O 39 Nanostructures III

Time: Thursday 15:00–18:00 Room: PHY C213

O 39.1 Thu 15:00 PHY C213

Spin-dependent excitation of surface states on ultrathin ferromagnetic films — •Martin Pickel[1], Anke B. Schmidt[2], Martin Weinelt[2], and Markus Donath[1] — [1]Physikalisches Institut, Universität Münster, Wilhelm-Klemm Str. 10, 48194 Münster — [2]Max-Born-Institut, Max-Born-Str. 2A, 12489 Berlin

Studying image-potential states with time-resolved two-photon photoemission (2PPE) has provided new insight into electron dynamics at surfaces. Recent spin-resolved measurements of electron dynamics in front of ultrathin iron films [1] even allow for the distinction between majority- and minority-spin electron scattering channels.

In this talk we discuss the initial, pump-induced spin polarization of the image-potential states in front of ultrathin iron and cobalt films on Cu(001). Following the argument of spin-integrated studies for the *n=1* image-potential state [2], the spin polarization can be ascribed to the initial bulk states and the dipole selection rules governing the pump process. Additionally, we observe linear dichroic effects with 2PPE.

Therefore, by 2PPE we do not only obtain information about image-potential states itself but also about the initial states. They must have a considerable overlap with the image-potential states which makes this method very surface sensitive.

[1] A. B. Schmidt et al., Phys. Rev. Lett. **95**, 107402 (2005)
[2] U. Thomann et al., Appl. Phys. B **68**, 531 (1999)

O 39.2 Thu 15:15 PHY C213

Embedded foreign atom interactions and cluster configurations: Co/Cu(001) — •Bene Poelsema, Nuri Öncel, Ronald Van Moere, and Harold J.W. Zandvliet — Solid State Physics; MESA+ Institute for Nanotechnology, University of Twente, P.O.Box 217; 7500 AE Enschede; The Netherlands

At low coverages (˜0.03 ML) of Co on Cu(001) and intermediate temperatures (300-380K), small clusters composed of embedded Co atoms coexist with larger adatom islands. The configurations and concentrations of the former have been analyzed, assuming (local) equilibrium. The observations of fluctuations of the shape/confiugrations of small embedded clusters encourage this assumption. Taking into account configuration entropy and assuming pairwise interactions leads to a surprisingly accurate description of the relative occurrence of monomers, dimers, trimers and tetramers. The same applies for the probability distribution of the various configurations of dimers, trimers and tetramers. These findings suggest an à posteriori confirmation of local equilibrium. The embedded Co-Co interactions have been found attractive for both nearest neighbour (NN) and next nearest neighbour (NNN) interactions. The latter (-93+/-5 meV) is twice as strong as the NN-interaction (-45+/-10 meV), which explains the predominance of observed c(2x2) building blocks in the clusters. With inclusion of NN- and NNN-interactions only moderate agreement between calculations and experiments is achieved. Adding a next-next nearest neighbour (NNNN) interaction term of -20+/-10 meV results in a very convincing fit of the configuration distributions of both trimers and tetramers.

O 39.3 Thu 15:30 PHY C213

Spin-resolved STM measurements of Co nanostructures on Pt(111) — •Focko Meier, Kirsten von Bergmann, Jens Wiebe, Matthias Bode, and Roland Wiesendanger — Institute of Applied Physics, Hamburg University, D-20355 Hamburg, Germany

The Co/Pt(111) sample system has been studied quite intensively in the past to investigate fundamental magnetic properties: using spatially-averaging optical techniques the direction and magnitude of the anisotropy of 2-dimensional Co nanostructures, chains at step edges and single atoms on Pt(111) have been probed.[1] We performed spin-resolved scanning tunneling microscopy measurements on Co nano-structures on Pt(111) to gain further insight into the electronic and magnetic properties of this system. The measurements were done in a LT-UHV-STM system below 13 K. Using magnetically sensitive tips (Fe- or Cr-coated W tips) we measured the electronic structure of ML and DL high Co with spatial and spin resolution to get access to the energy dependence of the spin polarization. Additionally we probed the response of Co nanostructures to an external magnetic field. The spatial resolution reveals the different switching mechanisms of multi-domain Co-nanowires and single-domain Co islands.

