS: Geometric and Chemical Insights for better characterization of PV materials — •Jens Neurohr[1], Hendrik Hähl[1], Karin Jacobs[1], Michael Klatt[2], and Frank Müller[1] — [1]Experimental Physics and Center for Biophysics, Saarland University, Campus E2 9, 66123 Saarbrücken, Germany — [2]German Aerospace Center (DLR), Institute for Material Physics in Space, 51170 Köln, Germany

Understanding the link between surface geometry and chemical properties is crucial for photovoltaic (PV) applications, especially in nanostructured materials like black silicon (b-Si). RMS roughness is commonly used to describe nanorough surfaces, but it cannot capture their complexity or predict behaviors such as bacterial adhesion [1] or chemical composition.

On steep, irregular surfaces, chemical analysis techniques such as X-ray photoelectron spectroscopy (XPS) becomes challenging. To overcome this, we use Minkowski functionals and tensors [2,3] to relate XPS data to detailed Atomic Force Microscopy (AFM) topography.

Our results show that nanoscale geometry strongly influences chemical surface analysis and that geometric descriptors provide a powerful framework for studying complex surfaces.

[1] C. Spengler et al., Nanoscale, 11 (2019) 19713.
[2] R. Schneider, W. Weil, Springer (2008).
[3] G. E. Schröder-Turk et al., Advanced Materials, 23 (2011) 2535.

O 54.2 Wed 10:45 HSZ/0201

Systematic Investigation of Colloidal Au Nanoparticles for High-Density III-V Nanowire Growth — •Pavithira Manoharan, Chris Yanic Bohlemann, Peter Kleinschmidt, Thomas Hannappel, and Juliane Koch — Fundamentals of Energy Materials,Technical University of Ilmenau, 98693 Ilmenau, Germany

Over the past two decades, nanoscale structures such as III-V nanowires (NWs) have become versatile components for electronic and photonic applications, including high-performance photovoltaic and photoelectrochemical systems. Many simulation studies show that the density and lateral arrangement of NWs play a decisive role in optimizing light absorption, charge separation, and surface reactions. However, growing ordered NW arrays remains technologically challenging and costly. In this work, we present a simple and cost-effective method for producing high-density, disordered III-V NW using commercially available Au colloid solutions as a source of the catalyst particles. We perform a systematic study on how experimental parameters, such as surface preparation and substrate deposition conditions, affect the resulting nanowire density and diameter. This comprehensive approach provides insight into catalyst behavior prior to the vapor-liquid-solid growth and enables controlled modification of the NW structures. We also evaluate the limitations and potential of this method for NW-based energy conversion architectures.

O 54.3 Wed 11:00 HSZ/0201

Imaging the transition from diffusive to Landauer resistivity dipoles — •Serhii Kovalchuk[1,2], David Kämpfer[1,3,4], Jonathan K. Hofmann[1,3,4], Timofey Balashov[1,3,5], Vasily Cherepanov[1], Bert Voigtländer[1,3,4], Ireneusz Morawski[2], F. Stefan Tautz[1,3,4], and Felix Lüpke[1,6] — [1]Peter Grünberg Institut (PGI-3), Forschungszentrum Jülich, 52425 Jülich, Germany — [2]Institute of Experimental Physics, University of Wrocław, 50-204 Wrocław, Poland — [3]Jülich Aachen Research Alliance (JARA), Fundamental of Future Information Technology, 52425 Jülich, Germany — [4]Lehrstuhl für Experimentalphysik IV A, RWTH Aachen University, 52074 Aachen, Germany — [5]Lehrstuhl für Experimentalphysik II A, RWTH Aachen University, 52074 Aachen, Germany — [6]II. Physikalisches Institut, Universität zu Köln, 50937 Köln, Germany

A point-like defect in a current-carrying conductor produces an electrochemical potential dipole that opposes the applied field. When the carriers mean free path is shorter than the defect size, the dipole reflects diffusive transport; when it is longer, ballistic scattering leads to a size-independent residual resistivity dipole as predicted by Rolf Landauer.

