O 11: Nanostructures at Surfaces I

Time: Monday 10:30–13:15 Location: WIL C107

O 11.1 Mon 10:30 WIL C107

Two Dimensional Square-like Bismuth Oxyiodine Nanosheets with High Efficient Visible-Light Driven Photocatalytic Activity — •Yan Mi, Min Zhou, Liaoyong Wen, and Yong Lei — Ilmenau University of Technology, Institute of Physics & IMN MacroNano(ZIK) Prof. Schmidt-Str. 26, 98693 Ilmenau (Germany)

Two dimensional (2D) square-like bismuth oxyiodine (BiOI) nanosheets with thickness of about 10 nm and exposed {001} facets are obtained by a facile hydrothermal route without any surfactant and speical solvent. The photocatalytic performance of as-prepared 2D square-like BiOI nanosheets are evaluated by the photodegradation of rhodamine-B (RhB), methyl orange (MO) and phenol under visible-light irradiation. The products show highly efficient photocatalytic performance and good photostability and recyclability under the visible light irradiation. The efficient visible-light driven photocatalytic activity can be ascribed to the thin 2D square shape nanosheet with exposed {001} facet, which provides appropriate diffusion length and self-induced internal static electric fields direction of BiOI, improves the separation efficiency of photoinduced electron-hole pairs in BiOI nanosheets.

O 11.2 Mon 10:45 WIL C107

Tandem nanostructure for solar water splitting — •Stefan Bösemann, Liaoyong Wen, Fabian Grote, and Yang Xu — Ilmenau University of Technology, Institute of Physics & IMN MacroNano (ZIK), Prof. Schmidt-Str. 26, 98693 Ilmenau (Germany)

A promising solution to challenge the problems of renewable energies like absence of sufficient storage facilities and energy transportation is offered by water splitting. In order to separate water into hydrogen and oxygen, a theoretical energy of 1.23 eV is needed, which can be up to 1.6 - 2.4 eV considering overpotentials. Besides, the minimum of the conduction band of the active semiconductor has to be lower than the redox potential of H+/H2 and the maximum of the valance band has to be higher than the redox potential of O2/H2O. Furthermore, lights absorption and material stability in electrolytes are very important aspects in regarding to efficient solar water splitting. To fulfill these requirements with only one absorber, a semiconductor with a large bandgap is necessary and thus can only absorb a small fraction of the incident sunlight. Hence, it is essential for an efficient water splitting system to be constructed of more than one absorbing material with different bandgaps to utilize a larger fraction of the incoming light and generate O2 and H2 in a single device. We have developed a tandem structure consisting of two-sided ordered semiconductor nanorods by using anodic aluminum oxide (AAO) templates. The two-sided ordered tandem architecture enables not only the complete water splitting but also a large surface and consequently an increased light absorption and a high surface reaction area.

O 11.3 Mon 11:00 WIL C107

Ab-initio simulations of copper-modified titania photocatalysts — •Nicola Seriani — The Abdus Salam ICTP

Titania modified with transition or coinage metals has a great potential as a photocatalyst for the conversion of water and carbon dioxide into hydrocarbons. In particular, copper is interesting for its positive effect on the activity of the system. Still, it is not clear yet what the role of copper is in the overall mechanism, for the photoabsorption, for charge separation and for the chemical reactions taking place on the system. To shed light on these aspects, first-principles simulations based on density functional theory have been performed in three cases: copper doping in bulk titania, small copper clusters on titania surfaces and large particles on titania surfaces. The (101) and (100) surfaces of anatase were considered. Regardless whether copper is present in the bulk or at the surface of titania, its presence has an effect on the local atomic structure of the semiconductor, as well as on the electronic structure of the system. The presence of copper can lead to changes in the edges of valence and conduction bands, but also to the appearance of mid-gap states, depending on the atomic structure of the cluster and the coordination of the copper atoms. Finally, water dissociation has been investigated. These results give an insight over the role of copper in the photoabsorption and in the subsequent steps of the photocatalytic cycle.