[1] Rusponi et al. nature materials, Vol 2, p546, 2003; Gambardella et al. Nature, Vol 416, p301, 2002; Science, Vol 300, p1130, 2003

O 39.4 Thu 15:45 PHY C213

Spin-polarized unoccupied states in Cu/Co/Cu(001) and Cu/Ni/Cu(001) thin-film structures — •Volker Renken[1], Dehong Yu[2], Georgi Rangelov[1], and Markus Donath[1] — [1]Physics Institute, University of Münster, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany — [2]Bragg Institute, Australian Nuclear Science and Technology Organisation, PMB 1, Menai NSW 2234, Australia

Ultrathin Cu films on thin fcc Co and Ni films grown on Cu(001) have been investigated by spin- and angle-resolved inverse photoemission. For no Cu overlayers but for increasing Co [1] and Ni film thickness on Cu(001), spin-polarized quantum-well states shift to higher energies and finally converge toward the lower band-gap boundary at the top of the sp-band. With little Cu overlayer coverage, the quantum-well states within the Co and Ni layers are still observed. With increasing Cu overlayer thickness, spin-polarized quantum-well states within the Cu layers are identified and eventually the Cu bulk sp-band is formed. Because the top of the sp-band is lower in energy for Cu compared to Co and Ni, a seemingly negative dispersion of the observed features with increasing Cu overlayer thickness appears. As a function of the electron momentum parallel to the surface, the quantum-well states develop into a surface resonance [2]. The loss of spin polarization of this surface resonance as a function of the Cu overlayer thickness reflects the penetration depth of the electron wave function.

[1] D.H. Yu et al., Phys. Rev. B 68 (2003) 155415,
[2] D.H. Yu and M. Donath, Europhys. Lett. 63 (2003) 729.

O 39.5 Thu 16:00 PHY C213

New methods to determine the sputtering yield at step edges — •Alex Redinger, Henri Hansen, and Thomas Michely — I. Physikalisches Institut, RWTH Aachen University, 52056 Aachen, Germany

STM investigations on pattern formation at grazing incidence ion bombardment are used to determine the sputtering yield at step edges. A Pt(111) crystal is bombarded with 5 keV Ar^+ ions at angles of incidence between 79° and 86° to the surface normal. A series of experiments at 83° and 550K sample temperature is used to determine the amount of removed material as a function of ion fluence. Relating for this series the number of ascending steps with the removed amounts allows to establish the sputtering yield at acending steps.
At 86° ion incidence and 550K sample temperature the step edge motion of prexisting steps due to ion bombardment is used to determine the step edge velocity. By taking into account the damage created by ion bombardment below the surface we could again determine the sputtering yield at an acending step edge. Both methods leed to simular results an are in good agreement with earlier experiments and MD simulations [1].

[1] Hansen et al. PRL 92, 246106 (2004)

O 39.6 Thu 16:15 PHY C213

Low-dimensional Supramolecular Structures by Design — •Nian Lin, Sebastian Stepanow, Dietmar Payer, Steve Tait, and Klaus Kern — Max-Planck-Institute for Solid State Research

Supramolecular chemistry provides powerful methodologies for the controlled generation of nanostructures following bottom-up fabrication principles. Here we present our systematic studies using surfaces as platforms to direct the assembly of novel low-dimensional supramolecular structures. The flexibility of the underlying non-covalent interactions, e.g., H-bond, ionic bond and metal-coordination, facilitates the formation of thermal equilibrium structures. We demonstrate that the information stored in the individual molecular building blocks, e.g., end groups, backbone symmetry, geometry and chemistry, can be transferred to the supramolecular organization level. As the first example we will show that by specific element substituation at the molecular backbones, one may steer 1D vs. 2D growth. Furthermore chiral organization can be controlled by modifying the molecular backbone symmetry. Then we will demonstrate that open network structures of tunable pore geometry can be obatined through careful selection of molecular structure and interamolecular binding modes. The chemistry and morphology of the surp-

porting surfaces are found to be important in determining the final strcutures. The surface-supported supramolecular systems represent promising materials for potential applications, e. g., in nano-patterning, surface templating, low-dimensional magnetic systems, heterogenous catalysis, sensing or molecular recognition.

