

O 54: Nanostructures at surfaces II

Time: Wednesday 16:45–19:15

Location: MA 042

O 54.1 Wed 16:45 MA 042

Dynamic AFM with reduced contact stiffness by the employment of nanowires — ●IVO KNITTEL, MOID BHATTI, and UWE HARTMANN — Fachrichtung Experimentalphysik, Universität des Saarlandes, 66123 Saarbrücken

Nanowire tips for atomic force microscopy, employing a nanowire or a "supertip" on top of a conventional AFM tip, have been found advantageous in many respects. Nanowire tips are employed for high-resolution imaging of high-aspect ratio sample features, but also in order to obtain well-defined and enhanced local fields. However, in many cases a nanowire at the tip is flexible, reducing the contact stiffness to extremely low values. The resulting effective tip-sample force-distance relation is characteristic and leads to an unusual dynamics in intermittent-contact AFM.

Nanocantilever-on-cantilever AFM tips were produced by modification of conventional silicon AFM tips by means of a focused ion beam. A second type of probes were multiwalled carbon nanotube AFM tips. In addition, the intermittent-contact interaction between a conventional AFM tip and several types of nanowires on substrates was investigated. Nanowires were freely standing with resonant frequencies between 10 MHz and 1 GHz and lengths between 5 μ m and 300 nm.

Experimental and simulated intermittent-contact distance-dependent resonance curves were compared. We show the existence of a third state of intermittent-contact cantilever dynamics besides the well-known "low-amplitude" and the "high-amplitude" states. The particular role of adhesion and dissipation is also discussed.

O 54.2 Wed 17:00 MA 042

Evaluation of the Growth Mechanism of Ag-TCNQ for Morphology Control — ●BENEDIKT RÖSNER, ANDREAS SPÄTH, STEPHAN WENZEL, and RAINER H. FINK — Department Chemistry and Pharmacy, University Erlangen-Nürnberg, Egerlandstr. 3, 91058 Erlangen

Silver-(7,7*,8,8*)-tetracyanoquinodimethane (Ag-TCNQ) represents a form of charge transfer salts which can be described as needle-shaped crystals. This material features interesting properties regarding optical, electrical and magnetic behaviour and is therefore an interesting candidate for use in field emission devices, opto-electric storage devices and boards based on organic components. The control of the morphology, which is strongly dependent on the growth mechanism, is an essential precondition for the production of nanostructured devices. Two bottom-up growth mechanisms have been described so far. [1,2] However, these mechanism lag to describe phenomena observed by various microscopic methods growing this material in different reaction environments. We therefore evolve a diffusion-controlled reaction mechanism based on the first approaches mentioned above and discuss the influence of different parameters on the behaviour of silver and TCNQ on the molecular scale. 1.*Cao, G.-Y., et al., Micron, 2005. 36: p. 285-290. 2.*Ye, C.-N., et al., Chin. Phys. Lett., 2004. 21: p. 1787-1790.

O 54.3 Wed 17:15 MA 042

Ordered Supramolecular Nanowires on a Neutral Substrate — ●ROOZBEH SHOKRI^{1,2}, FRANÇOISE SEREIN-SPIRAU³, JEAN M. SOTIROPOULOS⁴, GÜNTER REITER¹, and LAURENT SIMON² — ¹Physikalisches Institut, Universität Freiburg, Germany — ²Institut de Science des Matériaux de Mulhouse (IS2M), France — ³Institut Charles Gerhardt de Montpellier, France — ⁴Institut Pluridisciplinaire de Recherche sur l'Environnement et les Matériaux, Pau, France

Here we present a scanning tunneling microscopy study on a well-defined organic oligomer composed of three thiophene-benzene-thiophene units deposited onto graphene. Mono-layer graphene can be considered as a neutral substrate which only weakly interacts with the molecules and thus allows observing molecular organization processes dominated by molecule-molecule interactions. Our studies exhibit well-ordered 2D domains of these molecules consisting of long supramolecular wires formed by a pi-stacking arrangement between the thiophene endgroups. The precise molecular arrangement and measurements of the HOMO-LUMO gap and spatial mapping of the electronic states reveal the possibility of transporting charges through a hopping mechanism. Scanning tunneling spectroscopy in combination with DFT calculations manifest that the electronic states of the molecules are

not perturbed by the underlying graphene layer, i.e. decoupled from the substrate. Such weak interaction between molecules and graphene provides the possibility to image and "see" all molecular orbitals in detail, and to distinguish unambiguously individual molecular segments.

