SYSO 6: Self-Organizing Surfaces and Interfaces V

Time: Thursday 14:00–15:30 Location: GÖR 226

SYSO 6.1 Thu 14:00 GÖR 226

Morphometric Multi-scale Surface Science — •Stephen Watson — University of Glasgow

The characterization of self-assembled faceted surfaces is a central theoretical challenge in surface science, since the ensuing morphological statistics (morphometrics) impact applications in diverse areas. I'll discuss the morphometrics emerging from the attachment kinetics limited coarsening of a thermodynamically unstable crystalline surface. One commonly used model is a dissipative ("steepest descent") singularly perturbed fourth-order partial differential equation. We first show that its singular limit is naturally characterized through the asymptotic expansion of an Onsager-Raleigh-type Principle of Maximal Dissipation (PMD) [1]. The resulting limiting faceted surface is then characterized by an intrinsic dynamical system. The properties of the resulting Piecewise-Affine Dynamic Surface (PADS) predict the scaling law for the growth in time of a characteristic morphological length scale. We then introduce a novel computational geometry tool which directly simulates the coarsening dynamics of million-facet PADS. We conclude by presenting data consistent with the dynamic scaling hypothesis, and report a variety of associated morphometric scaling-functions.

[1] S.J. Watson & S.A. Norris, Scaling theory and morphometrics for a coarsening multiscale surface, via a principle of maximal dissipation, Physical Review Letters 96(17), Art. No. 176103 (2006).

SYSO 6.2 Thu 14:15 GÖR 226

Anti-coarsening and complex dynamics of step bunches on vicinal surfaces — •Marian Ivanov[1], Vladislav Popkov[2], and Joachim Krug[1] — [1]Institut für Theoretische Physik, Universität zu Köln, Zülpicher Str.77, 50937 Köln, Germany — [2]Dipartimento di Fisica Teorica "E. R. Caianiello", Universita degli Studi di Salerno, Via Ponte Don Melillo, 84084 Fisciano (SA), Italy

Using morphological instabilities one can produce templates for nanoscale technology. One example of such an instability is step bunching, which splits a regular vicinal surface into regions of low and high density of monoatomic steps. The dynamics of the surface is described by the Burton-Cabrera-Frank model with boundary conditions provided by mass conservation at the steps. We consider a one-dimensional step train evolving in the presence of sublimation, electromigration, step-step interactions and an Ehrlich-Schwoebel effect. We show that the interplay of sublimation and step-step interactions removes the conservation law for the crystal volume in the co-moving frame, which has been assumed in previous work [1,2]. As a consequence large step bunches are found to break up into smaller bunches of a characteristic size, and the monotonic coarsening dynamics of the volume-conserving model is replaced by a complex quasiperiodic pattern. A preliminary dynamic phase diagram summarizing the different behaviors as a function of the model parameters will be presented.

[1] V. Popkov, J. Krug, Europhys. Lett. 72, 1025 (2005), [2] V. Popkov, J. Krug, Phys. Rev. B 73, 235430 (2006)

SYSO 6.3 Thu 14:30 GÖR 226

Self-assembled growth of magnetic antidot arrays — •Kai Schlage[1], Sebastien Couet[1], Stephan V. Roth[1], Ulla Vainio[1], Mottakin Abul Kashem[2], Peter Müller-Buschbaum[2], Rudolf Rüffer[3], and Ralf Röhlsberger[1] — [1]HASYLAB at DESY, Notkestr. 85, D-22607 Hamburg, Germany — [2]TU München, Physik-Department, Lehrstuhl E13, James Frank-Str. 1, D-85747 Garching, Germany — [3]ESRF, BP 220, 38043 Grenoble, France

The self-assembled growth of magnetic nanostructures onto highly ordered (polymer) templates offers an elegant way to create magnetic nanostructures with a small variation in size and hence with well defined magnetic properties. Unfortunately, experimental methods are rare which allow to correlate the growth dynamics of the self-assembled nanostructures in-situ with its chemical and magnetic properties. In this contribution we present for the first time a combined grazing incidence small angle scattering (GISAXS) and nuclear forward scattering (NFS) study which offers the structural, chemical and magnetic sensitivity during such an in-situ deposition experiment. Iron is sputter deposited onto a diblock copolymer template which exhibits a surface morphology consisting of an ordered array of deep holes to create a magnetic antidot array. The experiemntal techniques combined here reveal the process of self-assembly of the deposited iron atoms with highest resolution in space, their chemical interaction with the polymer template (formation of oxide) and a remarkable onset of magnetic ordering compared to the growth of compact magnetic iron thin films.

