O 69: Nanostructures at Surfaces: Dots, Particles, Clusters

Time: Wednesday 18:15–20:30 Location: Poster A

O 69.1 Wed 18:15 Poster A

Plasmon-Enhanced Photoemission from Individual Silver Nanoparticles — •Kevin Oldenburg, Hannes Hartmann, Karl-Heinz Meiwes-Broer, Ingo Barke, and Sylvia Speller — University of Rostock, Institute of Physics, 18059 Rostock, Germany

The plasmonic response of metal nanostructures not only depends on material and shape but also on coupling phenomena to the environment. By optical excitation close to the resonance wavelength efficient electron emission can be triggered which is accessible using photoemission electron microscopy (PEEM)[1]. Here we study photoemission from individual silver particles produced in the gas phase and soft-landed onto silicon substrates. The electron emission is correlated to geometric properties obtained by atomic force microscopy (AFM) and discussed regarding particle size and cluster-surface interaction.

[1] M. Rohmer et al., Phys. Stat. Sol. B **247**, 1132 (2010).

O 69.2 Wed 18:15 Poster A

Plasmonically enhanced oriented fluorescence emission in metal-insulator-metal cavities — •Fabian Gossler[1], Matthias Stöter[2], Thorsten Schumacher[3], Markus Lippitz[3], Josef Breu[2], Andreas Fery[1], and Tobias A.F. König[1] — [1]) Institute of Physical Chemistry and Polymer Physics, Leibniz Institute of Polymer Research (IPF), Hohe Str. 6, 01069 Dresden — [2]Dept. of Inorganic Chemistry 1, University of Bayreuth, Universitätsstr. 30, 95440 Bayreuth — [3]Dept. of Experimental Physics 3, University of Bayreuth, Universitätsstr. 30, 95440 Bayreuth

For implementation of nanophotonic devices, a short life-time and an enhancement of the spontaneous emission is necessary. We fabricate a gold film coupled anisotropic silver nanocube cavity to systematically study the fluorescence enhancement of an oriented fluorophore. For a rational design, the plasmonic properties of the silver nanocubes are designed to match with the emission spectrum of a selected fluorophore. Silicate bilayers with intercalated fluorophores are used as emitting spacer due to their regular height of 4 nm on large scales and orientation of the dye molecules. Finite-difference time-domain (FDTD) simulations, atomic force microscopy (AFM), dark field spectroscopy, confocal and time-resolved photoluminescence measurements have been used to characterize the tailormade nanocavity. Threefold emission enhancement and significantly shorter life-times are observed inside the nanocavity. Electromagnetic simulations support the results and demonstrate the potential of this cavity enhancement as building block for application in plasmonic lasers and gain-loss metamaterials.

O 69.3 Wed 18:15 Poster A

Growth of MnSb Islands on GaAs Substrates — •Christian Klump[1], Carsten Godde[1], Julian Ritzmann[2], Arne Ludwig[2], Andreas Wieck[2], and Ulrich Köhler[1] — [1]Experimentalphysik IV, AG Oberflächen, Ruhr-Universität Bochum, Germany — [2]Lehrstuhl für Angewandte Festkörperphysik, Ruhr-Universität Bochum, Germany

Stacking multiple layers of quantum dots is an established technique for the fabrication of many optic and optoelectronic devices. Up to now, the stacked layers consisted of semiconductor quantum dots exclusively. However, for future spintronic devices, the integration of semiconductor quantum dots with ferromagnetic materials is essential. For this approach, MnSb is an interesting material with its high Curie temperature of 587 K and its compatibility with semiconductor substrates. The pairing of MnSb islands with InAs QDs is studied. As a first step, MnSb islands were grown on different GaAs substrates by MBE. Structural and magnetic properties have been studied by STM, LEED and MOKE.

