O 23: Nanostructures at surfaces: Dots, particles, clusters

Time: Tuesday 10:30–13:00 Location: H33

O 23.1 Tue 10:30 H33

Surface Photovoltage of Ag Nanoparticles and Au Chains on Si(111) — •Kristian Sell, Ingo Barke, Stefan Polei, Viola von Oeynhausen, and Karl-Heinz Meiwes-Broer — Universität Rostock, Institut für Physik, 18051 Rostock

We present surface photo voltage (SPV) measurements of deposited Ag nanoparticles on Si(111)7x7 and of the quasi one-dimensional Si(111)5x2-Au structure. Quantitative results are obtained from spatially resolved I(V) spectra under laser illumination. On Si(111)5x2-Au we determine the SPV as a function of laser power at different locations. An accurate value for the Fermi-level pinning position is obtained. Based on these results we establish and discuss a simple model for the band topology. It is confirmed by spatially-resolved local work function measurements utilizing the image-state derived field emission resonances. These results have interesting implications on the electronic properties of metal nanostructures on semiconductors with metallic surface states.

O 23.2 Tue 10:45 H33

Identifying low-coordinated atoms on oxide-supported Au clusters — Xiao Lin[1], •Niklas Nilius[1], Pekka Koskinen[2], Hannu Häkkinen[2], and Hans-Joachim Freund[1] — [1]Fritz-Haber-Institut der MPG, Faradayweg 4-6, D-14195 Berlin, Germany — [2]Department of Physics, University of Jyväskylä, P.O. Box 35, FI-40014 Finland

The outstanding chemical properties of small metal particles are partly governed by the perimeter atoms that are located at the boundary to the oxide support. Those edge and corner sites are unique due to their low coordination, a peculiar electronic structure and charge state. We have employed STM and DFT to characterize the perimeter atoms around planar Au clusters grown on a MgO/Ag(001) thin film. The atoms exhibit an enhanced state density with respect to the island center in conductance spectra taken around the Fermi level. Furthermore, they carry extra electrons resulting from a charge transfer from the MgO-Ag interface into the Au islands. Both effects render the perimeter atoms highly attractive for binding molecules, as demonstrated via CO adsorption experiments on the system.

O 23.3 Tue 11:00 H33

Gundlach oscillations and Coulomb blockade of Co nano-islands on MgO/Mo(100) — •Marco Pratzer, Christian Pauly, Martin Grob, and Markus Morgenstern — II. Physikalisches Institut B and JARA-FIT, Otto-Blumenthal-Straße, RWTH Aachen, 52074 Aachen

We studied the electronic properties of ultra thin MgO films (thickness 2 ML to 11 ML) on Mo(100) by scanning tunneling microscopy and spectroscopy at room temperature. Preparation of MgO has been done by molecular beam epitaxy of magnesium in O_2 partial pressure of $p = 10^{-7}$ mbar. The work function differences of the MgO film are mapped by field emission resonance states (Gundlach oscillations) by dz/dU-spectroscopy. We found parts of islands with significantly reduced workfunction ($\Delta\Phi = 0.6\,\mathrm{eV}$), which are tentatively assigned to charged defects within the MgO film. On top of the MgO films we prepared Co nano-islands with an area of about $A = 4\,\mathrm{nm}^2$ by molecular beam epitaxy. Due to the small capacity of the Co islands we observed Coulomb staircases at room temperature, respectively peaks in dI/dU-spectroscopy. Good agreement with orthodox theory is achieved showing variations of Q_0 for islands at different positions.

O 23.4 Tue 11:15 H33

Spatial and temporal resolved microscopic processes in dielectrics irradiated with swift heavy ions — •Orkhan Osmani[1,2], Nikita Medvedev[2], Marika Schleberger[1], and Baerbel Rethfeld[2] — [1]Universität Duisburg-Essen, Fakultät für Physik, Duisburg — [2]Technische Universität Kaiserslautern, Fachbereich Physik, Kasierslautern

When an ion with kinetic energies of some 100 MeV irradiated a target insulator structural modifications can be observed on the surface. These modifications originate from strong localized electronic excitations induced by the penetrating ion. These excited electrons propagate through the crystal and excite secondary electrons on their path thus creating an electronic cascade. Such excited electrons will thermalize with the target lattice by exciting phonons. The heating of the target lattice will result finally in a molten zone that can be detected by AFM for instance. The aim of this presentation is to give an understanding of the processes involved during irradiation of dielectrics. To this end we study the excitation and relaxation of the electronic system and the creation of phonons theoretically applying classical kinetic Monte Carlo method and the two temperature model.

