O 29: Nanostructures at surfaces: preparation

Time: Wednesday 10:30–12:45 Location: SCH A01

O 29.1 Wed 10:30 SCH A01

Formation of Nanostructures by Bimodal Growth of a Low Symmetry Magnetic Molecule on a Weakly Interacting Substrate — Sweetlana Fremy[1], •Alexander Schwarz[1], Knud Lämmle[1], Roland Wiesendanger[1], and Marc Prosenc[2] — [1]Universität Hamburg, Department Physik, IAP, Jungiusstr. 11, 20355 Hamburg — [2]Universität Hamburg, Department Chemie, IAAC, Martin-Luther-King Platz 6, 20146 Hamburg

We are interested in the properties of nanostructures formed by magnetic molecules. In this non-contact atomic force microscopy (NC-AFM) investigation we study the growth of Co-Salen, a planar Schiff-Base complex with Co as magnetic center, on NaCl(001). On this large band gap insulator we expect a rather weak coupling between molecule and surface. Apart from step decoration, we find nanowires, which form networks at higher coverages, and compact nanocrystallites. Molecular resolution on nanowires and nanocrystallites indicate that in both cases the molecules are arranged in the monoclinic bulk unit cell, which consists of 8 Co-Salen dimers. For the nanowires (nanocrystallites) the c-axis is oriented parallel (perpendicular) to the surface normal. From NC-AFM images recorded at 8 K after evaporating small quantities of molecules onto a cold substrate (T < 30 K), we know that the molecules initially adsorb as monomers. Hence, a transition from monomers to dimers must take place before the nanowires and nanocrystallites start to grow. In this presentation, the origin of the bimodal growth, the stability of nanowires and nanocrystallites as well as a model how and where the monomer-to-dimer transition takes place will be discussed.

O 29.2 Wed 10:45 SCH A01

Fabrication of a full-coverage polymer nanobrush on electron beam activated template — Nirmalya Ballav, Sören Schilp, and •Michael Zharnikov — Angewandte Physikalische Chemie, Universität Heidelberg, D-69120 Heidelberg, Germany

Along with chemistry, morphology is an important tool to adjust properties of surfaces and interfaces. One of the most promising approaches to control over surface morphology down to the nanometer scale is the fabrication of 3D polymer brush patterns by surface-initiated polymerization (SIP) combined with electron beam lithography (EBL). However, polymer brush patterns made by EBL-SIP are chemically inhomogeneous. Whereas the polymer brush itself is comprised of a polymer, the areas between the 3D features have a different chemical identity determined by the original template. As a result, the effects of morphology on one side and chemistry and surface energy on the other side can be entangled when using such patterns as model surfaces for, e.g., biology-inspired research. Here, we show that this drawback can be overcome by using a sophisticated primary template comprised of monolecular film with mostly deactivated amino tail groups suitable for SIP. Whereas SIP on such a template gives a thin but homogeneous background brush, the regeneration of these groups by electron beam activation lithography promotes the controlled growth of 3D polymer features on this background, resulting in the formation of chemically homogeneous morphology pattern exclusively comprised of the polymer material. The technique relies upon commercially available compounds and requires a low patterning dose (less than 1 mC/cm^2).

O 29.3 Wed 11:00 SCH A01

Selective adsorption of C_{60} on Si/Ge nanostructures — Konstantin Romanyuk, •Vasily Cherepanov, and Bert Voigtländer — Institute of Bio- und Nanosystems (IBN) and JARA-Fundamentals of Future Information Technology, Forschungszentrum Jülich, D-52425 Jülich, Germany

The similar nature of Si and Ge allows to grow epitaxial Si/Ge nanostructures using a surfactant like Bi to suppress Si-Ge intermixing. Those Si/Ge structures with an atomically sharp interface are suited to be used as templates for a next step of self-organized growth of a different material which selectively bonds to Si or Ge. For instance adsorption of organic molecules only on Si or Ge areas of the surface may lead to a desired fictionalization of the surface. We have explored a chemical selectivity for C_{60} deposition on Bi covered surface containing Si and Ge areas. It is found that molecules of C_{60} selectively adsorb on the Ge area substituting Bi atoms of the termination layer. Interestingly, this process is fully reversible. The C_{60} molecules desorb from the surface under Bi flux thereby restoring initial structure of the template surface. The obtained selectivity for adsorption of C_{60} gives new challenging opportunities for a successive fabrication of Si/Ge based nanostructures.

