

O 41: Nanostructures at Surfaces: Metals, Oxides and Semiconductors II

Time: Tuesday 14:00–16:00

Location: REC/PHY C213

O 41.1 Tue 14:00 REC/PHY C213

Lattice dynamics of laser-excited Au nanoclusters observed by femtosecond electron diffraction — ●THOMAS VASILEIADIS¹, DAWN WELLS², LUTZ WALDECKER¹, ALESSANDRA DA SILVA², ROMAN BERTONI¹, RICHARD PALMER², and RALPH ERNSTORFER¹ — ¹Fritz-Haber-Institut der Max-Planck-Gesellschaft, 14195 Berlin, Germany — ²Nanoscale Physics Research Laboratory, School of Physics and Astronomy, University of Birmingham, Birmingham B15 2TT, UK

Metallic nanoclusters (NCs) have dominated the field of light-harvesting technologies and photo-catalysis [1]. For all these applications it is important to know how heat flows in the nanoscale and if the crystalline order is affected. We address this question using femtosecond electron diffraction [2] to study size-selected Au NCs on various substrates [3]. We resolve lattice-heating, expansion and surface disordering using the height, scattering vector and width of diffraction peaks respectively. In addition, we show that for NCs on 2D crystals a pre-existing crystallographic texture can reveal morphological changes. Finally, we present a model of heat flow in low-dimensional heterostructures to estimate electronic and vibrational coupling to the substrate.

[1]M.L. Brongersma et al., Nat. Nanotech. 10, 25-34 (2015).

[2]L. Waldecker et al., J. Appl. Phys. 117, 044903 (2015).

[3]S. R. Plant, L. Cao, and R.E. Palmer, J. Am. Chem. Soc., 136, 7559-7562 (2014).

O 41.2 Tue 14:15 REC/PHY C213

3d-metal nanoparticles on tungsten, tungsten-oxide and tungsten-carbide — ●HENDRIK BETTERMANN, KNUTH SCHEIFF, JENS SCHUBERT, and MATHIAS GETZLAFF — Institute of Applied Physics, Heinrich-Heine-Universität Düsseldorf

Supported clusters and nanoparticles are rather interesting objects not only from a fundamental point of view but also for technological applications due to their electronic and magnetic properties. These properties typically show a strong size dependence. Interaction with the substrate during and after deposition significantly influences the particles' properties.

Our contribution is focused on size-selected nanoparticles made from Fe, Co, and Ni and their binary alloys. These particles are deposited on W(110) as well as the corresponding tungsten-oxide and -carbide superstructures. Two UHV-compatible nanoparticle sources, an Arc Cluster Ion Source (ACIS) and a magnetron sputter source (Haberland-type), can produce a wide range of particle sizes (4 to 15 nm).

Size and structural properties are investigated by STM (scanning tunneling microscopy) and LEED (low energy electron diffraction) under UHV conditions. Samples are tempered to determine the melting behaviour of the nanoparticles.

O 41.3 Tue 14:30 REC/PHY C213

A monolayer of hexagonal boron nitride on Ir(111) as a template for cluster growth — ●MORITZ WILL¹, PHILIPP VALERIUS¹, CHARLOTTE HERBIG¹, VASILE CACIUC², NICOLAE ATODIRESEI², and THOMAS MICHELY¹ — ¹II. Physikalisches Institut, Universität zu Köln, Zùlpicher Str. 77, 50937 Köln, Germany — ²Peter Grünberg Institut (PGI) and Institute for Advanced Simulation (IAS), Forschungszentrum Jùlich and JARA, 52425 Jùlich, Germany

Chemical vapor deposition of B₃N₃H₆ molecules on Ir(111) results in a well aligned monolayer of hexagonal boron nitride (h-BN). The center of each unit cell provides a chemisorbed valley area, where h-BN is hybridized with the Ir substrate. Through a scanning tunneling microscopy study we provide evidence that the valley regions are reactive and pin deposited atoms. In consequence, highly regular cluster arrays with a periodicity of 2.9 nm can be formed. For the case of Ir clusters, the size distribution is narrow. The average size can be tuned between a few to about 200 atoms for room temperature deposition. The thermal stability of the clusters is extraordinary, with a decay of the cluster lattice setting only at around 850 K, primarily through intercalation of the cluster material. Regularly positioned C clusters on h-BN are even observed after annealing to 1500 K. Compared to cluster arrays using graphene on Ir(111) as a template, the better order and the higher thermal stability make the arrays on h-BN/Ir(111) superior in terms of potential applications for nano-catalysis. We elucidated the cluster

binding mechanism of Ir clusters to h-BN/Ir(111) with the help of density functional theory calculations.

O 41.4 Tue 14:45 REC/PHY C213

Aggregation behaviour of silver clusters in room temperature ionic liquids — ●STEFANIE ROESE, ALEXANDER KONONOV, FLORIAN LIPPERT, and HEINZ HÖVEL — Fakultät Physik / DELTA, TU Dortmund, Otto-Hahn-Str. 4, 44221 Dortmund, Germany

Room temperature ionic liquids (RTIL) are well-known stabilizers for nanoparticles [1]. For now only a few studies of the stability of nanoparticles in RTILs are available [2], nevertheless the nanoparticle stability is of critical importance in controlling aggregation processes.

2 nm silver nanoparticles with a well-characterized size distribution (± 0.6 nm) are preformed in a supersonic nozzle expansion [3] and deposited afterwards into the ionic liquid. The cluster plasmon is investigated in-situ by UV/Vis absorption spectroscopy during cluster deposition as well as in temperature dependent measurements after deposition [4]. We observed that the storage temperature as well as the choice of anion and cation influences the cluster stability on timescales of several days. An activation energy for different aggregation states was calculated.

