

## O 15: Nanostructures at surfaces: Dots, particles, clusters, arrays I

Time: Monday 15:00–17:00

Location: WIL C107

O 15.1 Mon 15:00 WIL C107

**Formation of rare earth silicide clusters on Si(111)7x7** — ●MARTIN FRANZ, MONIR RYCHETSKY, STEPHAN APPELFELLER, and MARIO DÄHNE — Institut für Festkörperphysik, Technische Universität Berlin, Hardenbergstr. 36, D-10623 Berlin, Germany

Magic clusters on surfaces are of high interest because of their fascinating quantum properties and their possible application in future nanodevices. Here, the formation process as well as the structural and electronic properties of dysprosium silicide clusters on the Si(111)7x7 surface were studied using scanning tunneling microscopy (STM). The dysprosium silicide clusters were grown by molecular beam epitaxy using the 7x7 reconstructed Si(111) surface as a template for cluster formation using submonolayer metal coverages and moderate annealing temperatures. It was found that the clusters grow self-organized preferentially on the faulted halves of the 7x7 unit cells, and a variety of cluster shapes could be observed. At appropriate growth conditions, the formation of magic clusters, which appear centered on the 7x7 half unit cells, could be achieved. This project was supported by the DFG through FOR 1282.

O 15.2 Mon 15:15 WIL C107

**Tunable quantum dot arrays by self-assembled metal-organic networks** — ●NENAD KEPČIJA<sup>1</sup>, FLORIAN KLAPPENBERGER<sup>1</sup>, DIRK KÜHNE<sup>1</sup>, WOLFGANG KRENNER<sup>1</sup>, SVETLANA KLYATSKAYA<sup>2</sup>, ANDRES ARNAU<sup>3</sup>, JAVIER GARCIA DE ABAJO<sup>4</sup>, MARIO RUBEN<sup>2</sup>, and JOHANNES BARTH<sup>1</sup> — <sup>1</sup>Physik Department E20, TU München, Germany — <sup>2</sup>Institute of Nanotechnology, Forschungszentrum Karlsruhe, Karlsruhe, Germany — <sup>3</sup>Centro de Física de Materiales CSIC-UPV/EHU, 28008 San Sebastian, Spain — <sup>4</sup>Instituto de Optica CSIC, Serrano 121, 28006 Madrid, Spain

The confinement of Ag(111) surface state electrons by self-assembled, nanoporous metal-organic networks is studied using low-temperature scanning tunneling microscopy/spectroscopy and electronic structure calculations. The honeycomb networks of Co ligands and dicarbonitrile-oligophenyl linkers induce surface resonance states confined in the cavities with a tunable energy level alignment. With the help of a boundary element method (BEM) based on Greens functions the electronic structure is analyzed and compared to different confinement situations. We find that electron scattering on the molecules is repulsive and stronger than on the weakly attractive Co and that the networks represent periodic arrays of coupled quantum dots featuring uniform electronic levels.

O 15.3 Mon 15:30 WIL C107

**Comparing different molecular building blocks designed for covalent linking on noble metal surfaces** — ●MATTHIAS KOCH<sup>1</sup>, MARIE GILLE<sup>2</sup>, STEFAN HECHT<sup>2</sup>, and LEONHARD GRILL<sup>1</sup> — <sup>1</sup>Fritz-Haber-Institut der Max-Planck-Gesellschaft, Berlin, Deutschland — <sup>2</sup>Humboldt-Universität zu Berlin, Berlin, Deutschland