O 69.4 Wed 18:15 Poster A

Manipulating the nucleation behavior of MoO_x on Al_2O_3/NiAl(110) — •Rik Mom[1], Marcel J. Rost[1], Joost W.M. Frenken[1,2], and Irene M.N. Groot[3] — [1]Huygens-Kamerlingh Onnes Laboratory, Niels Bohrweg 2, Leiden, The Netherlands — [2]Advanced Research Center for Nanolithography, Science Park 104, Amsterdam, The Netherlands — [3]Gorlaeus Laboratories, Einsteinweg 55, Leiden, The Netherlands

Understanding and manipulation of the nucleation behavior of metals and metal oxides on oxidic substrates is essential for the production of catalysts and nanodevices. Due to the large number of non-equivalent sites typically available on an oxidic substrate [1], prediction of such behavior remains challenging. Here, we studied the nucleation of Mo and MoO_x on Al_2O_3/NiAl(110) using scanning tunneling microscopy. In both cases we find 3D growth, yet there are clear differences in the particle dispersion. The larger diffusion speed of Mo leads to larger particles and nucleation on domain boundaries and step edges, whereas for MoOx the dispersion depends on the preparation method. Manipulation of the MoO_x dispersion is possible through the choice of evaporant (Mo or MoO_x). When Mo is evaporated in a mild $5x10^{-7}$ mbar O_2 atmosphere, the resulting MoO_x shows wetting of domain boundaries and step edges. In contrast, preparation using MoO_x as evaporant, yields a random distribution of particles. The observed differences are explained by a large diffusion length of Mo before oxidation on the surface.

[1] G. Kresse *et al., Science* 308, 1440 (2005)

O 69.5 Wed 18:15 Poster A

Electrodeposition of nickel oxide nanoparticles on micron-sized CVD grown graphene for non-enzymatic glucose sensors with enhanced sensitivity — •Masoumeh Sisakhti[1], Eva-Maria Kirchner[2], Thomas Hirsch[2], and Christoph Strunk[1] — [1]Institut für Experimentelle und Angewandte Physik,Universität Regensburg — [2]Institut für Analytische Chemie, Chemo- und Biosensorik,Universität Regensburg

We report an optimized electrochemical approach for the non-enzymatic detection of glucose, based on CVD graphene ($100\times200\mu m^2$ in size), decorated with electrodeposited nickel oxide nanoparticles.
The electrochemical growth of the nanoparticles on the carbon nanomaterial was studied and optimized in detail to provide a composite material with large surface area consisting of homogeneous particle size distribution and small particle diameter ranging from 80 to 250 nm.
We studied the electrocatalytic properties of the devices by cyclic voltammetry (CV) and amperometry. Our results demonstrate that the amperometric sensors present electrocatalytic parameters such as a low detection limit of 25μM and wide linear response range of 25μ M to 6.4 mM, indicating that the device operates well in the desired concentration range.
The sensitivity of the micro-sized non-enzymatic amperometric sensor is sufficient for the production of highly integrated sensor arrays for drug screening in small volumes of body fluids.

O 69.6 Wed 18:15 Poster A

Monitoring the interaction of CO with graphene supported metal nanoparticles by vibrational spectroscopy — •Heshmat Noei[1], Marcus Creutzburg[1,2], Dirk Franz[1,2], and Andreas Stierle[1,2] — [1]Deutsches Elektronen Synchrotron DESY, Notkestr. 85, 22607 Hamburg, Germany — [2]Department of Physic, University Hamburg, D-20355 Hamburg, Germany

Small metal nanoparticles dispersed on porous substrates have gained interest in surface science because of their widespread applications, especially in heterogeneous catalysis. It was shown that nanoparticles form ordered arrays on graphene substrates using the moiré of graphene/Ir(111) as a template. The size of these nanoparticles can be carefully controlled on graphene/Ir(111) by the amount of deposited material. Here we report the first describing vibrational spectroscopic studies on Ir, Pt, Rh and Au metal-covered graphene/Ir(111) substrate using CO as probe and/or reactant to monitor the frequency of C-O binding to the metal nanoparticles. The UHV-IRRAS apparatus allowed us to record high-quality IR data and turned out to be a powerful tool to investigate well-arranged metal/grapehne/Ir(111) system. It is found that CO bound on two sites on metal clusters: (1) on-top terraces atoms at low CO coverage and (2) on top-edge atoms at higher CO coverage. The adsorption energy, thermal stability and shape of metal clusters on graphene/Ir(111) are further investigated with respect to the position and intensity of the C-O stretching bands.