We investigate this behaviour around nanoscale holes in thin Bi films on Si(111) using scanning tunneling potentiometry. The measured dipole amplitudes show a clear crossover from linear to constant scaling with decreasing hole size, marking the transition from diffusive to Landauer-type dipoles. This crossover allows us to extract the Fermi wave vector and estimate the carrier mean free path in the Bi films.

O 54.4 Wed 11:15 HSZ/0201

Current-driven Rb^+ intercalation for on-chip tuning of superconductivity in Rb_xC_{60} thin films — •Konstantin Shchukin[1,2], Oliver Gallego Lacey[3], Baptiste Coquinot[4], Jacek Jakowski[5], Jingsong Huang[5], Patrik Staudenmayer[1], Yannic Falke[2], Ram Prakash Pandeya[1], and Alexander Grüneis[1] — [1]Institut für Festkörperelektronik, Technische Universität Wien, Gußhausstraße 25, 1040 Vienna, Austria — [2]II. Physikalisches Institut, Universität zu Köln, Zülpicher Straße 77, 50937 Köln, Germany — [3]CEA, Université Grenoble Alpes, IRIG-Pheliqs, 38000 Grenoble, France — [4]Institute of Science and Technology Austria (ISTA), Am Campus 1, 3400 Klosterneuburg, Austria — [5]Center for Nanophase Materials Sciences, Oak Ridge National Laboratory, Oak Ridge, Tennessee, 37831, USA

Superconducting fullerides are usually synthesised by thermal or solution intercalation of alkali ions, which limits control of stoichiometry. We use electro-intercalation to drive Rb^+ into C_{60} thin films. Our on-chip setup combines *in-situ* growth, Raman spectroscopy and four-terminal transport, so that the stoichiometry x of Rb_xC_{60} is obtained from the $A_g(2)$ mode and linked to the superconducting transition temperature Tc. By varying the Rb/C_{60} ratio, we tune the films to superconducting Rb_3C_{60} and change T_c from 7 K to 26 K. Time-dependent Raman and transport data show that the Rb^+ electro-intercalation follows Butler-Volmer-type kinetics. Electro-intercalation enables precise, on-chip control of superconductivity in ultrathin fulleride films and is extendable to other porous and layered materials.

O 54.5 Wed 11:30 HSZ/0201

Mesoporous Cobalt Ferrite Thin Film Oxygen Evolution Electrocatalysts: The Role of Fe-Content on Structure, Activity and Stability — •Ann-Kristin Stief, Barbara Gonzalez-Navarrete, Stefan Lauterbach, Jan Philipp Hofmann, and Marcus Einert — TU Darmstadt, Darmstadt, Germany

Cobalt Ferrite is a promising alkaline Oxygen Evolution Reaction (OER) catalyst to replace state-of-the-art but expensive Ir- and Ru-based acidic OER catalysts in green hydrogen production. Given the limited and contradictory literature on the optimum stoichiometry of $Co_{3-x}Fe_xO_4$, we conducted a systematic stoichiometry study from x = 1.0 - 2.0 in increments of 0.2. To this end, mesoporous thin films were synthesized via dip-coating combined with soft-templating, using the commercially available polymer Pluronic F-127 for the first time. Electrochemical testing revealed that the x = 2.0 composition achieved the lowest iR-corrected overpotential (342 mV at 10 mA/cm^2), the smallest Tafel slope, and the lowest charge transfer resistance. Structural characterization disclosed enhanced crystallinity, reduced grain size and higher degree of inversion upon Fe-enrichment. X-ray Photoelectron Spectroscopy (XPS) further indicated that Fe-rich precatalysts form higher surface concentrations of hydroxide or defective oxide. Together, these findings contribute to the understanding of composition-structure-activity relations of Cobalt Ferrite OER catalysts, thereby laying a foundation for tailoring their catalytic performance. This work was supported by BMFTR within SINATRA (TWOB, Award Nr. 033RC036).

