

## O 87: Poster Session - Nanostructures at Surfaces: 1D and 2D Structures and Networks

Time: Wednesday 18:15–20:00

Location: P2/10G

O 87.1 Wed 18:15 P2/10G

**Confinement and Tailoring of Surface 2DEGs in Temperature-driven Molecular Nano-porous Network** — •LU LYU<sup>1</sup>, BENITO ARNOLDI<sup>1</sup>, JIN XIAO<sup>2</sup>, SINA MOUSAVION<sup>1</sup>, JOHANNES STÖCKL<sup>1</sup>, MANIRAJ MAHALINGAM<sup>1</sup>, BENJAMIN STADTMÜLLER<sup>1,3</sup>, and MARTIN AESCHLIMANN<sup>1</sup> — <sup>1</sup>Department of Physics and Research Center OPTIMAS, TU Kaiserslautern — <sup>2</sup>School of Science, Hunan University of Technology, Zhuzhou 412007, China — <sup>3</sup>Graduate School Materials Science in Mainz, Kaiserslautern

Controlling the quantum confinement of (spin-dependent) electronic states by design of two-dimensional (2D) organic nanoporous networks (NPNs) opens a unique avenue to accelerate the implementation of quantum technology in next-generation photonic and spintronic applications. In our previous study [1], a thermal-driven TPT NPN is found on Cu(111) surface. At low temperature, the formation of nanopores can confine the free 2D electron gas (2DEGs) of the surface into a regular array of quantum dots. Moreover, the electronic coupling between neighboring quantum dots induces a dispersive band structure in *k*-space near the Fermi level. Further, the confined 2DEGs can be modulated by the doped cobalt atoms. Combining the DFT and EBEM/EPWE (electron boundary elements and electron plane wave expansion methods), the details on spin-dependent electronic states are provided in Co-doped NPN. These findings pave the way to control 2DEGs in temperature-driven molecular networks.

[1] *J. Phys. Chem. C* **123**, 26263 (2019)

O 87.2 Wed 18:15 P2/10G

**Modeling of molecular stripe formation on insulating surfaces** — •CHRISTOPH SCHIEL<sup>1</sup>, MAXIMILIAN VOGTLAND<sup>2</sup>, RALF BECHSTEIN<sup>2</sup>, ANGELIKA KÜHNLE<sup>2</sup>, and PHILIPP MAASS<sup>1</sup> — <sup>1</sup>Fachbereich Physik, Universität Osnabrück, Germany — <sup>2</sup>Fakultät für Chemie, Universität Bielefeld, Germany

The interplay of intermolecular and molecule-surface interactions plays a decisive role for molecular structure formation. Insulating surfaces are interesting due to the weaker electronic coupling of the molecules to the substrate compared to metals. This allows for exploiting the rich variety of intermolecular interactions to a larger extent, in particular for pattern formation with specific applications in nanotechnology. Here we study theoretical approaches to model the stripe formation of 3-hydroxybenzoic acid (3-HBA) and 3-aminobenzoic acid (3-ABA) molecules on calcite (104). It is argued that adsorption-induced dipolar interactions cause an ordering towards a regular spacing between the molecular stripes [1]. We model the stripe formation by an anisotropic Ising model with dipole-dipole interactions. Stripe length and distance distributions are determined by Monte Carlo simulations and show good agreement with the experimental data. They allow us to give estimates for induced dipole moments and binding energies between molecules.

[1] J. L. Neff, H. Söngen, R. Bechstein, P. Maass, A. Kühnle, *J. Phys. Chem. C* **119**, 24927 (2015).

O 87.3 Wed 18:15 P2/10G

**Epitaxial growth of Bi on epitaxial graphene** — •CHITRAN GHOSAL<sup>1</sup>, JOHANNES APROJANZ<sup>1</sup>, and CHRISTOPH TEGENKAMP<sup>1,2</sup> — <sup>1</sup>TU Chemnitz, Germany — <sup>2</sup>Leibniz Universität Hannover, Germany