O 23.5 Tue 11:30 H33

Oxygen-induced shape changes of Pt nanoparticles on MgO(100) — •Uta Hejral, Andreas Stierle, Alina Vlad, Mélissa Delheusy, and Helmut Dosch — Max-Planck-Institut für Metallforschung, Heisenbergstr. 3, 70569 Stuttgart, Germany

Platinum nanoparticles on oxide carrier materials are used in heterogenous catalysis and are applied successfully in reactions like the oxidation of hydrocarbons or carbon monoxide [1]. In order to achieve better catalyst efficiency, lifetime and selectivity it is important to comprehend catalytic processes on an atomic basis. Thus, the interplay between particle shape, adsorbed oxygen, bulk oxides and catalytic activity needs to be understood. Therefore Pt nanoparticles have been grown epitaxially on MgO(100) substrates under controlled conditions. It has previously been reported that Rh nanoparticles undergo reversible shape changes induced by surface oxides [2]. We have studied oxygen-induced shape changes of Pt nanoparticles on MgO(100) by means of in situ x-ray diffraction. The experiment was performed at 300°C and oxygen pressures ranging from UHV to 500 mbar. The experimental results are compared to the theoretically predicted ones reported in [3].

[1] G. Rupprechter, in: Advances in Catalysis, eds. B. Gates and H. Knözinger, Vol. 51 (Elsevier, Amsterdam, (2007) p.134).

[2] P. Nolte et al., Science 321, 1654 (2008).

[3] N. Seriani et al., Journal of Physics: Condensed Matter 20, 184023 (2008).

O 23.6 Tue 11:45 H33

Towards nanocatalytic and -magnetic applications of cluster superlattices on the Ir(111)/graphene moiré — •Timm Gerber, Alpha T. N'Diaye, Carsten Busse, and Thomas Michely — II. Physikalisches Institut, Universität zu Köln

The graphene moiré on Ir(111) is a versatile template for the growth of well ordered cluster superlattices. Employing a newly developed method to ensure full graphene coverage without any rotational variants, we demonstrate entire sample coverage with a cluster superlattice. As a second step towards applications we introduce methods to enhance the thermal stabilty of cluster superlattices and to keep them intact under ambient conditions. In view of nanocatalytic applications we investigated formation and thermal decay of Au and Pt cluster superlattices. The interaction of Pt clusters upon adsorption of CO and O is reported. For the ferromagnetic metals Co, Fe, Ni and for Rh (being magnetic as small clusters) we investigated the ability to form cluster superlattices. For those elements that do not form cluster superlattices upon room temperature deposition cluster seeding with Ir or Pt was employed. The latter offers the possibility to create bimetallic clusters such as FePt and CoPt.

O 23.7 Tue 12:00 H33

Spectroscopy of Mass Selected Clusters — •Niklas Grönhagen[1], Ben Wortmann[1], Kolja Mende[1], Natalie Miroslawski[1], Stefanie Duffe[1], Bernd von Issendorff[2], Michael Moseler[2,3,4], and Heinz Hövel[1] — [1]TU Dortmund, Experimentelle Physik I — [2]Universität Freiburg, Fakultät für Physik — [3]Fraunhofer Institut für Werkstoffmechanik, Freiburg — [4]Freiburger Materialforschungszentrum

We deposited mass selected Ag clusters on C_{60} films at low temperatures. Their size ranged from Ag_{55}^{+} to $\mathrm{Ag}_{923\pm9}^{+}$ which correspond to closed shell icosahedra and in STM images they were found to stay size selected after the soft landing process. We investigated the electronic properties with ultraviolet photoemission spectroscopy (UPS). Because the dominant signal of C_{60} masks the signal of the clusters, for UPS experiments HOPG was used as a substrate instead. Coalescence was avoided by depositing and measuring at 40 K, which reduces the mobility of the clusters. For these samples we could detect the Ag

UPS signal. In further analysis we measured the size of the deposition spot using the spatial distribution of the energy integrated UPS cluster signal.

In addition we investigated clusters on 1 ML C_{60}/Au(111), which ranged from Ag_{55} to $Ag_{138\pm1}$ by using STS and compared them to previous STS measurements of Ag clusters on C_{60}/HOPG.

