O 49: Poster Nanostructures at Surfaces

Time: Tuesday 18:00–20:00 Location: P2

O 49.1 Tue 18:00 P2

Au induced nanostructures on Si(110) — •Stephan Appelfeller — MAX IV Laboratory, Lund University, Sweden

The deposition and annealing of small amounts of Au on clean Si substrates often lead to enticing nanostructures showing, e. g., spin ordering on vicinal Si(111) substrates or self-doping by adatoms on planar Si(111). A curious case are Au induced nanostructures on Si(110) for which the phase diagram is known in the submonolayer to monolayer regime, but for which few detailed studies exist, although, quasi-1D metallicity has been proposed for one of the nanostructures.

Here, the various nanostructures and their evolution are studied in real space using scanning tunnelling microscopy measured in MAX IVs SPM Support Lab, with core-level and angle-resolved photoemission spectroscopy obtained at the FlexPES beamline of the MAX IV Laboratory. For lowest Au coverages, a 2x1 superstrusture showing a distinct Au 4f core-level component forms. With increasing Au coverage, rows of 2x3 subunits develop leading to the formation of the 2x5 reconstruction with quasi 1D-metallicity and the two-domain (4,0)x(±1,3) high coverage phase, which shows a high stability and recoverability in UHV. This stability is shared with Au silicide nanowires, which grow in the mono- to multilayer Au coverage regime. Since there are no stable bulk Au silicides, the observation of Au silicide nanowires is a beautiful reminder that surfaces and interfaces in general are different and often deviate from bulk expectations.

O 49.2 Tue 18:00 P2

XPS study of CuO, WO3 and CuWO nanoparticles-based films — •Michal Procházka[1], Kalyani Shaji[2], Stanislav Haviar[2], Eliška Benediktová[2], Radomír Čerstvý[2], Ján Minár[1], Petr Zeman[2], and Jiří Čapek[2] — [1]New Technologies - Research Centre, University of West Bohemia, Univerzitní 8, Plzeň, 301 00, Czech Republic — [2]Department of Physics and NTIS - European Centre of Excellence, University of West Bohemia, Univerzitní 8, Plzeň, 301 00, Czech Republic

Interest in clean and sustainable technologies is rapidly growing and hydrogen is widely used in this field. With this development, more emphasis is placed on hydrogen gas sensors as hydrogen poses significant risks due to its explosive nature and flammability [1]. Structural parameters and surface properties plays a significant role in interaction of gas with sensor material [2]. Therefore, the nanoparticles of various materials are more and more explored. To understand the surface evolution after annealing in the air we measured XRD, SEM and XPS of CuO, WO3 and CuWO nanoparticles-based films prepared by magnetron-based gas aggregation technique.

[1] P. S. Chauhan, S. Bhattacharya, Hydrogen gas sensing methods, materials, and approach to achieve parts per billion level detection: A review, Int. J. Hydrogen Energy. 44 (2019) 26076-26099.

[2] H. Zhao, Y. Wang, Y. Zhou, Accelerating the Gas-Solid Interactions for Conductometric Gas Sensors: Impacting Factors and Improvement Strategies, Materials. 16 (2023).

O 49.3 Tue 18:00 P2

Hydroxyl Groups on Different Metal Doped Co_3O_4 Particle Catalysts Observed by Sum Frequency Generation Vibrational Spectroscopy — •Furong Yan[1], Carsten Placke-Yan[2], Zhipeng Huang[1], Yujin Tong[1], and R. Kramer Campen[1] — [1]Faculty of Physics and Center of Nanointegration (CENIDE), University of Duisburg-Essen — [2]Faculty of Chemistry and Institute of Inorganic Chemistry, University of Duisburg-Essen

Metal-doped Co_3O_4 nanoparticles are promising catalysts for the electrochemical oxygen evolution reaction (OER), with surface Co-OH groups playing a critical role in the water oxidation cycle. However, the influence of metal doping on the behavior of surface OH groups and its subsequent effect on OER activity remains uncertain.

Here, we investigate the effects of metal doping (Mn and V) on the bonding of OH groups using sum frequency generation (SFG) vibrational spectroscopy. Our results reveal that Mn-doped Co_3O_4 exhibits stronger bonding between OH groups and the surface compared to both pristine Co_3O_4 and V-doped Co_3O_4, leading to a reduction in OER activity. We propose two mechanisms: (1) an excess of OH groups can block active sites and increase charge transfer resistance, and (2) the stronger Co-OH bonds in Mn-doped Co_3O_4 may hinder the cleavage of Co-OH bonds, thereby impeding the OER process. These findings provide valuable insights into how surface interactions with OH groups can be tailored to optimize OER catalytic performance.

