O 30: Nanostructures at Surfaces III (Dots, Particles, Clusters)

Time: Tuesday 15:45–17:45 Location: H36

O 30.1 Tue 15:45 H36

Co on Pt(111): from monolayer islands to single atoms — •Focko Meier, Kirsten von Bergmann, Paolo Ferriani, Jens Wiebe, Matthias Bode, Katsushi Hashimoto, Stefan Heinze, and Roland Wiesendanger — Institute of Applied Physics, Hamburg University, D-20355 Hamburg, Germany

We used spin-resolved scanning tunneling spectroscopy (STS) to study the electronic and magnetic properties of Co monolayer islands and single atoms on the Pt(111) surface.

Within the Co monolayer islands the local stacking changes at the scale of only a few Å. This results in a highly inhomogeneous electronic structure due to the strong stacking dependence of the d-like surface resonance with respect to the Pt(111) substrate.[1] A similar stacking dependence of the electronic structure has been found on the single atoms where spectroscopic differences are related to the two possible adsorption sites of the Co atoms on the Pt(111) substrate.

Despite the electronic inhomogeneity, the magnetic domains and domain walls are clearly observed by spin-resolved STS. New insights into the anisotropy K of the Co were found by analyzing the width of the domain walls. Based on our analysis we propose an out-of-plane anisotropy of +0.08 meV/atom – +0.17 meV/atom for atoms within the islands which are out-of-plane magnetized, independently of their size.

[1] F. Meier et al. Phys. Rev. B 74, 195411 (2006)

O 30.2 Tue 16:00 H36

Single-atom contact and spectroscopy — •J. Kröger[1], N. Néel[1], L. Limot[1], H. Jensen[1], R. Berndt[1], K. Palotas[2], and W.H. Hofer[2] — [1]Christian-Albrechts-Universität zu Kiel, D-24098 Kiel, Germany — [2]University of Liverpool, Liverpool L69 3BX, United Kingdom

The tip of a scanning tunnelling microscope is controllably brought into contact with a flat surface of Au(111), with individual gold atoms on Au(111) and with a single Co atom adsorbed on Cu(100). Contact between the tip and the sample as well as between the tip and single atoms is established at roughly a conductance quantum. Conductance measurements performed on the face-centered cubic and hexagonal close-packed stacking domains of the Au(111) surface reconstruction lead to similar results. While for Cu(100)-Co the Kondo effect-induced resonance is retained in contact it becomes broader than in the tunnelling regime. Calculations indicate that the proximity of the tip shifts the cobalt d-band and thus affects the Kondo temperature.

O 30.3 Tue 16:15 H36

Quantum Confinement of Surface-State Electrons in Atomic-Scale Nanostructures — •L. Niebergall, V. S. Stepanyuk, and P. Bruno — Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, 06120, Germany

Surface-state electrons on (111) noble metal surfaces form a two-dimensional (2D) nearly free electron gas. Particularly fascinating phenomena occur if the surface electrons are confined to closed structures (quantum corrals, nanoislands, vacancy holes). Such structures can be considered as quantum resonators for surface-state electrons. We present the state of the art ab initio studies of quantum mirages and magnetic interactions in atomic-scale nanostructures [1]. We show that the spin-polarization of surface-state electrons can be projected to a remote location by quantum states of resonators. We find that the spin-polarization of surface-state electrons on transition metal surfaces can be manipulated by exploiting the quantum confinement of electrons [2]. Adatom self-organization induced by quantum confinement of surface electrons is demonstrated [3].

1. V.S. Stepanyuk, L. Niebergall, W. Hergert, P. Bruno, Phys. Rev. Lett. **94**, 187201 (2005).

2. L. Niebergall, V. S. Stepanyuk, J. Berakdar, P. Bruno, Phys. Rev. Lett. **96**, 127204 (2006).

3. V.S. Stepanyuk, N.N. Negulyaev, L. Niebergall, R. Longo, P. Bruno, Phys. Rev. Lett. **97**, 186403 (2006).

O 30.4 Tue 16:30 H36

Evolution of spin-polarized surface states on magnetic nanostructures: from a single adatom to monolayers — •Pavel Ignatiev, Valeriy Stepanyuk, Larissa Niebergall, and Patrick Bruno — Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle, Germany

Co nanoislands on metallic substrates have been investigated recently both theoretically and experimentally [1-3]. Surface states on Co nanoislands are spin-polarized. A pronounced peak of minority-spin character originating from strong hybridization of Co d-states with s-p states has been found below the Fermi energy. Here, we present the state-of-the-art ab initio calculations of electronic surface states on magnetic cobalt nanostructures placed on metallic substrates (Cu(111), Ag(111) and Au(111)). The evolution of spin-polarized surface states from a single adatom to monolayers is demonstrated. Interplay between structure of cobalt nanoislands and spin-polarized surface states is discussed.

