Decoupling epitaxial graphene from SiC(0001) surface by a germanium buffer layer — Konstantin Emtesev and Ulrich Starke — Max-Planck Institute for Solid State Research, Stuttgart, Germany

Epitaxial graphene layers formed on SiC surfaces are currently intensively investigated with respect to their electronic, structural, and electrical transport properties [1]. On the SiC(0001) surface graphene layers are separated from the substrate by an interfacial carbon layer. The latter has a graphene-like atomic arrangement with complex (6√3×6√3)R30° periodicity but lacks characteristic π-bands due to strong hybridization with the substrate [2]. In this work we demonstrate that the interfacial layer can be converted into quasi-free-standing graphene upon intercalation of Ge atoms at the interface. The electronic properties of the surface and the atomic structures of the newly formed interfaces were characterized by ARPES, XPS, and LEED. Deposition of germanium on the 6√3/3 reconstructed SiC(0001) surface and subsequent annealing steps were carried out in UHV following Kubler et al. [3]. Decoupling of the interface layer by intercalating Ge atoms begins at temperature of about 700°C as evident by the development of the electronic structure characteristic of a free-standing graphene. Depending on the amount of Ge deposited as well as on the annealing temperature the graphene layer exhibits electron or hole doping.


O 52.3 Wed 15:30 H31

SPM on epitaxial graphene on SiC — Markus Duschl and Franz J. Giessibl — Institute for Experimental and Applied Physics, University of Regensburg, 93040 Regensburg

For some years, graphene has been of wide interest due to its extraordinary properties. First measurements done on exfoliated graphene in ambient conditions indicate that it might be possible to determine the number of graphite layers by force spectroscopy [1]. The stiffness increases with a decreasing number of layers, down to graphene. We compare these measurements to data taken with a combined STM and AFM in UHV at room temperature on epitaxial graphene grown on SiC [2].


O 52.4 Wed 15:45 H31

Defect-induced electron scattering and metal-insulator transition in graphene — Aaron Bostwick, Jessica McChesney, Konstantin Emtesev, Thomas Seyller, Karsten Horn, Stephen D. Keaven, and Eli Rotenberg — 1Advanced Light Source, Lawrence Berkeley Lab, California USA — 2Fritz-Haber-Institut der MPG, Berlin — 3Institut für Physik der Kondensierten Materie, Universität Erlangen — 4Department of Physics, University of Oregon, USA

The influence of adsorbate-induced defects on the electronic properties of graphene are of great current interest. Here we show, using angle-resolved photoemission and conductivity measurements, that potassium and hydrogen adsorption on graphene induce very different types of defects in graphene prepared on SiC(0001). Whereas potassium acts as an electron donor, but causes only weak defect scattering, hydrogen locally saturates a carbon bond. This acts as a lattice defect, leading to a sharp reduction in conductivity, by several orders of magnitude even for coverages below 1% of a monolayer. Angle-resolved photoemission spectra reveal a concomitant change in the electron scattering rate and the dispersion of the graphene bands near the Fermi level. These changes are interpreted in terms of a breakdown of the quasiparticle picture and strong charge carrier localization through the hydrogen-induced defects.

O 52.5 Wed 16:00 H31

Quasi-free Standing Epitaxial Graphene on SiC by Hydrogen Intercalation — Camilla Coletti, Christian Riedl, Takayuki Iwasaki, Alexei A. Zhakhovskii, and Ulrich Starke — 1Max-Planck-Institut für Festkörperforschung, Heisenbergstr. 1, D-70569 Stuttgart, Germany — 2MAX-Lab, Lund University, Box 118, Lund, S-22100, Sweden