O 49.4 Tue 18:00 P2

Coral-like structures on nickel surfaces obtained by nitrogen plasma treatment — •Christina Meinert, Timo Wagner, Felix Schaumburg, Moritz Sünner, Nicolas Wöhrl, and Axel Lorke — Faculty of Physics, University Duisburg-Essen

For electrochemical processes, nickel sheets are commonly used as electrode material because of their low cost and easy handling. Here we report on the use of a microwave induced remote nitrogen plasma to change the surface of the nickel, improving the electrochemical and mechanical properties of the nickel electrode. During this process the surface obtains coral-like nanostructures and a nitridation of the nickel can be detected. AFM is employed to characterize these evolved nanostructures. Furthermore, EDX, Raman Spectroscopy and XPS are used to identify the chemical composition of the surface. In addition, wettability is probed as this is important for the efficiency of electrolysis. The plasma process is also applied to more complex surfaces than nickel plates such as wires and meshes. This allows to investigate the feasibility and limitations of treating these substrates.

O 49.5 Tue 18:00 P2

Exploring Topological Boundary Modes in Atomically Assembled Quantum Structures — •Adrian Weindl, Christoph Setescak, and Franz J. Giessibl — Faculty of Physics, University of Regensburg, D-93053 Regensburg, Germany

Single-atom and single-molecule manipulation enables the construction of quantum simulators: artificial structures assembled atom-by-atom or molecule-by-molecule to emulate key properties of complex systems that are challenging or impossible to fabricate directly. Using scanning tunneling microscopy (STM) and atomic force microscopy (AFM), we create two atomic-scale structures from individual CO molecules on Cu(111): a 1D Su-Schrieffer-Heeger (SSH) chain and a 2D Kagome lattice.

The 1D SSH chain represents a fundamental system capable of hosting topological boundary modes. We investigate the interaction between these boundary modes and the AFM tip. As the boundary modes are spatially localized and pinned in energy, they are not expected to undergo chemical bonding, unlike the bulk states of the chain, which may exhibit such interactions.

The 2D Kagome lattice on Cu(111) was initially proposed as a higher-order topological insulator, a classification that remains under debate. Through STM and AFM measurements, we aim to contribute to this ongoing discussion by introducing defects and analyzing the bonding behavior of the purported topological corner modes.

O 49.6 Tue 18:00 P2

Au vs. Ag: How Does the Choice of Substrate Influence the Formation of SAMs with Carboxylic Head Groups? — •Verena Müller[1], Julian Picker[1], Daniel Hüger[1], Christof Neumann[1], Marco Gruenewald[2], and Andrey Turchanin[1] — [1]Friedrich Schiller University Jena, Institute of Physical Chemistry, Lessingstraße 10, 07743 Jena, Germany — [2]Friedrich Schiller University Jena, Institute of Solid State Physics, Helmholtzweg 5, 07743 Jena, Germany

Self-assembled monolayers (SAMs) enable modification of various solid substrates at the molecular level, providing a wide range of applications in nanoscience and nanotechnology, *e.g.*, photonics, organic electronics and biochemical sensing.

In this contribution, we present a systematic investigation of the formation of SAMs with carboxylic head groups (–COOH) on Ag and Au substrates. To this end, we analyze the results for three molecular precursors: a Ru^{II}-polypyridine complex photosensitizer, hexadecanoic acid and *p*-terphenyl-4-carboxylic acid. Complementary surface science characterization methods - including X-ray photoelectron spectroscopy (XPS), low-energy electron diffraction (LEED), scanning tunneling microscopy (STM) and polarization-modulation infrared reflection absorption spectroscopy (PM-IRRAS) - were employed to confirm the successful SAM formations. The obtained results are utilized to gain insight into the nature of the chemical interaction between the carboxylate and the metal surface.

O 49.7 Tue 18:00 P2

Phase Transitions of Naphthalene-2,3-carbonitride Steered by Solvent Effects and Metal Ion Concentration Variation — •Longnan Yu[1], Li Wang[2], and Xiaoqing Liu[3] — [1]KIT, Karlsruhe, Germany — [2]Nanchang University, Nanchang, China — [3]Nanchang University, Nanchang, China

This study explores the structural phase transitions of naphthalene-2,3-carbonitride (2,3-DCN) on highly oriented pyrolytic graphite (HOPG) influenced by varying solvents and Cu2+ ion concentrations. By combining scanning tunneling microscopy and density functional theory, it is revealed that in 1-nonanoic acid,Cu2+ ions coordinate with 2,3-DCN and other ligands (Cl- or 1-nonanoic acid), forming structures with a coordination number of 4 that depend on the 2,3-DCN to Cu2+ molar ratio. In contrast, in 1-heptanoic acid,Cu2+ ions do not coordinate with 2,3-DCN, and phase transitions occur solely through altered hydrogen bonding. This work highlights solvent-dependent metal organic coordination as a novel strategy for tailoring nanoarchitectures.

