# O 67: Graphene IV

Time: Thursday 11:15–13:00 Location: WIL B321

O 67.1 Thu 11:15 WIL B321

**Electronic properties and localization of Fe atoms on bilayer graphene on Ru(0001)** — Thomas Eelbo, Mike Gyamfi, •Marta Waśniowska, and Roland Wiesendanger — Institute of Applied Physics, University Hamburg, Jungiusstr. 11, 20355 Hamburg

We have investigated the electronic properties and a localization of iron adatoms and clusters on monolayer and bilayer graphene on Ru(0001). The epitaxial monolayer graphene (MLG) on Ru(0001) displays a Moiré pattern revealing a strong electronic coupling with the substrate [1], but the second layer (BLG) reveals properties of uncoupled graphene with a Dirac point at -0.5 eV [2]. In order to provide insights into the electronic properties of single Fe adatoms on graphene on Ru(0001) we performed scanning tunneling microscopy/spectrocopy at 5 K. We find that Fe adatoms are weakly attached to MLG and form clusters. However, when atoms are adsorbed on BLG, they are attracted by point defects and strained regions of graphene. Scanning tunneling spectroscopy measurements show that adatoms adsorbed on defect sites reveal the existence of a resonance state at +0.5 eV for single adatoms on BLG, which is also observed for single Fe atoms on Ru(0001).

[1] S. Marchini *et al.*, *Phys. Rev. B* **76**, 075429 (2007)

[2] P. Sutter *et al.*, *NanoLett.* **9**, 2654 (2009)

O 67.2 Thu 11:30 WIL B321

**Nucleation behavior of Pt clusters on monolayer graphene supported by Ru(0001)** — •Christoph U. Lorenz[1], Albert K. Engstfeld[1], Harry E. Hoster[1,2], and R. Jürgen Behm[1] — [1]Ulm University, Institute of Surface Chemistry and Catalysis, 89069 Ulm, Germany — [2]Current address: Technische Universität München, Centre for Electromobility, 50 Nanyang Drive, Singapore 637553

The Moiré-type nm-scale patterns of graphene monolayers supported by metal single crystals were recently shown to allow facile fabrication of ordered arrays of virtually monodisperse metal nanoclusters by simple metal vapor deposition in UHV [1-3]. In this work we analyzed the nucleation behavior of Pt clusters on monolayer graphene supported by Ru(0001). The cluster size dependency on the deposition rate was determined by statistical evaluation of STM images. Furthermore we investigated the ripening behavior of the Pt clusters at elevated temperatures. The results of these experiments lead us to the proposal of mobile Pt oligomers during the initial nucleation process on the monolayer graphene films.

[1] A.T. N'Diaye et al., New J. Phys. 11, 2009, 103045.

[2] Yi Pan et al., Appl. Phys. Lett. 95, 2009, 093106.

[3] K. Donner and P. Jakob, J. Chem. Phys. 131, 2009, 164701.

O 67.3 Thu 11:45 WIL B321

**Nucleation and growth of magnetic nanoclusters on graphene moiré on Rh(111)** — •Philipp Leicht[1], Muriel Sicot[1], Samuel Bouvron[1], Ole Zander[1], Thomas Tietze[2], Eberhard Goering[2], Yuriy Dedkov[3], and Mikhail Fonin[1] — [1]Fachbereich Physik, Universität Konstanz — [2]Max-Planck-Institut für Metallforschung, Stuttgart — [3]Fritz-Haber-Institut der Max-Planck Gesellschaft, Berlin

Magnetic nanoclusters with narrow size distributions are of key importance in modern nanotechnology. The bottom-up fabrication of self-organized nanoclusters on graphene moiré templates has been shown recently [1,2] and suggests a viable way to applications such as data storage. In this work, we use a graphene moiré grown on Rh(111) as a template. Submonolayers of ferromagnetic metals including Ni, Fe and Co are deposited on the graphene moiré template at room temperature and at low temperature around 150 K and are investigated by scanning tunneling microscopy and by x-ray magnetic circular dichroism (XMCD). Deposition at room temperature shows significant differences in the growth mode for Ni compared to Fe and Co. Whereas Ni preferentially forms flat triangles with alignment to the moiré structure of the graphene template, the growth of Fe clusters shows only little faceting. Deposition at low temperatures yields smaller clusters with hemispherical shape and a narrow size distribution. XMCD measurements on the Ni clusters are currently in progress to study their magnetic behavior. References: [1] A. T. N'Diaye et al, Phys. Rev. Lett. 97, 215501 (2006) [2] M. Sicot et al, Appl. Phys. Lett. 96, 093115 (2010)

O 67.4 Thu 12:00 WIL B321

**Highly Anisotropic Dirac cones in epitaxial Graphene modulated by an island superlattice** — •Markus Etzkorn[1], Stefano Rusponi[1], Marco Papagno[2], Paolo Moras[2], Sergio Vlaic[1], Polina M. Sheverdyaeva[2,3], Daniela Pacile[4], Harald Brune[1], and Carlo Carbone[2] — [1]Institute of Condensed Matter Physics, Ecole Polytechnique Fédérale de Lausanne, Switzerland — [2]Istituto di Struttura della Materia-Consiglio Nazionale delle Ricerche, Trieste, Italy — [3]Sincrotrone Trieste, Trieste, Italy — [4]Istitut. Naz. di Fisica Nucleare and Dip. di Fisica Universit‘a della Calabria, Cosenza, Italy