The semimetal Bi still attracts a lot of interest because of its unique electronic properties such as a low carrier concentrations and large carrier mobilities. The mesoscopic Fermi wavelength gives rise to pronounced quantum confinement effects, e.g the semimetal to semiconductor transition. The surface states on Bi(111) reveal strong spin polarization and ultrathin Bi films are topologically non-trivial. Therefore, proximity coupling of Bi nanostructures to graphene may be used to tune the transport properties of the 2D relativistic electron gas. In this work we studied the growth of the Bi on epitaxial graphene on SiC(0001) by means of LEED and STM. While for low coverages Bi(110) are formed, Bi(111) structures were found in the high coverage regime. This allotropic transition occurs around 14 bilayers (5.6 nm) and significantly larger than the transition reported on Si(111) [1]. Moreover, needle-like structures along three different directions were found. For various Bi coverages, the widths of these Bi-structures is around 12 nm, apparently, due to a lateral quantum confinement effect. Contrary, magic heights were now observed. In order to probe proxim-

ity effects, we will present also first magneto transport measurements. [1] T. Nagao, et al. *Phys. Rev. Lett.*, **93**, 105501 (2004).

O 87.4 Wed 18:15 P2/10G

**Coupling of Yu-Shiba-Rusinov states on 2H-NbSe<sub>2</sub>** — •EVA LIEBHABER<sup>1</sup>, LISA RÜTTEN<sup>1</sup>, GAËL REECHT<sup>1</sup>, KAI ROSSNAGEL<sup>2,3</sup>, FELIX VON OPPEN<sup>1,4</sup>, and KATHARINA J. FRANKE<sup>1</sup> — <sup>1</sup>Fachbereich Physik, Freie Universität Berlin, Germany. — <sup>2</sup>Institut für Experimentelle und Angewandte Physik, Christian-Albrechts-Universität zu Kiel, Germany. — <sup>3</sup>Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany. — <sup>4</sup>Dahlem Center for Complex Quantum Systems, Freie Universität Berlin, Germany.

A magnetic impurity adsorbed on a superconducting substrate leads to the formation of Yu-Shiba-Rusinov (YSR) states. These are low-energy bound states inside the superconducting energy gap. YSR wave functions of two adjacent magnetic adatoms can hybridize and form symmetric and antisymmetric linear combinations. Increasing the number of adatoms leads to the formation of Shiba bands. In adatom chains, the spin texture and hence, the underlying physics, is dictated by the inter-atomic distance as well as by the nature of the coupling [1].

We investigate magnetic atoms on the superconductor 2H-NbSe<sub>2</sub> which is a layered van der Waals material. Its strong 2D character leads to a large spatial extent of the YSR wave functions facilitating the coupling between them [2]. We assemble adatom chains with different interatomic spacings using a superconducting tip and track the evolution of the YSR states.

[1] F. Pientka *et al.*, *Phys. Rev. B* **89**, 180505 (2014).

[2] G.C. Ménard *et al.*, *Nature Phys.* **11**, 1013 (2015).

O 87.5 Wed 18:15 P2/10G

**Coadsorption of shape-persistent macrocycles and fullerene derivatives on graphite: Lithography with the STM tip** — •JOSHUA BAHR, ANNEMARIE MEYER, TRISTAN J. KELLER, SIGURD HÖGER, and STEFAN-SVEN JESTER — Kekulé-Institut für Organische Chemie und Biochemie, Bonn, Deutschland

Shape-persistent arylene-alkynylene macrocycles self-assemble into 2D crystalline nanopatterns at the solid/liquid interface of highly oriented pyrolytic graphite (HOPG) and 1-phenyloctane, and are imaged *in situ* by scanning tunneling microscopy (STM) with submolecular resolution. The physisorption and packing of such species is driven by long extraannular alkoxy substituents, which also guarantee sufficient compound solubility for processing. The ability of macrocycles to template the adsorption of fullerenes on HOPG has gained recent interest, as it does not require covalent bond formation.[1] Here, we report on patterns of macrocycles on HOPG, that are metastable upon addition of fullerene PC<sub>61</sub>BM to the supernatant liquid phase. STM-tip induced local disturbance of such a system leads to desorption of the macrocycles and re-adsorption of cocrystals of both compounds. We discuss both potential and limits of STM-based supramolecular lithography at the solid/liquid interface. [1] G.-B. Pan, X.-H. Cheng, S. Höger, W. Freyland, *J. Am. Chem. Soc.* **2006**, *128*, 4218-4219.

O 87.6 Wed 18:15 P2/10G

**Isomorphic packing of carboxylic acid terminated arylene-alkynylenes and monodisperse oligomers on graphite** — •DAVID A. HOFMEISTER, LUCAS ROTHE, TRISTAN J. KELLER, SIGURD HÖGER, and STEFAN-S. JESTER — Kekulé-Institut für Organische Chemie und Biochemie, Rheinische Friedrich-Wilhelms-Universität Bonn, Gerhard-Domagk-Str. 1, 53121 Bonn, Germany.