O 54.4 Wed 17:30 MA 042

Oxygen adatoms on the MoO₂/Mo(110) surface: from nanoscale writing to oxide nanowires — ●OLAF LÜBBEN¹, SERGEY A. KRASNIKOV¹, SERGEY I. BOZHKO^{1,2}, BARRY E. MURPHY¹, and IGOR V. SHVETS¹ — ¹School of Physics, Trinity College Dublin, Dublin, Ireland — ²Institute of Solid State Physics, Russian Academy of Sciences, Chernogolovka, Russian Federation

Nanoscale writing using oxygen adatoms on the MoO₂/Mo(110) surface is demonstrated by scanning tunneling microscopy (STM). Oxidation of metal surfaces can produce a variety of ordered oxide nanostructures and two-dimensional surface oxides, which are of great significance for heterogeneous catalysis. High-temperature oxidation of the Mo(110) surface forms well-ordered molybdenum oxide nanorows separated by 2.5 nm. Further oxidation results in perfectly-aligned double rows of oxygen adatoms, imaged by STM as bright protrusions. These adatoms can be removed from the surface in a controlled fashion by the STM tip. Tip movement along the surface can be used for controlled lithography, with a minimum feature size of just 5 nm. Finally, deposition of Fe on the oxygen-rich MoO₂/Mo(110) surface leads to the formation of well-ordered Fe oxide nanowires with a zig-zag structure.

O 54.5 Wed 17:45 MA 042

2D-Quantum confinement in nanoporous networks — ●NENAD KEPČIJA¹, FLORIAN KLAPPENBERGER¹, WOLFGANG KRENNER¹, JAVIER GARCÍA DE ABAJO², and JOHANNES BARTH¹ — ¹Physik Department E20, Technische Universität München, James-Frank Straße, 85748 Garching, Germany — ²Instituto de Optica - CSIC, Serrano 121, 28006 Madrid, Spain

Quantum confinement of a 2D electron gas in supramolecular nanoporous networks is investigated using the Boundary Elements Method (BEM) based on Green's functions for finite geometries and electron plane wave expansion (EPW) for periodic systems. The "particle in a box" picture was analyzed for cases with selected symmetries that model previously reported architectures constructed from purely organic and metal-organic scattering centers. The networks can be seen as arrays of coupled quantum dots. By varying the appropriate parameters we demonstrate how the scattering properties affect the electronic characteristics. For the reported features of the local density of states (LDOS) we were able to separate lifetime broadening from splitting of quantum dot states due to nearest-neighbour interaction. For each system we analyze the local electron density distribution and relate it with the corresponding band structure. Thereby, we connect the complementary information typically obtained by local scanning tunneling spectroscopy and *k*-sensitive angle-resolved photoemission spectroscopy.

O 54.6 Wed 18:00 MA 042

Reactivity of Co-alloy clusters — ●IVAN BAEV, TORBEN BEECK, MICHAEL MARTINS, and WILFRIED WURTH — Universität Hamburg, Institut für Experimentalphysik

The chemical reactivity of small particles such as clusters strongly varies as a function of size in the Nano scale. Understanding the nature of chemical reactions at this small size limit is crucial for a further development of Nano catalysts. With our source "ICARUS" we can create a perfectly size selected cluster beam in the size range of 20 atoms per cluster. This beam is used to deposit clusters onto metallic substrates or thin oxide films. Clusters are deposited using the "soft-landing" technique to avoid fragmentation, agglomeration or implantation of the clusters into the substrate combined with a low surface coverage of less than 5% of a monolayer. Using core-level photoelectron spectroscopy at the BESSY U49-2PGM1 beamline the metallic core levels are measured as a function of cluster size and composition. The core level spectra are very sensitive to the chemical environment of the cluster so that chemical processes can be directly traced back to the cluster sites. Combined with the measurement of oxygen and carbon 1s core levels a stoichiometric interpretation of the surface reactions can be given. This work is supported by the DFG through the

collaborative research center SFB 668.

