

O 48 Nanostructures IV

Time: Friday 11:15–13:00

Room: WIL A317

O 48.1 Fri 11:15 WIL A317

Oxygen-Induced Faceting of Ir(210) — ●TIMO JACOB, PAYAM KAGHAZCHI, and MATTHIAS SCHEFFLER — Fritz-Haber-Institut der MPG, Faradayweg 4-6, 14195 Berlin

Although rough clean metal surfaces usually have higher surface free energies than their closed-packed analogs, adsorbates are able to modify this behavior and cause changes in surface morphology through reconstructions or facet formations. Using different surface sensitive techniques (e.g. STM or LEED) Madey *et al.* [1] found that Ir(210) shows interesting surface faceting at high oxygen coverages ($\theta > 0.5$ ML). The facets were identified as three-sided nanoscale pyramids with two (311) and one (110) planes.

In order to understand this effect we used density functional theory in combination with the *ab initio* atomistic thermodynamics and studied the influence of an oxygen atmosphere on the structure of Ir(210). Assuming an oxygen partial pressure of 1 atm, it turned out that below $T < 1000$ K the oxygen-covered facets are thermodynamically more stable than non-faceted O/Ir(210). Further heating reverts the substrate structure to planar O/Ir(210).

While most nanoscale pyramids consist of smooth and unreconstructed planes, some (110) facets show a complex reconstructed superstructure. Thus, present studies aim on the stability and an atomistic understanding of those structures.

[1] I. Ermanoski *et al.*, *Surf. Sci.* **549**, 1 (2004).

O 48.2 Fri 11:30 WIL A317

Nickel Nanowire Formation on Ir(100) — ●ANDREAS KLEIN, LUTZ HAMMER, and KLAUS HEINZ — Lehrstuhl für Festkörperphysik, Universität Erlangen-Nürnberg, Staudtstr. 7, D-91058 Erlangen

On the H-induced 5x1 phase of Ir(100) [1], where extended monoatomic Ir chains reside on top of an unreconstructed substrate, the growth of nickel proceeds layerwise up to the sixth layer. Rather unusually, each new layer starts with the development of extended nanowires of several hundred Angstrom length instead of compact islands. Their number first increases, then they locally coalesce into islands until finally the layer is completed. The growth of new wires on a just completed nickel layer always proceeds within shallow troughs which come by the corrugation of the underlying Ni film. The width of the nanowires increases with film thickness, whereby on the x th layer they consist exclusively of $(x-1)$ -atomic rows. This thickness-dependent size is due to the increasing width of the surface troughs which in turn is caused by local and layer dependent relaxations of the Ni layers above the Ir chains at the Ir-Ni interface. By Ni deposition on the clean reconstructed 5x1-hex phase of Ir(100) the hexagonal reconstruction is lifted ending up in the same local structure than on the 5x1-H phase, yet with considerably poorer long-range order. Consequently, the same nanowires are observed as before, however, with much shorter lengths and an earlier onset of coalescence leading to more compact island structures. [1] L. Hammer, W. Meier, A. Klein, P. Landfried, A. Schmidt, K. Heinz, *PRL* **91** (2003) 156101

O 48.3 Fri 11:45 WIL A317

Ordered cluster arrays on a graphite-Ir(111) moiré pattern — ●ALPHA NDIAYE, SEBASTIAN BLEIKAMP, and THOMAS MICHELY — I. Physikalisches Institut (IA) RWTH Aachen 52056 Aachen

Perfectly ordered Ir-cluster arrays can be formed on a functionalised Ir(111) surface. The clusters are bound in a hexagonal lattice with a lattice constant of 26 Å. Their size distribution is narrow and the size can be tuned from 6 to 150 atoms. The clusters possess a surprising thermal stability. Clusters with an average size of 5 atoms are stable up to 450 K. At low cluster sizes, different types of clusters can be distinguished.

Functionalisation of the Ir(111) surface is achieved through preparation of monolayer graphite sheets, which can be formed by pyrolysis of hydrocarbons. The superposition of the graphite and Ir(111) surface gives rise to the emergence of a $\sqrt{91} \times \sqrt{91}$ R5.23° moiré pattern. Ir clusters form, where threefold coordinated adsorption sites of the underlying Ir(111) lattice are in the center of the graphite honeycomb unit cells.

O 48.4 Fri 12:00 WIL A317

Scanning Tunneling Microscopy (STM) and Spectroscopy (STS) Investigations of Gold Nano-Particles in a Double-Tunneling-Junction Arrangement at Room-Temperature — ●ANNA TSCHETSCHETKIN, CHRISTOF DIETRICH, BERNDT KOSLOWSKI, and PAUL ZIEMANN — Abteilung Festkörperphysik, Universität Ulm, D-89069 Ulm

Au nano-particles were prepared on an epitaxial $Al_2O_3/Nb(110)/Sapphire$ layered system employing a micellar technique. This type of arrangement was analyzed by STM and STS at room temperature in ultra-high vacuum. For the as-prepared Au nanoparticles, STM shows an inhomogeneous surface of the particles while STS reveals Coulomb charging for about 60-70% of the particles if the tip is positioned at their apex. However, quantitatively the Coulomb gap is unexpectedly large and it depends sensitively on the tip position above the particle. By annealing the samples at temperatures up to 800°C, the surface of the particles becomes more homogeneous and is partly faceting, the Coulomb gap decreases, and its value becomes less sensitive to the tip position. The data then can be analyzed in terms of orthodox Coulomb blockade theory.