O 11.4 Mon 11:15 WIL C107

Large scale ordered binary nanopatterns via pre-patterned anodic aluminum oxide — •Liaoyong Wen, Yan Mi, Chengliang Wang, Fabian Grote, Huaping Zhao, Min Zhou, and Yong Lei — Ilmenau University of Technology, Institute of Physics & IMN MacroNano* (ZIK) Prof. Schmidt-Str. 26, 98693 Ilmenau Ilmenau, Ilmenau, Germany

Multicomponent nanopatterns, such as binary superlattices, consist of two or more kinds of materials or morphologically dissimilar nanocomponents. Unlike single component counterparts, multicomponent nanopatterns offer enormous diversities in the pattern shape, material composition and corresponding functionality. Nevertheless, there are very few simply lithographic techniques capable of constructing such nanopatterns in one single domain area. Nanoporous anodic aluminum oxide (AAO) has been intensively exploited as a template technique for the preparation of many kinds of nanostructures. However, the existing AAO only consist of single-sharp, monodisperse nanopores. Herein, we develop a novel selective etching approach to address this limitation and successfully generate ordered binary nanopores. The size of the binary nanopores is independently tunable without influencing the pattern periodicity and the well-established etching methods are scalable to arbitrary large area processing. More importantly, combing with other growth or deposition techniques, the ordered binary pores can act as a template to realizing different kind of ordered binary nanopatterns, such as binary nanowires, tubes or dots array.

O 11.5 Mon 11:30 WIL C107

Structure and Self-assembly of Two-dimensional Manganese Gallium Quantum Height Islands and One-dimensional Atomic Chains on Wurtzite GaN (000$\bar{1}$) — •Jeongihm Pak, Meng Shi, Andrada-Oana Mandru, Abhijit Chinchore, and Arthur Smith — Nanoscale and Quantum Phenomena Institute, Department of Physics and Astronomy, Ohio University, Athens, OH 45701 USA

We describe the spontaneous formation of five and six-monolayer quantum height manganese gallium islands and atomic chains on gallium-rich, nitrogen polar GaN(000$\bar{1}$). From ex-situ MOKE measurements at room temperature, we expect these MnGa islands to be ferromagnetic. The structural evolution is followed from the beginning of growth using reflection high energy electron diffraction, in which a dotted 2x pattern is observed to form. In-situ scanning tunneling microscopy is also used to investigate the islands* structures with atomic resolution. Based on all the observations, we propose possible bulk and surface models for the islands. A possible bonding structure at the substrate/island interface is also discussed in which Mn atoms substitute for Ga atoms within the Ga adlayer thus bonding with nitrogen, making the MnGa islands bonded directly to the last GaN bilayer. The atomic chain model on the six-layer island surface is also discussed. STM observations of atomic-chain interconnection on the six-layer island surface indicate a dynamic system at room temperature. The models presented here should serve as useful starting points for theoretical calculations.

O 11.6 Mon 11:45 WIL C107

Tunable superradiance in porphyrin chains on insulating surfaces — •Sebastiaan Vlaming and Alexander Eisfeld — Max Planck Institute for Physics of Complex Systems, Dresden, Germany

Recent experiments have shown that it is possible to synthesize collections of effective one-dimensional chains of non-covalently bound porphyrins on various surfaces.[1,2] We provide a study of the optical absorption properties of these systems, and we show that generally one expects the appearance of multiple superradiant transitions which can be both redshifted or blueshifted with respect to the monomer transitions. In addition, porphyrin chains can simultaneously support both redshifted and blueshifted features in the absorption spectrum. The energies, oscillator strengths and polarizations of the excitonic transitions can be understood in terms of Davydov splitting of chains with one transition per molecule. A distribution over chain lengths is proposed as a mechanism for the broadening of the superradiant transitions.

[1] S. Maier et al., Small 4, 115 (2008); Th. Glatzel et al., Isr. J. Chem. 48, 107 (2008). [2] C. Tröppner et al., Phys. Rev. B 86, 235407 (2012).

O 11.7 Mon 12:00 WIL C107

Structure formation of lipophilic molecules on surfaces: a computational study — •Pritam Kumar Jana and Andreas Heuer — Institute of Physical Chemistry, University of Muenster, Corrensstr. 28/30, Muenster, Germany

Understanding of STM images of different adsorbed molecules and the mechanism of structure formation is a very important aspect in the field of surface science due to its technological relevance. Here we are interested in the structure formation of lipophilic molecules, containing a nucleobase as the head group. Recently the group of Prof. Lifeng Chi has observed that N9-substituted adenine derivative in solution form two different types of structures (intercalation vs. stripe patterns) on the surface[1]. Repeating this experiment for vapor deposited molecules, an additional impact of deposition rate and substrate temperature on structure formation can be seen.

We present kinetic lattice Monte Carlo simulations where the molecules are represented in a minimum fashion, keeping the key properties of hydrogen bonding and van der Waals chain-chain interaction. Most model parameters can be taken from quantum-chemical calculations[1]. The quality of structure formation in dependence on flux and temperature as well as the relative fraction of both phases is analysed and compared with the experimental data.

[1] Z. Mu, O. Rubner, M. Bamler, T. Blömker, G. Kehr, G. Erker, A. Heuer, H. Fuchs, and L. Chi, Langmuir 29 (2013) 10737-10743.