O 69.7 Wed 18:15 Poster A

Reconstructed Cu(100)-c(2x2)N surface for self-organized nanoparticle deposition — •Kariman Elshimi, Julia Andrews, Torsten Veltum, Hendrik Bettermann, and Mathias Getzlaff — Institut für Angewandte Physik, Universität Düsseldorf, 40225 Düsseldorf

Self-organized nanoparticle deposition can be achieved on a nanopatterned Cu(100) surface. This enhances optical, electronic and magnetic properties of the materials, which are expected to be used in the near future technologies.

The Cu surface is cleaned in situ by repeated cycles of Ar^+ sputtering followed by annealing. The Cu(100)-c(2x2)N surface can be prepared by bombarding this surface with N_2^+ followed by annealing. With in situ scanning tunneling microscope (STM) and low energy electron diffraction (LEED) we characterize the surface. STM images show different surface morphology for different N_2^+ doses. The prepared surface at a small N_2^+ dose shows self-assembled square patches with surface structure c(2x2) on a clean Cu(100) surface.

We can produce different kinds of metal nanoparticles with several size-ranges from the gas phase using a continuously working arc cluster ion source or a magnetron aggregation source. The charged nanoparticles can be subsequently mass-to-charge filtered by an electrostatic quadrupole deflector. Therefore, the deposition and the behavior of the size-selected nanoparticles on the Cu(100)-c(2x2)N surface can be studied by STM and LEED.

O 69.8 Wed 18:15 Poster A

High-Temperature CsxC58 Solids — •Weippert Jürgen[1], Ulas Seyithan[1], Kern Bastian[1], Malik Sharali[2], Amati Matteo[3], Gregoratti Luca[3], Kiskinova Maya[3], Strelnikov Dmitry[1], Böttcher Artur[1], and Kappes Manfred M.[1,2] — [1]Institute of Physical Chemistry, Karlsruhe Institute of Technology (KIT), Fritz-Haber-Weg 2, 76131 Karlsruhe, Germany — [2]Institute of Nanotechnology, Karlsruhe Institute of Technology (KIT), Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany — [3]ESCA microscopy beamline Elettra - Sincrotrone Trieste, ScPA Area Science Park, 34149 Basovizza-Trieste, Italy

Co-depositing Cs and C58+ on HOPG surface led to a new material, CsxC58. The C58 carbon clusters form a scaffold which gets doped by Cs via diffusion across the empty interstitial sites to form bulk CsxC58. Upon heating most of the material survives to yield a doped high-temperature non-IPR fullerene solid, HT-CsxC58. This solid remains stable up to 1100 K, a temperature at which CsxC60 no longer exists. HT-CsxC58 exhibits considerably depleted Cs content (x<2) relative to the as-prepared CsxC58 bulk. The unique thermal stability results from covalent C-C bonds connecting the carbon cages. The Cs dopants contribute to the stability via weak ionic bonds with -C58-C58- oligomers. The HT-CsxC58 material shows a higher defect density, which we attribute to Cs ions relieving the defecting of cages during heating. The topography of the HT-CsxC58 material is dominated by coexisting areas distinguished by their Cs/C58 ratio. The Cs rich islands become striking surface features after air exposure.

O 69.9 Wed 18:15 Poster A

Fabrication and investigation of near-surface spin centers in high-purity single crystal diamond — •Nicolas Wöhrl[1], Reinhard Remfort[1], Stefan Borgsdorf[2], Tanmoy Chakraborty[3], Ulrich Köhler[2], Dieter Suter[3], and Volker Buck[1] — [1]Faculty of Physics and CENIDE, University of Duisburg-Essen, Lotharstraße 1, 47057 Duisburg, Germany — [2]Experimentalphysik IV, AG Oberflächen, Ruhr-Universität Bochum, Germany — [3]Experimentelle Physik IIIA, Technische Universität Dortmund, Germany