O 29.4 Wed 11:15 SCH A01

Heat transfer in swift heavy ion irradiated Insulators — •Orkhan Osmani[1,2], Marika Schleberger[1], and Bärbel Rethfeld[2] — [1]Universität Duisburg-Essen, Fachbereich Physik, 47057 Duisburg — [2]Technische Universität Kaiserslautern, Fachbereich Physik, 67653 Kaiserslautern

After irradiation of insulators of the perovskite type with an MeV ion beam under glancing incidents periodic nano patters on the surface can be observed [1]. To interpret the experimental data ab initio assisted calculations for the model system 100 MeV Xe → $SrTiO_3$ have been performed [2]. For this system the electronic energy loss is calculated and used to compute the electronic excitation induced by the primary ion. The heat transport into the lattice away from the track core is performed in terms a two temperature model (TTM), a coupled system of diffusion equations. The heat transport is governed by a diffusivity parameter which is usually treated as a constant. However in the case of an insulator this is not appropriate. Therefore, a temperature dependent diffusivity is introduced, resulting in locally molten areas which agree well with the experimentally observed nano patterns. It will be shown that with a temperature dependent diffusivity, the TTM solution is no longer unique and is strongly depending on the spatial discretization chosen for the modeling [3].

[1] Nature Nanotechnology 2, 290-294 (2007)
[2] Journal of Physics: Condensed Matter 20, 315001 (2008)
[3] Laser and Particle Beams (Submitted)

O 29.5 Wed 11:30 SCH A01

Lithographic Fabrication of Clean Iron Nanostructures via Electron-Beam Induced Deposition in UHV — •Thomas Lukasczyk[1,2], Michael Schirmer[1,2], Marie-Madeleine Walz[1,2], Florian Vollnhals[1,2], Hans-Peter Steinrück[1,2], and Hubertus Marbach[1,2] — [1]Lehrstuhl für Physikalische Chemie II — [2]Interdisciplinary Center for Molecular Materials (ICMM), Universität Erlangen-Nürnberg, Egerlandstr. 3, D-91058 Erlangen

The generation of nanostructures with arbitrary shapes and well defined chemical composition is still a challenge. One approach is the technique of electron-beam induced deposition (EBID) in which a highly focused electron-beam is used to locally crack, e.g. metal containing, precursor molecules, resulting in the deposition of the non-volatile fragments. Up to now, virtually all experiments were performed in high vacuum environments, resulting in a typical metal content of the EBID deposits of 15% to 60%. By utilizing an ultra-high vacuum system, we achieved an iron purity of at least up to 95% with the precursor iron pentacarbonyl ($Fe(CO)_5$) [1]. The purity and morphology of the deposits is strongly influenced by the surface quality and by the sample temperature. The findings discussed in the work at hand represent a route towards the lithographic fabrication of metallic nanostructures (< 20 nm) with arbitrary shapes and high purity as well as the large scale generation of iron clusters (< 10 nm) with controlled cluster density and an extremely narrow size distribution.
This work was supported by the DFG under grant MA 4246/1-1.
[1] T. Lukasczyk, et al., Small 4(6) (2008) 841.

O 29.6 Wed 11:45 SCH A01

Surface vacancy channels through ion channeling — •Alex Redinger[1], Sebastian Standop[1], Yudi Rosandi[2], Herbert M. Urbassek[2], and Thomas Michely[1] — [1]II. Physikalisches Institut, Universität zu Köln, Zülpicher Strasse 77, 50937 Köln, Germany — [2]Fachbereich Physik, Technische Universität Kaiserslautern, Erwin-Schrödinger-Straße, D-67663 Kaiserslautern, Germany