O 23.8 Tue 12:15 H33

Size-dependent alignment of Fe nanoparticles upon deposition onto W(110) — •Armin Kleibert[1], Andris Voitkans[2], and Karl-Heinz Meiwes-Broer[3] — [1]Swiss Light Source, Paul Scherrer Institute, CH-5232 Villigen, Switzerland — [2]Institute of Solid State Physics, University of Latvia, LV-1063 Riga, Latvia — [3]Institute of Physics, University of Rostock, D-18051 Rostock, Germany

Size, shape, structure and orientation of supported nanostructures have crucial impact on their catalytic, electronic, optical and magnetic properties. Thus, gaining control over these parameters is subject of intense research. Deposition of preformed clusters has attracted much attention in the past since it enables stabilization of nanostructures far from equilibrium and virtually any material and particle size combination. While fragmentation, diffusion and sintering of deposited nanoparticles have been intensively studied in the past, still little is known about the orientation of the nanoparticles upon deposition. In this contribution we present an in situ reflection high energy electron diffraction (RHEED) study on mass-filtered Fe nanoparticles upon deposition onto W(110). We find that clusters below a critical diameter align spontaneously in an epitaxial manner on W(110). Larger particles land preferentially on their surface facets but with random azimuthal orientation with respect to the substrate lattice [1]. These results show that even a random deposition process can lead to uniformly oriented nanostructures.

[1] A. Kleibert, A. Voitkans, and K.-H. Meiwes-Broer, submitted.

O 23.9 Tue 12:30 H33

Mechanism of metal nanostructure self-ordering during oblique deposition on pre-patterned surfaces — •Satoshi Numazawa and Karl-Heinz Heinig — Forschungszentrum Dresden-Rossendorf, Dresden, Germany

During oblique metal vapor deposition perpendicular to ripples of pre-patterned surfaces, a chain-like formation of metal nanoclusters along the ripples has been observed. The metal nanoclusters are located on the slopes which point towards the evaporation source. The self-ordering of metal nanoclusters has not been observed for normal deposition and for low-angle deposition parallel to the ripple direction. The features of the metal nanostructure depend strongly on the evaporation angle. Here, by means of 3D lattice kinetic Monte Carlo simulations, we studied the process of silver deposition on pre-patterned, oxidized Si surfaces. The experimentally observed Ag nanostructures could be reproduced. It was shown that the extremely low sticking probability of deposited Ag together with a slope-dependent deposition rate leads to a strongly selective Ag nanocluster nucleation on the surface because the nucleation rate depends on the square of the adatom concentration.

O 23.10 Tue 12:45 H33

Electrospray Ion Beam Deposition: A New Approach to Investigate the Mn12-Acetate Molecular Magnets on Metal Surfaces by Scanning Tunneling Microscopy — •Zhitao Deng[1], Christian Michaelis[1], Alicia Forment-Aliaga[1,2], Nicha Thontasen[1], Steffen Kahle[1], Nicola Malinowski[1], Markus Ternes[1], Stephan Rauschenbach[1], and Klaus Kern[1,3] — [1]MPI-FKF, Stuttgart, Germany — [2]Instituto de Ciencia Molecular, Universitat de València, Paterna, Spain — [3]Institut de la Matière Condenseé, EPFL, Lausanne, Switzerland

A well defined sample preparation is crucial in order to achieve the ultimate goal of probing the single spin properties of a single molecular magnet. Films of monolayer and submonolayer coverage of the single molecule magnet Mn_{12}-acetate ($[Mn_{12}O_{12}(CH_3COO)_{16}(H_2O)_4]\cdot 2CH_3COOH\cdot 4H_2O$) were prepared in-situ on Au(111) surface in ultra high vacuum using electrospray ion beam deposition (ES-IBD). The samples were characterized by several surface sensitive techniques including matrix assisted laser desorption ionization mass spectrometry (MALDI-MS) and scanning tunneling microscopy (STM). The Mn_{12}-acetate molecules were deposited by a electrospray ionization source[1] in negative mode. STM measurements at a temperature of 40K show that the molecules are trapped at the elbow sites of the reconstructed Au(111) surface at the initial stage. With increasing molecular coverage, molecules aggregate in the fcc region of the Au(111) surface at first and in the hcp region for even higher coverage. [1] Small **2** (2006), 540-547