O 39.7 Thu 16:30 PHY C213

Nanopatterning by a Combination of Micellar and Conventional Lithographic Techniques — •Christian Pfahler, Sabrina Brieger, Oliver Dubbers, Achim Manzke, Alfred Plettl, and Paul Ziemann — Solid State Physics, University of Ulm, D-89069 Ulm, Germany

Diblock copolymers of PS-b-P2VP, dissolved in toluene, form reverse micelles comprised of a P2VP core and a PS corona. The core can be loaded with e.g. HAuCl4. By dip coating, these micelles are deposited onto substrates. Subsequently the polymer is removed and Au-nanoparticles are created in an isotropic Hydrogen plasma. This micellar technique was used to produce 14 nm Au nanoparticles with spacings of 100 nm, which form hexagonally well ordered arrays on Si. Some lithographic applications of these particles will be demonstrated: Deposited on Si wafers, they can be used directly as an etching mask for pillar fabrication by an anisotropic plasma etching process with a CF4/CHF3 gas mixture. In this way, heights of more than 100 nm and aspect ratios of 10 were achieved. It will further be demonstrated that the array of pillars can be transferred into a corresponding array of cylindrical holes which offer additional applications. A typical diameter of the cylindrical holes is less than 20 nm with an aspect ratio of 10. Both preparation techniques can be applied to amorphous Si films as well, which can be evaporated onto any insulating substrates or metallic films. By combining this approach with conventional ebeam lithography, one can position the micelles on the nanoscale. For this purpose, first metal or, in a new process route, resist templates have to be prepared lithographically.

O 39.8 Thu 16:45 PHY C213

Production of ordered nanometer sized pits with Focused Ion Beams (FIB) — •F. Ghaleh[1], R. Köster[1], H. Hövel[1], L. Bruchhaus[2], J. Thiel[2], and R. Jede[2] — [1]Universität Dortmund, Experimentelle Physik I, 44221 Dortmund, Germany — [2]Raith GmbH, Hauert 18, Technologiepark, 44227 Dortmund, Germany

Nanometer sized pits on HOPG substrate can be used as nucleation centers to produce clusters with a narrow size distribution. In previous experiments [1] nanometer sized pits were produced by sputtering and oxidizing of the sample. As result we get nanopits which are a few nanometers wide and just one monolayer deep. The pits are distributed at random locations on the surface.

In the present study a focused beam of gallium ions is used to produce the defects at localized positions on the substrate. The Focused Ion Beam (FIB) facility used here was developed within the NanoFIB Project [2]. It can achieve a resolution of about 10 nm [3]. The oxidation of a sample structured with FIB allows to measure areas structured with very small ion intensity or the penetration depth of the incident ions.

[1] H. Hövel, Appl. Phys. A **72**, 295 (2001).
[2] http://www.nanofib.com.
[3] J. Gierak, D. Mailly, P. Hawkes, R. Jede, L. Bruchhaus, L. Bardotti, B. Prével, P. Mélinon, A. Perez, R. Hyndman, J.-P. Jamet, J. Ferré, A. Mougin, C. Chappert, V. Mathet, P. Warin, J. Chapman, Appl. Phys. A **80**, 187 (2005).

O 39.9 Thu 17:00 PHY C213

Influence of STM measurements during MOVPE — •Bert Rähmer[1], Markus Pristovsek[1], Raimund Kremzow[1], Markus Breusing[2], and Wolfgang Richter[2] — [1]TU-Berlin, Institut für Festkörperphysik, Hardenbergstr. 36, 10623 Berlin — [2]Università degli Studi di Roma "Tor Vergata", Via della Ricerca Scientifica 1, 00133 Roma, Italy

We developed a Scanning Tunnelling Microscopy (STM) and its deviate Atomic Force Microscopy (AFM) that measures *in-situ* the surface topography in real time and real space with high spatial resolution during Metal-Organic Vapour Pressure Epitaxy (MOVPE) growth. The set-up of STM is simpler for good resolution. AFM has the advantage, to be able to measure also on semi-isolating substrates like sapphire. Last year we described the set-up and presented first measurements of a step-bunched GaAs sample at 500 °C. Additionally we showed measurements with the *in-situ*STM during the growth of InAs quantumdots on GaAs, which show different growth regions in the proximity on the scanning region. We measured the sample *ex-situ* with a Atomic Force Microscope (AFM), with Scanning Electron Microscopy (SEM) and Energy Dispersive X-Ray Diffraction (EDX). The origin of different areas is a temperature reduction by the STM tip. This can be compensating by adjusting the growth conditions accordingly.