O 48.5 Fri 12:15 WIL A317

SERS substrates produced by tailor-made metal nanoparticles using laser irradiation — ●BLÁZQUEZ SÁNCHEZ D.¹, GALLASCH L.², SCHMIDT H.², KRONFELDT H.D.², HUBENTHAL F.¹, and TRÄGER F.¹ — ¹Institut für Physik and Center for Interdisciplinary Nanostructure Science and Technology-CINaT, Universität Kassel, Heinrich-Plett-Str. 40, 34132 Kassel, Germany — ²Institute of Optics, Technical University Berlin, Hardenbergstrasse 36, 10623 Berlin, Germany

New tailor-made SERS substrates are presented which are based on precise control of the shape of nanoparticles (NPs) prepared by self-assembly of atoms on dielectric substrates. By applying nanosecond light pulses of appropriate fluence and wavelength oblate Ag or Au particles with a fixed shape have been fabricated. The method relies on the pronounced shape dependence of the absorption coefficient of metal NPs dominated by the excitation of surface plasmon polaritons. These resonances lead to a field enhancement in the vicinity of the particle surface, an effect widely exploited in surface enhanced Raman spectroscopy. With our manufacturing method, SERS substrates with tunable plasmon resonances can be simply produced for specific excitation wavelengths and detection ranges. Ag substrates were prepared here with and without a protective coating having a plasmon resonance at about 2.4 eV. SERS spectra of pyrene were obtained with excitation at 514 nm for all substrates indicating a good reproducibility. The substrates did not show degradation during the measurements and those with protective coatings yielded still 60 % of the SERS intensity of uncoated substrates indicating their potential usefulness for the analytical detection of specific molecules.

O 48.6 Fri 12:30 WIL A317

Near- and Farfield Scattering Properties of Metal Nanoparticles Excited by Radially Polarized Light — ●PHILLIP OLK¹, T. HÄRTLING¹, J. RENGER¹, S. GRAFSTRÖM¹, L. M. ENGL¹, B. GORZOLNIK², M. OTT², and M. MÖLLER² — ¹Institut für Angewandte Photophysik, TU Dresden, 01062 Dresden — ²Deutsches Wollforschungsinstitut an der RWTH Aachen e.V., 52056 Aachen

We report on the optical investigation of gold nanoparticles (NPs) having a diameter between 8 and 100 nm. Single, optically isolated NPs as well as NPs in an ordered, quasi regular lattice obtained by a micellar technique [1] have been analyzed. Besides conventional linearly polarized illumination at several distinct wavelengths in the visible regime, we also consider radial polarization modes [2]. The latter polarization, if focused by a lens, causes the focal electric field vector to be perpendicular to the substrate surface. This allows us inducing an effective electrical dipole momentum $\vec{\mu}$ in NPs which is parallel to the optical propagation direction \vec{k} . Field calculations by means of multiple multipole method [3] and intensity measurements using dielectric tips in our scanning near-field optical microscope (SNOM) are compared with respect to the fractional content of scattered light contributing to the signal detected by the optical near field probe. The aftermath for SNOM imaging of nanoscopic metal structures on transparent substrates is discussed.

[1] J. P. Spatz *et al.*, *Langmuir* **16**, 407 (2000).

[2] A. A. N. Mark *et al.*, *Opt.Lett.* **7**, 1929 (2002).

[3] Ch. Hafner, *The Generalized Multipole Technique for Computational Electromagnetics*; Artech House Books, Boston (1990).

O 48.7 Fri 12:45 WIL A317

Optical Properties of Gold Nanoparticles close to a Gold Surface — •ADRIANA RUEDA, MARCO STEMMLER, NOELIA BOCCHIO, and MAX KREITER — Max-Planck Institute for Polymer Research, Ackermannweg 10, 55128 Mainz, Germany

Studies of the optical properties of spherical gold nanoparticles placed close to a gold flat surface will be discussed. According to electromagnetic theories [1] particles with localized electromagnetic resonances like gold nanoparticles can interact with a metal surface producing a special kind of resonance (called the gap mode) generating large enhancements of the near field in the gap between the particle and the surface. This effect was studied in some detail experimentally in an inorganic system by Okamoto et al. [2]. As a well-defined model system we use gold nanoparticles with diameters in the range of 20-250 nm linked to a thin gold film deposited onto a glass substrate by means of an organic self-assembled monolayer of linker molecules, allowing for a selective positioning of functionalities as fluorophores in the gap. The resulting multilayered system was studied with multiwavelength surface plasmon resonance measurements which are highly sensitive to effects taking place at the surface. If the gold nanoparticles are regarded as an effective layer [3], these measurements allow for the detection of resonances in the polarisability due to gap excitation.

[1] P.K. Aravind and H. Metiu, *Surface Science* **124**, 506 (1983)

[2] T. Okamoto and I. Yamaguchi, *J.Phys.Chem.* **107** (38), 10321 (2003)

[3] M.A.Plunkett et al., *Langmuir* **19**, 6837 (2003)