O 49.8 Tue 18:00 P2

Bottom-up realization of quasi-1D electronic states from Cs atoms on InSb(110) — •Niek Aarts, Annique Krieg, Emil Sierda, Danis Badrtdinov, Brian Kiraly, Elze Knol, Gerrit Groenenboom, Mikhail Katsnelson, Malte Rösner, Daniel Wegner, and Alexander Khajetoorians — Institute for Molecules and Materials, Radboud University, Nijmegen, The Netherlands

1D-electronic systems are predicted to exhibit very different physical phenomena compared to 2D and 3D systems. Scanning tunnelling microscopy (STM) and spectroscopy (STS) provide a way to study 1D electronic systems on surfaces in a bottom-up approach with atomic-scale precision by utilising atomic manipulation.

Here, we study the electronic states of quasi-1D structures that result from coupling individual Cs atoms adsorbed on InSb(110) using low-temperature STM and STS. When constructing chains of Cs atoms, we observe the formation of quantized electronic states in energy with a modulated charge density along the chain. We can tune these electronic states by changing the length and Cs density of the chain. Modifying the chain length, changes the spacing of the electronic states. Changing the density of Cs atoms, changes the onset energy of the electronic states. We ascribe these observations to a 1D-particle in a box behavior for the lowest electronic states. For the electronic states at higher energy, we observe deviations from the simple particle in a box description. These deviations could be due to the onset of states with a higher order orbital symmetry or due to a coupling of these states to a bath.

O 49.9 Tue 18:00 P2

Investigation of onset field variations in annealed and as-deposited NbTiN samples through field emission scanning microscopy — •Frederic Braun[1], Isabel Díaz-Palacio[2], Lea Preece[2], Florian Brockner[1], Robert Zierold[2], Marc Wenskat[2], Wolfgang Hillert[2], and Dirk Lützenkirchen-Hecht[1] — [1]Bergische Universtiät Wuppertal — [2]Universität Hamburg

Current superconducting radio frequency (SRF) cavities are predominantly constructed from high purity Niobium which is pushed to its theoretical limit. To enhance future cavity performance by minimizing operational power losses and increasing accelerating field strength, the focus of research must shift to alternative cavity materials. An effective strategy involves depositing superconducting thin films like NbTiN or Nb3Sn on the cavity inner walls. Heat treating NbTiN may further optimize film properties. In this study various samples, including as deposited NbTiN and annealed NbTiN are analyzed via a Field Emission Scanning Microscopy (FESM). Current-voltage-curves allow the determination of onset-fields for parasitic field emission . Mapping these fields at e.g., 1 nA reveals lateral variations due to thin film inhomogeneities, defects or surface contaminations Additionally, assessing long term surface stability through constant current measurements over an extended period is crucial for practical cavity applications.

O 49.10 Tue 18:00 P2

Surface Reconstructions and Photocatalysis of Thermally Reduced LiNbO$_3$ and BaTiO$_3$ Single Crystals — •Marta Macyk[1], Andrzej Jasicki[1], Llorenç Albons[2], Konrad Szajna[1], Martin Setvin[2], Dominik Wrana[1], and Franciszek Krok[1] — [1]Marian Smoluchowski Institute of Physics, Jagiellonian University, Krakow, Poland — [2]Department of Surface and Plasma Science, Charles University, Prague, Czech Republic

Perovskite oxides, such as BaTiO$_3$ (BTO) and LiNbO$_3$ (LNO), exhibit a wide range of different stoichiometries and crystal structures that make them ideal candidates for applications in optoelectronics and catalysis. Their properties can be tuned by the change of stoichiometry and the introduction of oxygen vacancies achieved by annealing under Ultra High Vacuum (UHV).

This poster presents a comparative study of surface reconstructions for tetragonal BaTiO$_3$(001) and hexagonal LiNbO$_3$(0001) after UHV annealing under low oxygen partial pressure. LEED analysis reveals a (1×1) to $(\sqrt{5} \times \sqrt{5})$R26.6° transition for BTO, while LNO undergoes a (1×1) to $(\sqrt{3} \times 6)$R30° transition, ending with (3×3) structure at temperatures near 1200°C. Morphological studies using SEM, STM, and AFM show the formation of nanowire structures aligned with the substrates' crystallographic directions, offering insights into controlled surface engineering. Furthermore, photocurrent measurements at variable temperature were performed on the thermally modified crystals to evaluate their photocatalytic and pyrocatalytic activity under ambient conditions.

O 49.11 Tue 18:00 P2

Freestanding thin film cryo-EM samples for electrospray ion beam deposition and molecular imaging — •Stephanie Stankard, Stephan Rauschenbach, Lukas Eriksson, and Jingjin Fan — Department of Chemistry, University of Oxford

Over the past decade, cryogenic electron microscopy (cryo-EM) has become the dominating method for imaging in structural biology, a method in which samples are conventionally made by plunge freezing.

Combining cryo-EM with soft landing, electrospray ion beam deposition (ES-IBD) is a novel approach where intact, folded protein gas phase ions are landed onto the cryo-EM samples. For this, supported grids are required, which also need to be electron-transparent, and conductive. Often also ice needs to be grown on them after protein deposition.

Here, we present an analysis and optimisation of various thin, freestanding, amorphous carbon films for the purpose of application as a ESIBD and cryo-EM substrates.