The self-organized formation of molecular nanostructures on surfaces is of high interest for potential applications in future nanotechnology. A key challenge in this field is the controlled variation of the intermolecular interaction with a particular focus on strong chemical bonds, which would ensure for high stability of the nanostructures. Moreover, it should allow the formation of extended conjugated electronic systems that are of interest for efficient charge transfer. The on-surface synthesis method [1] is very promising in this regard as it fulfills both requirements and allows to covalently bind individual molecular building blocks on a surface. It is realized by activating specific side groups, i.e. thermal dissociation of halogen substituents. In this study, we have systemically compared the self-organization of various similar molecular building blocks on different noble metal surfaces by low temperature scanning tunneling microscopy (STM). The adsorption geometry and covalent connection of the poly-aromatic molecules turns out to depend strongly on the chemical structure of the molecules and their interaction with the metal surface. Moreover, the interaction of the molecules with the metallic surface was modified by tert-butyl-legs that lift the molecular core from the surface and compared with the same molecule without such groups. [1] L. Grill et al., Nature Nanotech., 2 687 (2007)

O 15.4 Mon 15:45 WIL C107

**Self-assembly of Co rings on hexagonal boron nitride** —

●FABIAN DONAT NATTERER, FRANÇOIS PATTHEY, and HARALD BRUNE — Institute of Condensed Matter Physics (ICMP), Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland

Upon deposition of minute amounts of cobalt on hexagonal (h) boron nitride at low temperature, we observe the formation of nanostructures lying like a necklace around the circular part of the (12 x 12) h-BN/Rh(111) moiré unit cell. These atomic chains, bent to a closed ring of 2 nm diameter, contain at least four and up to 10 equidistant Co atoms. Low temperature scanning tunneling microscopy results indicate short range repulsion between the ring atoms. Interactions with the electric field of the tunnelling tip or gentle annealing either transform the ring into a compact Co cluster or completely remove it from the scanning region. Surprisingly, new atomic rings renucleate in different moiré cavities or are converted from existing Co clusters at elevated temperatures. At low Co coverage, the rings are several tens of (12 x 12) unit cells apart, implying large Co adatom diffusion rates, down to the lowest studied deposition temperatures of 8 K.

O 15.5 Mon 16:00 WIL C107

**Growth of grooved Si and Ge/Si surfaces by selective adsorption of C<sub>60</sub>** — ●STEFAN KORTE, VASILY CHEREPANOV, and BERT VOIGTLÄNDER — Peter Grünberg Institut (PGI-3), Forschungszentrum Jülich, 52425 Jülich, Germany, and JARA-Fundamentals of Future Information Technology

Ge/Si nanostructures can be grown using Bi as surfactant in order to suppress Si-Ge intermixing and to facilitate layer-by-layer growth. With an appropriate choice of growth conditions one can achieve a chemical selectivity for C<sub>60</sub> adsorption on Bi terminated Si and Ge/Si surfaces. C<sub>60</sub> molecules then adsorb only on the step edges of a Si(111) surface or onto the Ge area of Ge/Si heterostructures, respectively. During subsequent growth of Si and Ge C<sub>60</sub> can be used to mask those parts of the surface and prevent growth of further Si and Ge layers. When Si or Ge is deposited onto the surface it grows layer-by-layer on the free Si terraces and not on the C<sub>60</sub> covered areas.

This masking has been demonstrated for C<sub>60</sub> covered Ge nanowires on Si and for C<sub>60</sub> covered Si step edges. It enables us to grow Si and Ge thin films with parallel grooves by an appropriate sequence of MBE depositions. Surfaces with 3 nm deep and less than 10 nm wide trenches were fabricated.

O 15.6 Mon 16:15 WIL C107

**Supported silver and copper clusters for photocatalysis** — ●VLADIMIR POPOK, INGO BARKE, ANTJE NEUBAUER, STEFAN LOCHBRUNNER, and KARL-HEINZ MEIWES-BROER — Institut für Physik, Universität Rostock, Universitätsplatz 3, 18051 Rostock, Germany

Nanometer-sized metal particles deposited onto surfaces are of significant interest for applications in catalysis. In the current study, nanoparticles of silver and copper in the size range from ca. 5 to 18 nm were formed using arc-discharge and magnetron sputtering cluster ion sources and deposited on silica glass substrates. The prepared cluster-assembled samples have been studied in order to increase the efficiency of existing catalytic schemes for hydrogen production, which is of high practical importance. In particular, Ir photosensitizers (PS) in combination with palladium, platinum or iron catalysts are known to be promising systems for reduction of aqueous protons to hydrogen. We deposited the PS on cluster-covered samples and studied their optical properties. It is found that in presence of metal clusters the ligand-centered optical transitions of the PS are significantly increased accompanied by a change of the photoluminescence. These findings indicate considerable effect of the metal nanoparticles on the electronic structure of the PS, a fact that might be of relevance for the improvement of photo-catalytic reactions.