We present angle-resolved photoemission spectroscopy measurements of Graphene (G) on Ir(111) perturbed by self-assembled Ir clusters. While G/Ir(111) exhibits a sixfold symmetric band structure, the cluster superlattice induces a threefold symmetry with a strong renormalization of the electron group velocity close to the Dirac point giving rise to highly anisotropic Dirac cones. For the region up to 0.5 eV below $E_F$ a tight binding model of free standing G predicts an asymmetry of $\frac{v_{\Gamma K}-v_{p\Gamma K}}{v_{p\Gamma K}} = 5\%$. For G/Ir(111) we measure a value of $\frac{v_{\Gamma K}-v_{p\Gamma K}}{v_{p\Gamma K}} = 16 \pm 2\%$ indicating that the periodically modulated interaction between the G and the Ir-substrate already alters the band structure. This effect significantly increases for the case of the Ir superlattice on G/Ir(111) where we find $\frac{v_{\Gamma K}-v_{p\Gamma K}}{v_{p\Gamma K}} = 70 \pm 5\%$. We further observe an influence of the cluster superlattice on the electronic gaps in the graphene band structure.

O 67.5 Thu 12:15 WIL B321

**DFT and Photoemission Study of Water and Ammonia Adsorbed on Graphene/Ni(111)** — •Stefan Böttcher[1,2], Martin Weser[1], Karsten Horn[1], Yuriy Dedkov[1], Elena Voloshina[2], and Beate Paulus[2] — [1]Fritz-Haber Institut der Max-Planck Gesellschaft, Berlin, Germany — [2]Freie Universität Berlin, Berlin, Germany

In order to use graphene in "real-world" application, the influence of ambient conditions has to be examined. We investigate the interaction of small molecules, $H_2O$ and $NH_3$, with graphene/Ni(111) as model for ambient environment. We compare our results obtained with spectroscopical methods (ARPES and NEXAFS) and their comparison with DFT calculations. The live-PES measurements were performed in order to study the growth mode and the amount of adsorbed molecules. For NEXAFS and ARPES experiments we have prepared a reproducible amount of less than one molecular layer of water or ammonia on the graphene/Ni(111) interface. The inert properties of graphene/Ni(111) are confirmed, but we found a weak interaction of the physisorbed molecules with the graphene/Ni(111) system. The DFT calculations with GGA-PBE and PBE-D2 functionals were performed for several system geometries, which are based on the NEXAFS data. From the combination of ARPES and NEXAFS we can compare the experimentally and theoretically obtained electronic structures, to assign possible origins for the obtained interactions.

O 67.6 Thu 12:30 WIL B321

**Structural and Electronic Properties of Graphene - Nanographene Systems** — •Stefan Eilers[1], Stefan Machulik[1], W Ted Masselink[1], Klaus Müllen[2], and Jürgen P Rabe[1] — [1]Institute of Physics, Humboldt-Universität zu Berlin, Germany — [2]Max Planck Institute for Polymer Research, Mainz, Germany

Graphene, because of its unique combination of electronic, optical and mechanical properties, is an attractive electrode for functional molecules. On the other hand, nanographenes can be synthesised with various functionalities, which could find use in applications for future molecular and organic electronics. But can a functional system of graphene and nanographenes be realised? We show that nanographenes can self-assemble on exfoliated monolayer and bilayer graphene to form functional highly ordered molecular layers with defined orientations and electronic properties, largely independent of surface roughness and local environment. We present scanning tunnelling microscopy data at the solid-liquid interface for graphene and nanographene as well as tunnelling spectroscopy data. Graphene as electrode and substrate for aligned layers of functional molecules on insulating wafers offers a wide range of potential applications and the aggregation of functional molecules from solution supplies a basis for future cost-effective production of devices.

O 67.7 Thu 12:45 WIL B321

**Fabrication of metal patterns on freestanding graphenoid nanomembranes** — •Andre Beyer, Andrey Turchanin, Christoph T. Nottbohm, Nils Mellech, Mark Schnietz, and Armin Gölzhäuser — Fakultät für Physik, Universität Bielefeld, Universtätsstr. 25, 33615 Bielefeld

Metallic patterns on freestanding ultrathin supports are desirable for many applications in modern optics or nanomechanics. The authors present four fabrication paths to create gold patterns that are supported by 1 nm thick freestanding graphenoid nanomembranes from self-assembled monolayers. Two fabrication schemes apply resist based lithographic processes to define gold structures on nanosheets. The gold/nanomembrane hybrids are then released from their substrates to form a freestanding structure. In two further fabrication schemes, the direct metal deposition of metal onto a freestanding graphenoid is performed. All four schemes are capable of producing gold patterns on two-dimensional nanomaterials, thus resembling new paths for the routine fabrication of free-floating metallic structures.