

## TT 24: Graphene: Adsorption, Intercalation and Doping II (joint session O/TT)

Time: Monday 16:45–18:15

Location: MA 043

TT 24.1 Mon 16:45 MA 043

**Initial investigation of the coexistence of different structural conformations, obtained via high temperature deposition of PbPc on epitaxial graphene grown on 6H-SiC(0001)** — ●CHITRAN GHOSAL<sup>1,2</sup>, SAMIR MAMMADOV<sup>1</sup>, MARTINA WANKE<sup>1</sup>, FLORIAN SPECK<sup>1</sup>, THOMAS SEYLLER<sup>1</sup>, and CHRISTOPH TEGENKAMP<sup>2</sup> — <sup>1</sup>Professorship of Technical Physics, Institute of Physics, TU-Chemnitz — <sup>2</sup>Professorship of Solid Surfaces Analysis, Institute of Physics, TU-Chemnitz

Epitaxial deposition is one of the well documented ways of doping of graphene[1]. Therefore, it is crucial to be able to study the different possible structural configurations that can be obtained via the deposition techniques.

This study deals with the analysis of different periodic structures obtained via the deposition of PbPc on epitaxial graphene, which was grown on 6H-SiC(0001) surfaces. The graphene was characterized by LEED and high resolution XPS measurements as well as STM. PbPc molecules were deposited afterwards at high temperatures of around 330degC and densely packed molecular films were grown under UHV conditions. Fourier analysis of large scale STM images revealed the coexistence of two non-orthogonal lattice structures (1.2nm X 1.6nm) and (1.35nm X 1.4nm) forming different islands separated by grain boundaries in between. The variability of the structures underlines the weak interaction of the PbPc molecules with the substrate.

[1] I. Gierz, C. Riedl, U. Starke, C. R. Ast, and K. Kern, Nano Lett. 8, 4603 (2008).

TT 24.2 Mon 17:00 MA 043

**Investigation of PbPc self-assembly on graphene: Atomic resolution and spectroscopy data** — ●NHUNG NGUYEN<sup>1,2</sup>, HA NGUYEN<sup>1</sup>, and CHRISTOPH TEGENKAMP<sup>1</sup> — <sup>1</sup>TU Chemnitz — <sup>2</sup>Duy Tan University, Vietnam

Shuttlecock-like lead-Phthalocyanine (PbPc) with its two equivalent stable up- and down states corresponding to ON/OFF switch is used for high density data storage of three- orders-magnitude capability higher than the present high density storage materials capability [1]. In addition, absorption of organic molecules on graphene surface due to the charge transfer mechanism between them is one of the promising methods to break the symmetries in graphene, localize the electronic states toward open a bandgap, which makes graphene useful as a nano-electronics material [2]. Here the self-assembly of PbPc on one monolayer graphene/SiC surface is investigated by means of scanning tunneling microscopy and spectroscopy (STM/STS) in ultra-high vacuum. Due to the weak molecule-substrate interaction as well as the thermodynamic stability, shuttlecock PbPc molecules are only deposited with Pb atom pointing upward (face-up) into the first monolayer, but face-up or face-down states appear randomly on the second layer. The occupied and unoccupied orbitals of PbPc on graphene are distinguished intuitively. The influences of surface coverage, substrate temperature and substrate properties (buffer layer and quasi-free-standing graphene substrates) on self-assembly of PbPc will be discussed. [1] Phys Chem Chem Phys., 2015, 17,23651. [2] PhysRevB., 2009, 80, 033404.

TT 24.3 Mon 17:15 MA 043

**Physical adsorption on graphene: from ultra-long ranged attraction to full screening of weakly interacting substrates** — ●ALBERTO AMBROSETTI and PIER LUIGI SILVESTRELLI — via Marzolo 8, 35131 Padova, Italy

The Lifshitz-Zaremba-Kohn (LZK) theory is commonly regarded as the correct large-distance limit for the van der Waals (vdW) interactions between adsorbates and solid substrates. However, recent experiments are challenging the universality of the LZK theory over a broad spectrum of nanoscale materials. By overcoming the conventional *local* permittivity approximation, here we demonstrate that physical adsorption on graphene and other low-dimensional materials can exhibit highly non-trivial features. Substrate-adsorbate vdW interactions can be extremely long-ranged and externally tunable. Moreover, graphene can effectively screen weakly interacting supporting substrates, emerging as an effective tool for the experimental modulation of adsorption processes.