Photons from ideal single-photon sources exhibit quantum mechanical characteristics and therefore allow applications in novel fields including quantum cryptography and spintronics. However, the biggest challenge for the implementation of this concept is maintaining the coherence of the quantum states for a sufficiently long time. One promising candidate for this task is the nitrogen-vacancy center in diamond. The main aim of this project is the fabrication and investigation of near-surface NV–centers in high-purity single-crystal diamond films. Preparation of these active elements close to the surface with good properties is a task which is not yet sufficiently accomplished, especially when readout is desired to be by optical as well as electronical means. In this project the influence of diamond properties as well as structure and termination of the diamond surface on the spin centers is investigated. Pure single-crystal diamond films are homoepitaxially grown by microwave plasma assisted chemical vapor deposition and the film quality is characterized by standard methods. NV centers are produced by ion implantation and properties investigated spectroscopically.

O 69.10 Wed 18:15 Poster A

3d metal naoparticles deposited on graphene — •Torsten Veltum, Wolfram Gilbert, Hendrik Bettermann, and Mathias Getzlaff — Institut für Angewandte Physik, Heinrich-Heine-Universität Düsseldorf, 40225 Düsseldorf

In the past few years graphene gained the attention of scientists due to its unique mechanical and electrical properties. In addition to this, fabrication and deposition of nanoparticles on a substrate is of great interest for studies, e.g. as model catalysts. In this contribution we compare the properties of nanoparticles deposited on graphene with those on a 3d metallic thin film.

A thin cobalt film is epitaxially grown by electron beam evaporation on a W(110) single crystal under ultra-high vacuum conditions. To achieve a structurally ordered monolayer graphene on the ferromagnetic substrate we use chemical vapour deposition with propylene. The structure of this system is characterized in-situ by means of scanning tunnelling microscopy (STM) and low energy electron diffraction (LEED).

The nanoparticles are produced using two different gas aggregation sources, an arc cluster ion source (ACIS) and a magnetron sputter aggregation source (Haberland type), with different size distributions and subsequently mass-selected. After the deposition on the sample under softlanding conditions, the structural analysis of the nanoparticles is carried out by STM.

O 69.11 Wed 18:15 Poster A

Deposition and surface interaction of 3d-metal nanoparticles on W(1 1 0) — •Hendrik Bettermann and Mathias Getzlaff — Institute of Applied Physics, University of Duesseldorf

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 which show a strong dependence on their size. Interactions between nanoparticles and substrate during and after deposition are an important influence on particle properties.

Our contribution is focused on nanoparticles of 3d-metal alloys. The sizes range from 3 to 15 nm (1e5 to 1e7 amu). Two nanoparticle sources are attached to our UHV system. An Arc Cluster Ion Source (ACIS) produces nanoparticles of 7 nm height and above. A magnetron sputter source (Haberland-type) gives access to smaller sizes. Particles are mass/charge filtered prior to deposition. Size and structural properties are investigates by scanning tunneling microscopy (STM) under UHV conditions. Deposition on substrates other than tungsten will be given as comparison.

O 69.12 Wed 18:15 Poster A

The copper-dioxolene switch controlled by acceptor doping: DFT+U vs. many-body model approach — •Tomasz Ślusarski[1], Tomasz Kostyrko[1], and Victor Garcia-Suarez[2] — [1]Faculty of Physics, A. Mickiewicz University, Poznań, Poland — [2]Departamento de Fisica, Universidad de Oviedo, Oviedo, Spain

A Cu-dioxolene complex with valence tautomeric properties connected to Au(111) surface with an alkanethiol linker[1] is investigated with the density functional theory within GGA+U approach. We study the effect of doping with ICl2 acceptor molecules on the properties of the adsorbed complex. We use the results of the DFT calculations to compute the parameters of an effective many-body model. The model is subsequently studied with a help of exact diagonalization. We also consider model of the junction where the Cu-dioxolene and the acceptor molecule are the central part in the scattering region. We compute the transmission function of the junction in the equilibrium case for different positions of acceptor molecule.

Our main conclusion is that the charge and spin state of the valence tautomeric switch could be well controlled using the acceptor doping. This finding can be useful in development of memory storage or molecular switches.

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References [1] T. Kostyrko, T. Ślusarski, Appl. Surf. Sci. (2015) http://dx.doi.org/10.1016/j.apsusc.2015.11.049