O 54.6 Wed 11:45 HSZ/0201

Probing Electromagnetic Chirality in Nanoresonators Using Scanning Reflection Anisotropy Microscopy — •Fabian Haake — ETH Zurich, Switzerland

We report on the application of a Scanning Reflection Anisotropy Microscope (SRAM) to study metasurfaces consisting of chiral nanoresonators. SRAM is a polarization-modulated optical method previously applied to strain mapping in crystalline materials and, more recently, demonstrated for amorphous systems (Sendra *et al.*, 2023; APL. 124, 171102, 2024). The structures were fabricated on Si_3N_4 TEM membranes using electron-beam lithography and metal deposition. Arrays of left- and right-handed resonators were fabricated and probed, showing a wavelength-dependent RAS contrast between the

two enantiomorphic forms. Finite-element simulations under circularly polarized illumination reproduce the observed handedness-dependent responses. The results demonstrate that SRAM sensitively resolves enantiomer-specific optical signals at the microscopic scale, enabling direct characterization of electromagnetic chirality in metasurfaces.

O 54.7 Wed 12:00 HSZ/0201

Self-assembly of linear three-ring aromatic thiols on Au(111) and their conversion into 2D molecular materials — •Verena Müller[1], Anna-Laurine Gaus[2], Daniel Hüger[1], Julian Picker[1], Christof Neumann[1], Max von Delius[2], and Andrey Turchanin[1] — [1]Friedrich Schiller University Jena, Institute of Physical Chemistry, Lessingstrasse 10, 07743 Jena, Germany — [2]Ulm University, Institute of Organic Chemistry, Albert Einstein Allee 11, 89081 Ulm, Germany

Self-assembled monolayers (SAMs) allow surface modification at the molecular level and moreover have the ability of crosslinking with low-energy electrons to form mechanically stable and transferable 2D materials, so-called carbon nanomembranes (CNMs).

We investigate the self-assembly of linear, three-ring aromatic thiols on Au(111) and their subsequent electron-induced conversion into carbon nanomembranes (CNMs). Our study examines terphenylthiol (TPT) derivatives with distinct terminal groups (-F, -CF_3, -NO_2) as well as a pyridinebiphenyl compound. Utilizing complementary surface science techniques - X-ray photoelectron spectroscopy (XPS), low-energy electron diffraction (LEED), and scanning tunneling microscopy (STM) - we elucidate the structural properties of the resulting self-assembled monolayers (SAMs) and investigate their transformation into CNMs. The resulting CNMs exhibit tunable gas permeation characteristics, governed by the chemistry of the precursor molecules and the SAM structure.

O 54.8 Wed 12:15 HSZ/0201

Liquid Flame Spray Enables Durable, Transparent, and Super-repellent Silica Coatings — •Suhad Sbeih — German Jordanian University, Amman, Jordan

Developing coatings that are simultaneously transparent, durable, and highly water-repellent remains a long-standing challenge in materials science. In this work, we show that the liquid flame spray (LFS) technique offers a fast and scalable solution. In this process, a silica precursor is combusted to generate nanoparticles that deposit on moving substrates, forming a hierarchical surface texture in a single step. By carefully adjusting the burner-substrate distance, precursor concentration, and coating velocity, we produced coatings that combine optical clarity with extreme water repellency, reaching contact angles above 150° and roll-off angles below 10°.

Beyond these surface properties, the coatings exhibited outstanding durability and retained their performance after rinsing, condensation, tape, and scratch tests. The results highlight LFS as a versatile approach for engineering multifunctional surfaces that bring together transparency, robustness, and super-repellency. Such coatings open new opportunities for large-area applications in optics, energy devices, and biomedical technologies.