TT 24.4 Mon 17:30 MA 043

**Advances in ultra-low energy ion implantation of low di-**

**mensional materials** — ●HANS HOFSSÄSS and MANUEL AUGE — II. Physikalisches Institut, Universität Göttingen, Germany

Doping of 2D materials by ion implantation has unique requirements regarding ion energy, ion energy spread, ion beam optics, sample preparation and sample electrical conductivity. Efficient incorporation of low energy ions into 2D lattices requires energies well below 50 eV. We use a 30 keV mass selected ion beam, guided through differential pumping stages and homogenized by a beam sweep. The beam is then decelerated in a UHV-chamber down to energies as low as 10 eV onto an area of 1 cm<sup>2</sup> up to 2.5 cm<sup>2</sup>. Up to now ion sources are available for B, C, N, F, P, S, Mn, Se, W and Au ions. Ion sources for elements Al, Fe, As and rare earth elements are under development. The implanted areal concentration and elemental composition are verified with in-situ Auger spectroscopy and more quantitative with Rutherford backscattering by implanting into amorphous carbon films as test samples. The detection limit is below 1\*10<sup>14</sup> ions/cm<sup>2</sup> for heavier elements. Implanted B can be analyzed with the <sup>11</sup>B(p,2α) nuclear reaction with a detection limit of about 1\*10<sup>14</sup> B/cm<sup>2</sup>. Challenges for ULE ion implantation such as non-flat substrates, charging of substrates, cleaning of surfaces and lateral controlled implantation will be briefly discussed. Some examples for doped graphene and MoS<sub>2</sub> are presented

TT 24.5 Mon 17:45 MA 043

**growth of fe3o4 nanorod arrays on graphene sheets for application in electromagnetic absorption fields** — ●HUANMING ZHANG<sup>1</sup>, MIN ZHOU<sup>1</sup>, YANG XU<sup>1</sup>, SHIPU XU<sup>1</sup>, YUJIN CHEN<sup>2</sup>, and YONG LEI<sup>1</sup> — <sup>1</sup>Institute für Physics & IMN MacroNano (ZIK), Technische Universität Ilmenau, 98693 Ilmenau, Germany — <sup>2</sup>Key Laboratory of In-Fiber Integrated Optics, Ministry of Education, College of Science, Harbin Engineering University, 150001 Harbin, China

A facial strategy is developed to fabricate a three-dimensional (3D) Fe3O4 nanorod array/graphene architecture, in which Fe3O4 nanorods are grown on both surfaces of the graphene sheets. The measured electromagnetic parameters show that the 3D architecture exhibits excellent electromagnetic wave-absorption properties, that is, more than 99% of electromagnetic wave energy can be attenuated by the 3D architecture if it is added in only 20 wt% of the paraffin matrix, as the thickness of the absorber is in the range from 2.38 to 5.00 mm. The analysis of the electromagnetic (EM) absorption mechanism reveals that the excellent EM absorption properties are related to the special 3D architecture, and therefore, the construction of graphene-based 3D heteronanostructures is effective in obtaining lightweight EM absorbers with strong absorption properties.

TT 24.6 Mon 18:00 MA 043

**Continuous in-plane graphene-hexagonal boron nitride layer from a single molecular precursor** — ●FEDERICA BONDINO<sup>1</sup>, SILVIA NAPPINI<sup>1</sup>, IGOR PÍŠ<sup>1,2</sup>, TEVFIK ONUR MENTEŞ<sup>2</sup>, ALESSANDRO SALA<sup>2</sup>, ANDREA LOCATELLI<sup>2</sup>, STEFANO AGNOLI<sup>3</sup>, MATTIA CATTELAN<sup>3</sup>, and ELENA MAGNANO<sup>1</sup> — <sup>1</sup>IOM-CNR, Laboratorio TASC, S.S. 14-km 163.5, 34149 Basovizza, Trieste, Italy — <sup>2</sup>Elettra - Sincrotrone Trieste S.C.p.A., S.S. 14-km 163.5, 34149 Basovizza, Trieste, Italy — <sup>3</sup>Department of Chemical Sciences, University of Padua, Padova 35131, Italy

We will show that it is possible to grow a continuous sp<sup>2</sup> hybridized material composed by graphene and hexagonal-boron nitride (h-BNG) in the same two dimensional sheet with the thermal decomposition of a single molecular precursor [1,2]. This surface-synthesis route allows an easy and controlled preparation of an high-quality h-BNG monolayer on the surface of several substrates. The temperature is the principal parameter to selectively grow the h-BNG layer in competition with hybridized B-C-N layers. The reactivity and the confinement of metal nanostructures in the interface between h-BNG and its solid substrate will be discussed in comparison with graphene. Basic processes, chemical composition, substrate interaction and changes accompanying the growth and intercalation process will be discussed based on results obtained by synchrotron radiation experimental techniques, such as high-resolution X-ray photoelectron spectroscopy and microscopy and X-ray absorption spectroscopy. 1. S. Nappini et al. Adv.Funct.Mater. 26, 1120 (2016). 2. S. Nappini et al. Carbon 120, 185 (2017).