O 26: Poster Session II: Nanostructures at surfaces II

Time: Monday 13:30–15:30 Location: P

O 26.1 Mon 13:30 P

Single-crystal graphene on Ir(110): a uniaxial template — •Stefan Kraus[1], Felix Huttmann[1], Timo Knispel[1], Jeison Fischer[1], Ken Bischof[1], Alexander Herman[2], Marco Bianchi[3], Raluca-Maria Stan[3], Ann Julie Holt[3], Vasile Caciuc[4], Shigeru Tsukamoto[4], Heiko Wende[2], Philip Hofmann[3], Nicolae Atodiresei[4], and Thomas Michely[1] — [1]Universität zu Köln, Germany — [2]Universität Duisburg-Essen, Germany — [3]Aarhus university, Denmark — [4]Forschungszentrum Jülich, Germany

A single-crystal sheet of graphene is grown on the low-symmetry substrate Ir(110) by thermal decomposition of ethylene at 1500 K. While the bare Ir(110) is heavily reconstructed at room temperature due to the formation of nano-facets, scanning tunneling microscopy reveals that the adsorbed graphene suppresses this reconstruction entirely and large atomically flat areas are observed. The superposition of the graphene with the Ir(110) lattice gives rise to a wave pattern with clear crests and troughs along the [001] direction while the atomic lattice of the graphene is under very weak lateral strain ($< 0.2\%$ compared to graphite). Density functional theory calculations confirm the observed wave pattern and show a strong variation from weak (crests) to strong chemical binding (troughs). Angle-resolved photo emission spectroscopy shows no sign of a Dirac cone, which is in agreement with the large variety of binding motifs and partial sp^3 hybridization. We showcase the use of this uniaxial template by the global alignment of sandwich-molecular wires — one-dimensional organo-metallic structures — parallel to the crests and troughs.

O 26.2 Mon 13:30 P

Selective Area Growth of III-V Nanowires on High-Index GaAs Substrates — •Gunjan Nagda[1,2], Daria Beznasiuk[1,2], Tobias Saerkjaer[1,2], Martin Espineira[1,2], Sara Martí-Sanchez[3], Jordi Arbiol[3], and Peter Krogstrup[1,2] — [1]Center for Quantum Devices, Niels Bohr Institute, University of Copenhagen, 2100 Copenhagen, Denmark — [2]Microsoft Quantum Materials Lab, 2800 Lyngby, Denmark — [3]Catalan Institute of Nanoscience and Nanotechnology (ICN2), CSIC and BIST, Campus UAB, 08193 Bellaterra, Barcelona, Catalonia, Spain

Using a patterned SiO_2 mask we report on selective area growth of III-V materials on high-index GaAs substrates using molecular beam epitaxy (MBE). This platform is used to define 1D semiconductor nanowire (NW) networks with excellent surface selectivity for quantum transport studies. Due to the dependence of NW faceting on the substrate orientation and the trench direction within the oxide mask, non-standard substrate orientations such as (211)A and (211)B, and (311)A and (311)B open the pathway to obtain a multitude of geometries. The NW faceting observed using atomic force microscopy (AFM) and cross-sectional transmission electron microscopy (TEM) is in good agreement with the facets predicted on the basis of the stereographic projections of the substrate orientations. The equilibrium shapes are determined using Wulff construction along with constraints imposed by the oxide mask. Comparison with experimental findings is used to determine whether a particular growth is driven by thermodynamically determined surface energy minimization or by kinetic parameters.

O 26.3 Mon 13:30 P

2D covalent organic frameworks on monolayer MoS2 — •wenbo lu[1], davor čapeta[2], mihaela enache[1], and meike stöhr[1] — [1]Zernike Institute for Advanced Materials, University of Groningen, Netherlands — [2]Center of Excellence for Advanced Materials and Sensing Devices, Institute of Physics, Bijenička 46, 10000 Zagreb, Croatia