SYSO 6.4 Thu 14:45 GÖR 226

STM investigations on Cyclopentene terminated GaAs(001)-surfaces — •M. Ewald[1,2], R. Passmann[1,2], T. Bruhn[1,2], B.O. Fimland[3], M. Kneissl[1], N. Esser[1,2], and P. Vogt[1] — [1]TU Berlin, Institut f. Festkoerperphysik, Hardenbergstr.36, 10623 Berlin, Germany — [2]ISAS Berlin, Albert-Einstein-Str.9, 12489 Berlin, Germany — [3]NUST, NO-7491 Trondheim, Norway

The functionalisation of semiconductor surfaces with organic molecules is crucial for the development of new devices. Particulary in biosensoric and medical applications exists a wide field of applications. The first aim of our investigation was, to analyse the binding configuration and binding structure of small cycloalkenes, like cyclopentene, and their influence on the different GaAs(001) surface reconstructions. It was possible to develop a first structure model for the binding of cyclopentene on the GaAs(001) c(4x4) and (2x4) surface. Our STM measurements show, that the atomic structure of the GaAs surface influences the arrangement of the cyclopentene molecules. While cyclopentene molecules on the c(4x4) reconstruction show no long range order, the molecules on the (2x4) surface arrange on top of the dimer rows along the [110] direction. The different interface arrangements for the adsorption of cyclopentene on GaAs c(4x4) and (2x4) can be explained by the suggested structure models. Furthermore, in the case of cyclopentene on GaAs(001) c(4x4) surface, there is a local order that can be attributed to the binding of three molecules to one unit cell.

SYSO 6.5 Thu 15:00 GÖR 226

DFT-study of Pt induced Nanowires on Ge(001) — •Danny Vanpoucke and Geert Brocks — University of Twente, Enschede, The Netherlands

The deposition of Pt on a Ge(001) surface gives rise to the spontaneous formation of nanowire (NW) arrays. These one atom thick NWs are defect and kink free with a length only limited by the underlying β-terrace. We present an *ab-initio* density functional theory (DFT) study of the underlying β-terrace and the NWs. For over 100 geometries the total energies were calculated and a comparison was made between their simulated scanning tunneling microscope (STM) images and the experimental STM images of this system. From this we identified the geometry of the β-terrace and present a formation path for the NWs as function of increasing local Pt density. Our results show the β-terrace has a structure similar to the clean Ge(001) surface, but with one in four Ge surface atoms replaced by a Pt atom giving rise to a checkerboard pattern of Pt-Ge and Ge-Ge surface dimers. Furthermore we show that solitary NWs have a slightly different structure than NWs in NW arrays, and connect the difference in geometry to the difference in observed experimental STM images. Most remarkably, we show by direct comparison to experimental STM images that the experimentally observed "platinum"NWs[1], in fact, consist of *germanium* atoms located in Pt lined troughs[2].

[1] O. Gurlu et al., Appl. Phys. Lett. 83, 4610 (2003)
[2] D. E. P. Vanpoucke and G. Brocks, Phys. Rev. B **77**, 241308(R) (2008)

SYSO 6.6 Thu 15:15 GÖR 226

Fabrication of Functional Hybrid Nanostructured Materials Based on Self-Assembled Dendrimers Templating Metallic Nanoparticles — •Amir Fahmi, Torsten Pietsch, and Nabil Gindy — Department of Mechanical, Materials and Manufacturing Engineering, Faculty of Engineering, University of Nottingham, UK

Dendrimer-stabilized nanoparticles are promising candidates for the application of functional nanoparticles in bio- and physiological environments. Herein, different types of dendrimers are used to template colloidal nanoparticles, e.g. metals or semiconductors, in aqueous medium at room temperature. The dendrimers acts as a nanoreactor and simultaneously serves as effective reducing- and stabilizing agent. Due to their unique molecular architecture and monodispersity in terms of molecular weight, dendrimers provide excellent control over the particle size and size distribution. Indeed, significantly contribute

to direct the structures formation in thin film. Our results indicate that depending on the types and generation of the dendrimers a variety of hybrid nanostructured materials are fabricated. It was also found that the nanoparticles growing within the dendritic matrix is governed by different templating mechanism. One of the main characteristics is their ability to guide the optical properties as a function of the nanoparticle size and their surface composition. The morphology and optical properties of dendrimer-stabilized metal- and semiconductor nanoparticles are investigated with respect to the dendrimer's generation for a variety of applications such as nanoelectronics, bio-molecular technology and catalysis.