Arylene-alkynylenes form supramolecular nanopatterns at the solid/liquid interface of graphite (HOPG), that are imaged by scanning tunneling microscopy with submolecular resolution. The structure of the two-dimensional (2D) crystals depends on the exact geometry of the shape-persistent backbones, the substitution with functional groups that mediate the interaction of such species, and (intermolecularly interdigitating) alkoxy side chains. Here, we report on (i) arylene-alkynylenes that carry OC<sub>16</sub>H<sub>33</sub> side chains and carboxylic end groups and are obtained in a stepwise synthesis, and (ii) monodisperse oligomers of alike systems obtained by oxidative Glaser coupling of acetylene-terminated precursors and subsequent separation by recycling gel permeation chromatography. Both species form isomorphous 2D packings, which is drawn back to alike spatial requirements of (i)

carboxylic acid dimers that form after adsorption and (ii) butadiynylene units.

O 87.7 Wed 18:15 P2/10G

**Electronic and magnetic structure of oriented sandwich-molecular wires on graphene/Ir(110)** — ●STEFAN KRAUS<sup>1</sup>, ALEXANDER HERMAN<sup>2</sup>, FELIX HUTTMANN<sup>1</sup>, KEN BISCHOF<sup>1</sup>, NICO ROTHENBACH<sup>2</sup>, KATHARINA OLLEFS<sup>2</sup>, MARCO BIANCHI<sup>4</sup>, RALUCAMARIA STAN<sup>4</sup>, ANN JULIE HOLT<sup>4</sup>, JAN DREISER<sup>5</sup>, SHIGERU TSUKAMOTO<sup>3</sup>, NICOLAE ATODIRESEI<sup>3</sup>, PHILIP HOFMANN<sup>4</sup>, HEIKO WENDE<sup>2</sup>, and THOMAS MICHELY<sup>1</sup> — <sup>1</sup>Universität zu Köln, Germany — <sup>2</sup>Universität Duisburg-Essen, Germany — <sup>3</sup>Forschungszentrum Jülich, Germany — <sup>4</sup>Aarhus university, Denmark — <sup>5</sup>Paul Scherrer Institut, Switzerland

Sandwich-molecular wires are one-dimensional arrangements of alternating metal atoms and cyclic molecules which, when synthesized on a surface, can interlock with each other and form islands. Here, we use europium as metal reactant and cyclooctatetraene as ligand. We choose the substrate Gr/Ir(110) which has a two-fold symmetric moiré, in order to achieve a global wire orientation. Excluding defects we observe wire formation only along the [001] direction, which allows for band structure investigations using ARPES. Although it is not possible to observe the  $\pi$ -derived bands, we find a flat band stemming from the 4f-states. The comparison with DFT calculations allows us to estimate the Hubbard U for the wires. While XMCD for these wires

on Gr/Ir(111) shows a hysteresis at 5K, this hysteresis is suppressed in the oriented wires on Gr/Ir(110). We speculate that the more reactive binding of Gr/Ir(110) leads to this suppression, while the electronic configuration of Eu 4f<sup>7</sup> is left unchanged.

O 87.8 Wed 18:15 P2/10G

**Thermal- vs. Light-Induced on-Surface Polymerization** — ●CHRISTOPHE NACCI and LEONHARD GRILL — Department of Physical Chemistry, University of Graz, 8010 Graz, Austria

The on-surface synthesis of covalently linked molecular precursors via Ullmann coupling reaction is an efficient approach to produce novel functional materials. The dissociation of specific bonds and the formation of new covalent ones can be induced by using different external stimuli. While many studies exist on the thermal control of the reaction, very few studies have reported a photochemical approach to form polymers at single-crystal surfaces. The purpose of this work is to get insight into the reaction pathways from individual molecular species to one-dimensional polymers by driving the reaction either by heat or by light illumination. The molecular precursors were deposited in ultrahigh vacuum onto a Au(111) surface where polymerization occurs. Two stimuli, thermal- and photo-induced polymerization by using UV light, were employed and systematically compared. The structural characterization of the product results by low-temperature scanning tunneling microscopy and the corresponding polymer length distributions will be shown.