Two-dimensional (2D) transition metal dichalcogenides (TMDs) have received increasing attention as promising materials for different applications. One possibility to precisely tune the electronic and optical properties to the desired applications is based on adsorbing well-ordered organic assemblies TMDs. Here, a study of on-surface synthesis of 2D covalent organic frameworks (COFs) on monolayer molybdenum disulfide (MoS2) on highly oriented pyrolytic graphite (HOPG) will be presented. Monolayer MoS2 films were synthesized by chemical vapor deposition and transferred to HOPG. The transferred MoS2 was characterized by atomic force microscopy and scanning tunneling microscopy (STM), from which we conclude that the transferred MoS2 is of high-quality with micrometer sized domains. For COF formation, 1,4-benzenediboronic acid (BDBA) was deposited onto the MoS2/HOPG. The structure of the formed 2D COFs was studied with STM. The dehydration of BDBA results in the formation of a long-range ordered honeycomb molecular network on MoS2. Our results show the possibility of using 2D COFs to build up ordered organic/2D TMDs interfaces, which is promising for the fabrication of hybrid organic-inorganic devices possessing tailored structures and properties.

O 26.4 Mon 13:30 P

Theoretical analysis of chemical transformation of π-conjugated polymers steered by internal vibrational modes — •Adam Matěj[1,2], Michal Otyepka[1], Miroslav Medveď[1], and Pavel Jelínek[1,2] — [1]Regional Centre of Advanced Technologies and Materials, Palacký University, Šlechtitelů 27, 783 71 Olomouc, Czech Republic — [2]Institute of Physics, The Czech Academy of Sciences, Cukrovarnická 10, 162 00, Prague 6, Czech Republic

The rational design of increasingly complex electronic materials for molecular electronics and quantum technologies has been an active field of research in organic electronics. Recent developments of on-surface synthesis open novel strategies to tailor one-dimensional π-conjugated polymers. In this work, we employ quantum-mechanical calculations for the description of structural and electronic properties of π-conjugated ethynylene bridged polymers. Additionally, we introduce novel synthetic strategy forming π-conjugated ladder polymers with non benzenoid pentalene bridges by exploiting the relation between π-conjugation, topological phase and vibrational modes of the polymer. Selected vibrational mode of ethynylene bridged bisanthene polymer is shown to be the key feature allowing the cyclization of ethynylene into pentalene linker, which is not observed in topologically trivial anthracene polymer. Finally, we present reaction mechanism highlights differentiating anthracene and bisanthene π-conjugated ethynylene bridged polymers, leading to successful cyclization in bisanthene but prevent the reaction on anthracene polymer completely, which is in direct agreement with experiments.

O 26.5 Mon 13:30 P

Coupling of YSR states in 1D chains of Fe atoms on Nb(110) — •Felix Friedrich, Robin Boshuis, Matthias Bode, and Artem Odobesko — Physikalisches Institut, Experimentelle Physik II, Universität Würzburg, Am Hubland, 97074 Würzburg, Germany

The pair-breaking potential of magnetic impurities in a superconducting host material gives rise to in-gap peaks, so called Yu-Shiba-Rusinov (YSR) states. Coupling of these states leads to the formation of molecular-like bonding and antibonding modes in impurity dimers [1], YSR bands in many impurity systems [2], and constitutes a platform for the formation of Majorana fermions at the ends of one-dimensional chains [3]. To obtain a more detailed understanding of the interaction of multiple magnetic impurities, we investigate the coupling of YSR states in short one-dimensional Fe chains on clean Nb(110). By functionalizing STM tips with a CO molecule we are able to resolve single atoms in nearest neighbor lattice positions of self-assembled Fe chains. Spectroscopic measurements reveal that the splitting of the single atom YSR states becomes more complex with increasing chain length. Furthermore, differential conductivity maps uncover an intriguing dependence of the odd or even spatial symmetry of the individual states on the chain length. The experimental results will be compared to theoretical models.