O 39.10 Thu 17:15 PHY C213

A Two-dimensional Porphyrin-based Porous Network Featuring Communicating Cavities — •Nikolai Wintjes[1], Hannes Spillmann[1], Andreas Kiebele[1], Meike Stöhr[1], Thomas Jung[2], Davide Bonifazi[3], Fuyong Cheng[3], and François Diederich[3] — [1]Department of Physics, University of Basel, CH-4056 Basel — [2]Paul Scherrer Institute, CH-5232 Villigen PSI — [3]Laboratory for Organic Chemistry, ETH-Zürich, CH-8093 Zürich

The unique electrochemical and photophysical properties of porphyrin and [60]fullerene compounds make them promising candidates for the construction of two- and three-dimensional organic-based materials. Therefore, a detailed understanding of these molecular systems is crucial for a further and targeted development of new molecularly based materials. Metallo-porphyrins and their derivatives have been shown to be exceedingly useful building blocks for the construction of 3D supramolecular functional networks due to their excellent thermal and chemical stability and synthetic versatility. Nonetheless, no 2D analogon has been reported so far, although these could be interesting for various potential applications such as catalysts, molecular sieves, or chemical sensors. Herein we report on an unprecedented two-dimensional porphyrin network featuring dynamic pores capable of hosting fullerenes following a bottom-up approach at a single crystal silver surface. Surface- and porphyrin-driven long-range interactions between the C60 guest molecules and porphyrin layer resulted in the formation of exceptionally large supramolecular hybrid chains and islands as evidenced by Scanning Tunneling Microscopy (STM).

O 39.11 Thu 17:30 PHY C213

Intermixed patterns of perylene derivatives on Ag(111) — •Meike Stöhr[1], Markus Wahl[1], Tomas Samuely[1], Till Riehm[2], Thomas A. Jung[1,3], and Lutz H. Gade[2] — [1]Institute of Physics, University of Basel — [2]Insitute of Inorganic Chemistry, University of Heidelberg — [3]Laboratory for Micro- and Nanostructures, Paul-Scherrer-Institute

Self-assembled systems are in the focus of nanotechnology research because of their potential use in the bottom-up creation of functional supramolecular structures. Potential applications of such systems include several functional groups. Therefore, the intermixing of different molecular compounds will become a key issue. In our approach we made use of H-bonding to form well-ordered intermixed patterns of two different perylene derivates. These are PTCDA (3,4,9,10-perylene-tetracarboxylic-dianhydride) and DPDI (4,9- diaminoperylenequinone-3,10-diimine) [1]. In an UHV-setup consisting of different chambers for sample preparation and characterization thin films of DPDI and PTCDA were prepared by evaporation on Ag(111). The sample characterization was carried out with a homebuilt STM. For a ratio of 1:1 and a total coverage of about one monolayer, an ordered intermixed pattern was observed. We assume that each PTCDA molecule is interacting via H-bonding with four neighbouring DPDI molecules and vice versa. Furthermore, different intermixed patterns were observed depending on the ratio of the molecules and on the total coverage. [1] Gade et al., Angew. Chem. Int. Ed. 42 (2003) 2677

O 39.12 Thu 17:45 PHY C213

Thermal boundary conductance of solid-solid interfaces — •Boris Krenzer, Andreas Janzen, Anja Hanisch, Matthias Wielens, and Michael Horn-von Hoegen — Universität Duisburg-Essen, Fachbereich Physik, Lotharstr. 1, 47057 Duisburg

With decreasing size the thermal properties of nanoscale devices become more and more important. The thermal conductivity of such devices is drastically altered compared to simple heat diffusion given in bulk material. Especially the cross plane thermal conductivity in layered structures is determined by the thermal conductivity of the interface between the neighboring layers. The microscopic picture of this situation is that phonons only have a certain probability to cross the interface and carry energy from one material to the other. The most two basic models for the calculation of the phonon transmission probability are the acoustic mismatch model (AMM) and the diffusive mismatch model (DMM). For low temperatures when the dominant phonon wavelength is much larger than the interface roughness the AMM is used for the calculation. With increasing temperature the dominant phonon wavelength becomes

comparable to the interface roughness and the transmission probability is calculated within the DMM. In the past the models explained the observed TBC at low temperatures but failed at higher temperatures where the experimental TBC was found to be orders of magnitude higher than the prediction. Recently we measured the TBC of the Bi/Si-interface which is in good agreement with the predictions. In this talk the AMM and DMM are presented in general and the results of the calculations will be applied to the Bi/Si-system.