[1] L. Diekhöner, M. A. Schneider, A. N. Baranov, V. S. Stepanyuk, P. Bruno, and K. Kern, PRL 90, 236801 (2003)

[2] O. Pietzsch, A. Kubetzka, M. Mode, and R. Wiesendanger, PRL 92, 057202 (2004)

[3] M. V. Rastei, J.P. Bucher, P.A. Ignatiev, V.S. Stepanyuk, and P. Bruno, submitted to PRB

O 30.5 Tue 16:45 H36

Selfassembled growth and magnetism of ordered arrays of nanometer size Co clusters — •Axel Enders, Jian Zhang, Violetta Sessi, Jan Honolka, and Klaus Kern — MPI für Festkörperforschung, Heisenbergstraße 1, D-70569 Stuttgart

In this talk we will show how spherical clusters of less than 3 nm diameter can be fabricated on substrates by buffer layer assisted growth, without the implications usually associated with epitaxy. The resulting clusters are randomly distributed over the bare substrate surface. However, the application of such clusters as individually addressable magnetic units requires their controlled arrangement into well-defined ordered arrays. We are therefore guiding the clusters with the morphology of periodic network structures prefabricated on the substrate. We use mechanically extremely stable boron nitride nanomeshes as template surfaces. We will demonstrate that ordered cluster layers with a filling factor of more than 75% are achieved by repeated cluster deposition cycles onto the nanomesh. We will discuss the magnetic properties of the cluster ensemble as well as the application of the mesh as reactor for the fabrication of ordered, binary alloy clusters.

O 30.6 Tue 17:00 H36

Co clusters on the boron nitride nanomesh — •Thomas Brugger, Martina Corso, Simon Berner, Thomas Greber, and Jürg Osterwalder — Physik-Institut, Universität Zürich, Winterthurerstrasse 190, 8057 Zürich

Recently a new boron nitride nanostructure was discovered. Exposing a Rh(111) surface to borazine $(HBNH)_3$ at high temperature leads to a very regular 13-by-13 superstructure of hexagonal boron nitride (*h*-BN). This self-assembled nanostructure called nanomesh exhibits pores of the size of about 2 nm and a periodicity of 3.2 nm [1]. The nanomesh is thermally very stable and even resistant against air and water exposure.

We study the use of the nanomesh as a template for metal cluster growth. Scanning tunneling microscopy was used to examine the size distribution and the location of the clusters. Former studies of Co on *h*-BN/Ni(111) show 3D clusters with a linear height to apparent width relation and 2D clusters of constant height for several apparent widths [2]. On the nanomesh we find quite monodisperse 3D clusters of Co that preferably stick in the nanomesh pores. They have an apparent diameter comparable to the mesh pore diameter. This demonstrates that the nanomesh works as a template. The magnetic properties of the clusters are under investigation.

[1] M. Corso et al., Science 303 (2004) 217
[2] W. Auwärter et al., Surface Science 511 (2002) 379

O 30.7 Tue 17:15 H36

interaction of scanning tunneling microscopy tip with adatoms, mesoscopic islands and molecules on metal surfaces — •kun tao[1], ren z huang[1], volodymyr v maslyuk[2], mads brandbyge[3], ingrid mertig[2], valeri stepanyuk[1], patrick bruno[1], and jurgen kirschner[1] — [1]Max-Planck-Institute of Mi-

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We perform a realistic atomistic modeling and ab initio calculations for the tip interaction with magnetic adatoms, nanoislands and single molecules on metal surfaces. The electronic states and the magnetic moment of adatoms are found to depend strongly on the distance between the tip and the adatom[1]. Our results reveal tip-induced shape transitions in nanoislands as the tip approaches the surface[2]. Atomic relaxations in the tip, nanoislands and a substrate are discussed. The interaction between 3d adatoms and a single benzene molecule on Cu(001) is studied. Our results show that magnetic and transport properties of such magnetic systems can be significantly affected by the STM tip.

1.R.Z. Huang, V.S. Stepanyuk, A.L.Klavsyuk, W. Hergert, P.Bruno, and J. Kirschner,Phys. Rev. B 73 153404 (2006).

2.R.Z. Huang, V.S. Stepanyuk, and J. Kirschner, J. Phys. Cond. Matter 18, L217(2006).

O 30.8 Tue 17:30 H36

Mechanical properties of Au_{55} clusters investigated by NC-AFM — •Georgeta Radu, Dirk Mautes, and Uwe Hartmann — Institute of Experimental Physics, Saarland University, D-66041 Saarbrücken, Germany

In recent years, non-contact atomic force microscopy (NC-AFM) became a powerful tool for imaging at high resolution as well as for probing specific surface properties. In order to investigate the mechanical properties of individual clusters, thin films of ligand-stabilized Au_{55} clusters have been deposited on Au(111) and highly oriented pyrolytic graphite (HOPG) substrates. The NC-AFM images show locally ordered monolayer islands on the Au(111) substrate and disordered ones on the HOPG substrate. Frequency shift- and damping-versus-distance measurements on individual clusters as well as on the bare substrate were performed. The interaction force and dissipated energy were deduced from the experimental curves. Combining the experimental results with theoretical models, the strength and the distance dependence of the interaction force between tip and an individual Au_{55} cluster has been analyzed quantitatively. Furthermore, the individual contributions of the gold core and the ligand shell could be identified in the interaction between tip and an individual Au_{55} cluster. The measured energy dissipation is of the same order as the energy of vibrational modes due to bondstretching in the ligands and between the gold atoms and the ligands. Therefore, the energy is most likely dissipated into vibrations of the ligands through a stochastic dissipation mechanism.