O 11.8 Mon 12:15 WIL C107

Electrostatic interaction between colloids trapped at an electrolyte interface — •Arghya Majee, Markus Bier, and Siegfried Dietrich — Max Planck Institute IS and University of Stuttgart, Germany

Self-assembly of stably trapped colloidal particles at electrolyte interfaces has attracted much interest in recent years. For large separations between the charged particles, the repulsive part of the interaction can be compared to a dipole-dipole interaction. However for distances close to the particle this simple dipolar picture cannot be applied. In this contribution we will consider the case of colloids situated very close (˜50-100 nm) to each other at an electrolyte interface by going beyond the superposition approximation [1]. Within an appropriate model exact analytic expressions for the electrostatic potential as well as for the surface and line interaction energies are obtained. They demonstrate that the widely used superposition approximation, which is commonly applied to large distances between the colloidal particles, fails qualitatively at small distances and is quantitatively unreliable even at large distances. Our results contribute to an improved description of the interaction between colloidal particles trapped at fluid interfaces.

[1] "Electrostatic interaction between colloidal particles trapped at an electrolyte interface" by A. Majee, M. Bier, and S. Dietrich (submitted).

O 11.9 Mon 12:30 WIL C107

Nanocomposites with functions of biomedical nanorobots — •Ievgen Pylypchuk and Petro Gorbyk — Ukraine, Kyiv, Gen. Naumov str. 17

The modern level of nanotechnology permits creating unique means for medicine and biology. Their introduction into practice is the basis of the contemporary progress in diagnostics and therapy, in particular, at the cell and genetic levels. Researchers* interest in magnetosensitive biocompatible nanoparticles arises from the possibilities to control their motion in biological medium by external magnetic *eld, use for targeted drug delivery, form local hyperthermia zones, create new types of adsorbents, means for early diagnostics of diseases, etc.

Recent advances in cross-disciplinary nanoscience and nanotechnology have led to further and rapid developments of new *nanohybrids* as probes for molecular imaging, MRI, neutron capture therapy(NCT), targeted drug delivery, different kinds of therapy which are sensitive to pH, magnetic field, neutron irradiation etc. All of these parametres inherent to biomedical nanorobots.

Developed methods of immobilization of different bio-compounds on to surface of nanosized magnetite. Nanocomposites was characterized by vibrating sample magnetometry, IR-spectroscopy, X-ray diffraction and X-ray photoelectron spectroscopy etc.

O 11.10 Mon 12:45 WIL C107

Large-scale Replication of Optical Nanostructures Inspired by Blue Morpho Butterflies — •Claudia Zeiger, Norbert Schneider, Alexander Kolew, Marc Schneider, Radwanul H. Siddique, Hendrik Hölscher, and Matthias Worgull — Institute of Microstructure Technology (IMT), Karlsruhe Institute of Technology (KIT)

Morpho butterflies show an impressive iridescent blue color which does not originate from pigmentation but from sophisticated nanostructures. The "Christmas-tree-like" morphology of these structures has been investigated for a long time since numerous technical applications could benefit from the large-scale replication of Morpho-like structures, ranging from pigment-free colors to thermal imaging sensors and chemical sensors. However, the large-scale replication of sophisticated 3D micro- and nanostructures faces difficulties even today.

We developed a technology to overcome this problem and to fabricate such structures on large scales in a cost-effective way. Our unique combination of hot embossing and microthermoforming allows the easy implementation of other non-optical features like superhydrophobicity and self-cleaning as well. Hot embossing is applied to imprint nanostructures in a polymer foil which is subsequently shaped on the microscale by microthermoforming. This process enables the replication of structure sizes several orders of magnitude smaller than conventional thermoforming. We demonstrate the features of this technique by manufacturing optical structures inspired by Morpho butterflies as well as refractive gratings.

O 11.11 Mon 13:00 WIL C107

Parallel Fabrication of User Defined Patterns Using Scanning Particle Lens Array — •Wei Guo — Manufacturing Technology Research Laboratory, B38f Sackville Street Building, School of Mechanical Aerospace and Civil Engineering, The University of Manchester, Manchester, M13 9PL

Direct laser writing of parallel patterns over a large area is achieved by an efficient and low-cost technique using scanning particle lens array. With near-field enhancement created by particle lenses, a single laser beam can be split into millions of nano laser jets. By scanning the laser beam at various angles, user defined patterns such as lines, curves and even letters can be generated simultaneously. Up to 100 million periodic features with nano or sub-micro scale can be produced within tens of seconds over an area of 5 mm * 5 mm. In addition, overwriting same patterns on previous locations can be performed without any relocation or misalignment issues.