Damage patterns of single ion impacts on Pt(111) have been studied by scanning tunneling microscopy (STM) and molecular dynamics simulations (MD). Low temperature experiments, where surface diffusion is absent, have been performed for Argon and Xenon ions with energies between 1 keV and 15 keV at an angle of incidence of 86° measured with respect to the surface normal. Ions hitting preexisting illuminated step edges penetrate into the crystal and are guided

in open crystallographic directions, one or more layers underneath the surface (subsurface channeling). In the case of Argon channeling the resulting surface damage consists of adatom and vacancy pairs aligned in ion beam direction. After Xenon channeling thin surface vacancy trenches along the ion trajectories - surface vacancy channels - are observed. They result from very efficient sputtering and adatom production along the ion trajectory. This phenomena is well reproduced in molecular dynamics simulations of single ion impacts at 0 K. The damage patterns of Argon and Xenon impacts can be traced back to the different energy losses of the particles in the channel. Channeling distances exceeding 1000 Å for 15 keV Xenon impacts are observed.

O 29.7 Wed 12:00 SCH A01

Simulation of nanostructuring on sputtered surfaces by multi/rotating ion beams — •Taha Yasseri[1], Reiner Kree[1], and Alexander K. Hartmann[2] — [1]Institute for Theoretical Physics, University of Göttingen, Friedrich-Hund Platz 1, D-37075 Göttingen, Germany. — [2]Institute for Physics, University Oldenburg, Carl-von-Ossietzky Strasse 9-11, D-26111 Oldenburg, Germany

Pattern formation on solid surfaces by ion beam sputtering (IBS) is intensively studied. Recent studies use continuously rotating samples or rotation with only a discrete number of directions. We have used our previously developed Monte Carlo model of IBS to systematically study these situations. For discrete directions we found: (1) either a superposition of single ion-beam patterns or a dominant pattern, depending upon the directions may be observed. (2) In the special case of two beams aligned in opposite directions, roughness of the surface decreases and movement of patterns is suppressed. A sudden change in azimuthal angle ($\Delta\phi$) of ion beam leads to a relaxation of existing ripples into a new direction. We have determined this relaxation time (τ_0), which defines a characteristic angular frequency $\omega_0 = \Delta\phi/\tau_0$. For rotating sample with frequency $\omega \approx \omega_0$ we found an oscillatory behavior of patterns and roughness of the surface.

O 29.8 Wed 12:15 SCH A01

Ion beam noise may support pattern formation by sputtering — Reiner Kree[1], •Taha Yasseri[1], and Alexander K. Hartmann[2] — [1]Institute for Theoretical Physics, University of Göttingen, Friedrich-Hund Platz 1, D-37075 Göttingen, Germany. — [2]Institute for Physics, University Oldenburg, Carl-von-Ossietzky Strasse 9-11, D-26111 Oldenburg, Germany

It is discussed in the literature that, beam divergence may produce new scenarios of pattern formation on surfaces by ion beams sputtering (IBS). We have extended the continuum theory and the Monte Carlo simulation of IBS. pattern formation to include noisy beam which is following a *Kent distribution*, which is a reasonable approximation of the experimentally observed beam divergence.

We found several pattern forming scenarios differing from the Bradley-Harper scenario, which are discussed mainly using Monte Carlo data and a linear mode analysis of the continuum theory.

O 29.9 Wed 12:30 SCH A01

Metastable wetting on structured surfaces — •Rosa Poetes, Kathrin Holtzmann, and Ullrich Steiner — Cavendish Laboratory, University of Cambridge, Cambridge, UK

Wetting on surfaces has traditionally been divided into hydrophobic and hydrophilic wetting. More complex behaviour on structured surfaces has been explained using the differences between Cassie-Baxter and Wenzel wetting. Recently, it has been shown that other metastable wetting states, which cannot be explained fully by either Wenzel or Cassie-Baxter wetting, can exist on rough or structured surfaces.

We are exploring metastable wetting states on hydrophilic and hydrophobic surfaces. In order to find the parameters influencing the existence and lifetime of metastable wetting states, we use both highly rough non-regular and highly structured regular surfaces with hydrophilic and hydrophobic material properties.

We are exploring the pressure dependence of the metastable states using a water tank for immersion of the samples and also studying how the wetting changes with time. Further, we are exploring the influence of different structural parameters upon the metastable state stability by using highly structured samples with different height, width and overhang ratios.

Understanding the lifetime and stability of metastable wetting states will allow for further research into strong superhydrophobic materials with predictable surface properties.