O 54.7 Wed 18:15 MA 042

Behavior of Co, Fe and FeCo alloy nanoparticles deposited on W(110) — •WOLFGANG ROSELLEN, HENDRIK BETTERMANN, TORSTEN VELTUM, and MATHIAS GETZLAFF — Institute of Applied Physics, University Duesseldorf

In contrast to free nanoparticles, deposited clusters and particles become more and more interesting from a technological point of view due to their size dependent electronic and magnetic properties. Therefore, it is important to have access to the structure of the particles after deposition. In this contribution we will discuss different aspects of mass and therefore size selected magnetic 3d-nanoparticles deposited on W(110). The deposited nanoparticles, mainly Fe, Co and their alloys are investigated by means of Scanning Tunneling Microscopy in-situ under UHV conditions. For our investigations we assemble the nanoparticles in the gas phase by a UHV compatible Arc Ion Cluster Source (ACIS)[1] being developed for softlanding condition. At this regime, a kinetic energy below 1 eV/atom, nanoparticles could be deposited without deformation. We will discuss the properties of individual particles as well as statistically appreciable particle ensembles. Therefore, we will report on size dependent structural properties including crystallographic structure, height and size, shape, the influence of substrate etc. We will additionally focus on the melting behavior of nanoparticles. Finally, we demonstrate a method for the spontaneous orientation of Fe, Co and alloy nanoparticles deposited on W(110).

[1] R.-P. Methling et al., European Physical Journal D **16**, 173 (2001)

O 54.8 Wed 18:30 MA 042

Transition metal adatoms on Rh(111) supported monolayer boron nitride — •FABIAN DONAT NATTERER, FRANÇOIS PATTHEY, and HARALD BRUNE — Institute of Condensed Matter Physics (ICMP), Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland

The low temperature adsorption of transition metal (TM) adatoms (Ti, Cr, Mn, Fe and Co) onto Rh(111) supported boron nitride (BN) monolayers leads to different behaviors. A bistable adsorption complex is found for Mn, Fe and Co. One of its states strongly weakens the boron nitride substrate binding of more than 100 boron and nitrogen atoms. In consequence, the BN layer locally acts as a soft membrane that is elastically deformed in the presence of the scanning tunneling microscope tip. For Ti and Cr, different spectral features are observed depending on the hydrogen exposure, showing a concomitant modification of the TM adatom electronic structure.

O 54.9 Wed 18:45 MA 042

RHEED Study of Ag Nanoparticles for catalytic reactions —

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Size-selected silver clusters deposited on amorphous alumina films can act as high performance nanocatalysts for the partial oxidation of propylene [1].

This contribution focuses on *in situ* reflection high energy electron diffraction (RHEED) investigations of deposited Ag clusters on amorphous alumina films. For randomly oriented particles a ring structure, similarly to the Debye-Scherrer rings in conventional X-ray powder diffraction is expected [2]. Diffraction patterns after different sample treatments (heating, varying ambient environment) are presented. The cluster structure and orientation with respect to the substrate is discussed. The analysis is supported by height distributions obtained from *ex situ* AFM measurements.

[1] L.M. Molina et al., Catalysis Today **160**, 116 (2011)

[2] A. Kleibert et al., Phys. Status Solidi B **247**, 1048 (2010)

O 54.10 Wed 19:00 MA 042

Study of collective efforts of catalytic activity and photo-activation phenomenon for an enhanced response of SnO2 based thin film sensors towards methane gas — •DIVYA HARIDAS¹ and VINAY GUPTA² — ¹Department of Physics, Keshav Mahavidyalaya, University of Delhi, Pitampura, Delhi, India-110034 — ²Department of Physics and Astrophysics, University of Delhi, Delhi, India-110007

Detection of methane is always a great cause of concern for safety productions in mines and chemical factories. The present study investigates the twin effect of UV illumination and catalytic activity on methane sensing characteristics of SnO2 sensors. The sensitivity and selectivity of pure SnO2 thin film sensors are improved by loading it with different catalyst (Pd, Pt, Ni, Au) clusters (8 nm). Palladium clusters catalyst showed an enhanced sensor response (97.6%) towards 200 ppm of methane detection at an operating temperature of 220°C. Further, optimizing the thickness of Pd clusters leads to an enhanced sensing response of 97% to 99% over a wider temperature range (160°C to 240°C) for 10 nm thick Pd clusters. The room temperature response of the same sensor increases to 99.7% under UV illumination which is attributed to the efficient catalytic dissociation of methane molecules besides the spillover process at room temperature. Results indicate the possibility of utilizing the sensor structure with novel dispersal of Pd catalyst clusters on SnO2 film surface for efficient detection of methane at room temperature under the illumination of UV radiations.