[1] S.-H. Ji *et al.*, Phys. Rev. Lett. **100**, 226801 (2008)
[2] M. Ruby *et al.*, Phys. Rev. Lett. **115**, 197204 (2015)
[3] S. Nadj-Perge *et al.*, Science **346**, 602 (2014)

O 26.6 Mon 13:30 P

Tailoring vortex core polarity and vortex chirality by in-plane and out-of-plane magnetic fields — •Andrea Ehrmann[1] and Tomasz Blachowicz[2] — [1]Bielefeld University of Applied Sciences, Faculty of Engineering and Mathematics, Bielefeld, Germany — [2]Silesian University of Technology, Institute of Physics - Centre for Science and Education, Gliwice, Poland

Vortex states in magnetic nanodots can be used to store data, defined by the core polarity and/or the vortex chirality. Preparing nanodots with dimensions leading to magnetization reversal by vortex states is technologically not problematic if material and dimensions are cho-

sen carefully [1,2]. Defining core polarity and vortex chirality reliably, however, needs more sophisticated approaches [3]. Here we give an overview of the influence of different out-of-plane and in-plane bias fields on these values, showing that in clusters of circular nanodots, out-of-plane fields can be applied to define and to switch the vortex core polarity without influencing the vortex chirality simultaneously. This enables defining both properties independently and thus preparing quaternary vortex-based memory devices.

[1] A. Ehrmann, T. Blachowicz, J. Magn. Magn Mater. 475, 727-733 (2019)

[2] A. Ehrmann, T. Blachowicz, Hyperfine Interactions 239, 8 (2018)

[3] A. Ehrmann, T. Blachowicz, Proc. of 2018 IEEE 8th International Conference on "Nanomaterials: Applications & Properties" 1, 01NMM08 (2020)

O 26.7 Mon 13:30 P

A differential equation for plowing-induced structuring of polymer films — •Enrico Gnecco[1], Jana Hennig[1], Pedro J. Martinez[2], and Juan J. Mazo[2] — [1]Otto Schott Institute of Materials Research, Friedrich Schiller University Jena, Germany — [2]Department of Condensed Matter Physics, University of Zaragoza, Spain

The formation of ripple structures out of plowing wear is a well-known but scarcely understood phenomenon in polymer physics. Here we discuss this process on the example of polystyrene thin film scratched by silicon nanotips. The physical interpretation relies on the stick-slip motion of the tip, which is simultaneously indented and elastically pulled along the surface. The dependence of the ripple orientation on the geometry of the scanned area is numerically reproduced with an original equation for the tip motion in an energy landscape mirroring the surface evolution. Eye-catching examples will include square, circle, star and heart shaped geometries, but potential applications of our model will be also mentioned.

[1] J.J. Mazo et al., Plowing-induced structuring of compliant surfaces, PRL 122 (2019) 256101 [2] P.J. Martinez et al., Numerical study of pattern formation in compliant surfaces scraped by a rigid tip, PRE, accepted (2021)

O 26.8 Mon 13:30 P

Comparing the Nanomechanics and the Chemical Properties of NC-AFM Tips — •Damla Yesilpinar[1,2], Bertram Schulze Lammers[1,2], Alexander Timmer[2], Zhixin Hu[3], Wei Ji[4], Saeed Amirjalayer[1,2,5], Harald Fuchs[1,2], and Harry Mönig[1,2] — [1]Physikalisches Institut, Westfalische Wilhelms-Universitat, Muenster, Germany. — [2]Center for Nanotechnology, Muenster, Germany. — [3]Center for Quantum Joint Studies and Department of Physics, Tianjin University, Tianjin, China — [4]Department of Physics and Beijing Key Laboratory of Optoelectronic Functional Materials & Micro-Nano Devices, Renmin University of China, Beijing, China — [5]Center for Multiscale Theory and Computation, Muenster, Germany

Controlling the identity of the tip-terminating species in AFM constitutes a milestone for investigations of surfaces and adsorbates. Highlighting the importance of the mechanical tip properties, we consolidate the interpretation of such studies by comparing the performance of four atomically defined tips, namely Cu-, Xe-, CO-, and CuOx-tips. Using a nano-structured copper oxide surface, we investigated their imaging performances and capabilities in force mapping during the lateral manipulation of single adsorbed atoms. Cu-tips easily reacts with surface oxygen or the adsorbate, while chemically inert Xe- and CO-tips allow entering the repulsive force regime enabling increased resolution. But their high flexibility leads to tip-deflection and related artefacts. The combination of chemical passivation and mechanical rigidity for the CuOx-tip turns out decisive for chemical-specific imaging and for a superior performance in manipulation experiments.