The geometric cluster structure is determined in first EXAFS measurements performed at beamline P64, DESY, where the effect of aggregation can be seen in a change in the resulting lattice constant.

[1] J. Dupont, J. D. Scholten, Chem. Soc. Rev. 39, 1780 (2010). [2] K. Richter, A. Birkner and A. Mudring, Phys. Chem. Chem. Phys. 13, 7136 (2011). [3] H. Hövel, S. Fritz, A. Hilger, U. Kreibitz and M. Vollmer, Phys. Rev. B 48, 18178 (1993). [4] D. Engemann, S. Roesse and H. Hövel, J. Phys. Chem. C, 120, 6239 (2016).

O 41.5 Tue 15:00 REC/PHY C213

Size dependent changes in the electronic structure of manganese oxide nanoparticles and clusters probed by soft X-ray absorption and emission spectroscopy — ●MARC F. TESCH¹, MARYAM N. SHAKER^{1,2}, DANIELA SCHÖN^{1,2}, NIKLAS CIBURA³, EMAD F. AZIZ^{1,2}, and JENNIFER STRUNK³ — ¹Helmholtz-Zentrum Berlin für Materialien und Energie, 12489 Berlin — ²Fachbereich Physik, Freie Universität Berlin, 14195 Berlin — ³MPI für chemische Energiekonversion, 45413 MÜLHEIM an der Ruhr

Nanoscale objects are of tremendous interest for novel applications since they can exhibit significant changes in their material properties compared to the bulk material. This is interesting for catalytic applications because the quantum size effect, causing a bandgap widening, can facilitate photocatalytic reactions. We present a study on MnOx nanoparticles, which are promising candidates to act as environmental friendly water oxidation catalysts. Nanoparticles of different sizes were obtained by pulsed laser ablation and nanoclusters were produced in a self-arrangement process from solution with grafting and impregnation techniques on mesoporous silica. The samples are studied by means of soft X-ray absorption spectroscopy and resonant inelastic X-ray scattering at the Mn L-edges. The combination of these techniques allows tracking changes in the electronic structure of the unoccupied as well as of the occupied 3d valence states. The two sample systems are compared with respect to each other and to spectra of bulk references and an overview of the particle size dependence on the catalytic activity and the electronic structure will be given.

O 41.6 Tue 15:15 REC/PHY C213

The diffuse scattering pattern from nanostructured surfaces — ●VICTOR SOLTWISCH¹, ANALIA FERNANDEZ HERRERO¹, MIKA PFLÜGER¹, JÜRGEN PROBST², ANTON HAASE¹, and FRANK SCHOLZE¹ — ¹Physikalisch-Technische Bundesanstalt — ²Helmholtz-Zentrum Berlin

Laterally periodic nanostructures were investigated with grazing incidence small angle X-ray scattering. To support an improved reconstruction of nanostructured surface geometries, we investigated the origin of the contributions to the diffuse scattering pattern which is correlated to the surface roughness. Resonant diffuse scattering leads to a palm-like structure of intensity sheets. Dynamic scattering generates the so-called Yoneda band caused by a resonant scatter enhancement at the critical angle of total reflection and higher-order Yoneda bands originating from a subsequent diffraction of the Yoneda enhanced scat-

tering at the grating. Our explanations are supported by modelling using a solver for the time-harmonic Maxwell's equations based on the finite-element method.

O 41.7 Tue 15:30 REC/PHY C213

Flux- and Fluence-dependent Nanocone-formation on InP under ion-irradiation — •DETLEF KRAMCZYNSKI^{1,2} and HUBERT GNASER¹ — ¹AG Grenzflächen/Nanomaterialien/Biophysik, Uni Kaiserslautern — ²Nanoparticle Process Technology, Uni Duisburg-Essen

Samples of InP-wafers have been irradiated with 2.1 keV Ar-ions at various combinations of flux (0.9 to $1.6 \cdot 10^{14}$ ions/(cm²s)) and fluence (0.4 to $2.4 \cdot 10^{18}$ ions/(cm²)), at vertical incidence and at room temperature.

The result is a rich phase-diagram wherein the size-distribution of the Nanocones, their global-scale surface-coverage and their local-scale tendency to agglomerate as islands very delicately depend on the proper combination of flux and fluence.

The suggested explanation is a multi-species adatom-diffusion-process, with thermally-enhanced adatom-diffusion being responsible for the global-scale phenomena and the energy-deposition of the ions being responsible for the local-scale phenomena.

O 41.8 Tue 15:45 REC/PHY C213

Topological States and nearly flat Electron Band in engineered atomic Lattices — •ROBERT DROST^{1,2}, TEEMU OHJANEN¹, ARI HARJU¹, and PETER LILJEROTH¹ — ¹Aalto University Department of Applied Physics, Puumiehenkuja 2, 02150 Espoo, Finland — ²Max Planck Institute for Solid State Research, Heisenbergstr. 1, 70569 Stuttgart, Germany

Topological materials exhibit protected edge or boundary modes that have been proposed for applications in spintronics and quantum computation. The essential physics of several topological systems are captured in two-dimensional tight binding models which can be implemented in artificial lattices. This approach makes it possible to test theoretical proposals in systems with precise control over the models parameters or design quantum materials with tailored properties. We use low-temperature scanning tunnelling microscopy to fabricate such lattices with atomic precision and probe the resulting density of states. We implemented two Hamiltonians of fundamental importance using vacancy defects in a chlorine layer on Cu(100): The Su-Schrieffer-Heeger dimer chain with topological domain walls and the Lieb lattice with a nearly flat electron band.