O 15.7 Mon 16:30 WIL C107

**CO induced unpinning of Pt clusters from the Ir(111)/graphene moiré** — ●TIMM GERBER<sup>1</sup>, JAN KNUDSEN<sup>2</sup>, PATRICK STRATMANN<sup>1</sup>, ELIN GRÄNÄS<sup>2</sup>, KARINA SCHULTE<sup>3</sup>, CARSTEN BUSSE<sup>1</sup>, JESPER ANDERSEN<sup>2</sup>, and THOMAS MICHELY<sup>1</sup> — <sup>1</sup>II. Physikalisches Institut, Universität zu Köln, Germany — <sup>2</sup>Division of Synchrotron Radiation Research, Department of Physics, Lund University, Sweden — <sup>3</sup>MAX-Laboratory, Lund University, Sweden

The Stability of catalyst particles under reactive conditions is of crucial importance for their performance and durability. Here we investigated the adsorption of CO and its effect on the stability of Pt-cluster superlattices with a periodicity of 2.5 nm on a graphene layer on Ir(111).

XPS and TPD both suggest that CO adsorbs on-top and preferentially at cluster step edges, but also on cluster facets. Further, upon CO adsorption XPS signals a weakened binding of the Pt clusters to their graphene substrate: the C1s feature characteristic for cluster binding diminishes. For small clusters with an average size below 10 atoms this unpinning implies cluster diffusion and cluster coalescence, as observed dynamically through STM image sequences. Larger clusters with an average size around 20 atoms remain fixed upon room temperature CO adsorption.

To prevent cluster coalescence in the early stages of cluster growth and to obtain the most regular Pt-cluster superlattices the CO partial pressure during Pt deposition should be minimal. Otherwise adsorbed CO causes unpinning and subsequent coalescence of small intermediate clusters already during the growth process.

O 15.8 Mon 16:45 WIL C107

**Frictional and electrical characterization of nanostructures induced by slow highly charged ion bombardment of HOPG surfaces** — •QUAN SHEN<sup>1</sup>, ROBERT RITTER<sup>2</sup>, GREGOR KOWARIK<sup>2</sup>,

FRIEDRICH AUMAYR<sup>2</sup>, and CHRISTIAN TEICHERT<sup>1</sup> — <sup>1</sup>Institute of Physics, University of Leoben, A8700 Leoben, Austria — <sup>2</sup>Institute of Applied Physics, Vienna University of Technology, A1040 Vienna, Austria

Bombardment of a highly ordered pyrolytic graphite (HOPG) surface with slow, highly charged ions (Ar q+ and Xe q+) can be considered as a model system for surface layer modification. The topographic identification of the induced surface by atomic force microscopy (AFM) measurement in conventional tapping mode is difficult[1]. However, using Friction Force Microscopy, where the cantilever is scanned perpendicular to its long axis in contact mode, the ion impact locations (dots) can be revealed as zones of enhanced friction in both, topographic and friction images. For quantitative lateral force measurements, an improved wedge calibration method is employed[2]. The microscopic friction force coefficient of the ion impact locations on the surface has been determined as a function of ion charge state. The impact dot size detected by friction images clearly depend on the ion charge state. For electrical characterization of the ion bombarded surface, we employed conductive AFM, which clearly showed an increased conductivity at ion impact locations.

[1] R. Ritter, et al. , Nucl. Instrum. Meth. Phys. Res. B 268 (2010). [2] M. Varenberg, et al. , Rev. Sci. Instrum. 74 (2003).