Epitaxial graphene grown on silicon carbide (SiC) is an appealing material for future electronic applications. It combines most of the interesting properties of free standing graphene to a manufacturing friendly planar structure. Most of the remaining skepticism towards this material is related to the strong interaction with the SiC substrate. The SiC surface is covalently bound to the first carbon layer, which act as a buffer-layer and therefore fail in displaying graphene properties. The undesired effects originating from this strong coupling, such as intrinsic n-type doping and degraded transport properties, affect the overlying graphene layers. Annealing the samples in molecular hydrogen offers an elegant solution to the problem of graphene-SiC coupling. ARPES, CLPES and LEEM demonstrate that hydrogen atoms migrate through the graphene layers, intercalate between the SiC substrate and the buffer-layer and bind to the Si atoms of the SiC(0001) surface. Thus the buffer-layer, decoupled from the SiC substrate, is turned into a quasi-free-standing graphene monolayer. Similarly, epitaxial monolayer graphene turns into a decoupled bilayer. The intercalation process represents a highly promising route towards epitaxial graphene based nanoelectronics.

O 52.6 Wed 16:15 H31

X-ray absorption and magnetic circular dichroism of graphene/Ni(111) — Martin Weber, Yvonne Rehder, Karsten Horn, Muriel Sicot, Mikhail Fonin, Aleksei Pribravskij, Elena Voloshina, Yuriy Dedkov, — 1Fritz-Haber-Institut der Max-Planck-Gesellschaft, Berlin, Germany — 2Universität Konstanz, Germany — 3MAX-Lab, Lund, Sweden — 4Freie Universität Berlin, Germany

A long electronic mean free path and negligible spin-orbit coupling in graphene render this material ideal for applications based on ballistic transport like the spin filed effect transistor and the perfect spin-filtering device. The model system, graphene/Ni(111), is of special interest, providing an ideal interface between graphene and ferromagnetic material, from a structural point of view. Here we present the studies of the electronic and magnetic properties of the lattice-matched graphene/Ni(111) interface which were performed by means of angle-resolved x-ray absorption spectroscopy (XAS) and x-ray magnetic circular dichroism (XMCD) at the Ni L2,3 and C K absorption edges. The XAS C 1s → π* σ* spectra show pronounced changes as the angle, α, between the electrical vector of the light and surface normal is varied, reflecting the symmetry of the final state. XMCD reveals an induced magnetic moment of the carbon atoms in the graphene layer aligned parallel to the Ni 3d magnetization. Our experimental results are discussed in the light of recent density-functional theory calculations and previous results on the observation of induced magnetism in
An ab initio study of graphene and graphene nanoribbons doped with boron clusters — Cem Özdoğan1, Jens Kunstmann2, Alexander Quandt3, and Holger Fehske3 — 1Department of Computer Engineering, Cankaya University, Ankara, Turkey — 2Institute for Materials Science and Max Bergmann Center of Biomaterials, Dresden University of Technology, Germany — 3Institut für Physik, Ernst-Moritz-Arndt-Universität Greifswald, Germany

We present results from an ab initio study of graphene and graphene nanoribbons (GNR) doped with B7 clusters. We already showed that this system might serve as a blueprint for the controlled layout of graphene based nanodevices, where the semiconducting properties are supplemented by parts of the graphene matrix and the metallic wiring is provided by chains of boron clusters [1,2]. We study how the B7 clusters alter the physical properties of GNRs. A special focus is put on the magnetic properties of zigzag GNRs. [1] A. Quandt, C. Özdoğan, J. Kunstmann, and H. Fehske, Nanotechnology 19, 335707 (2008). [2] A. Quandt, C. Özdoğan, J. Kunstmann, and H. Fehske, phys. stat. solidi (b) 245, 2077 (2008).

Effect of Noble-Metal Contacts on the Electronic Structure of Graphene — Andrei Varykhalov1, Markus R. Scholz1, Timur K. Kiri2, and Oliver Rader1 — 1Helmholtz-Zentrum Berlin für Materialien und Energie — 2Institute for Solid State Research, IFW Dresden

Graphene-metal contacts are crucial for a future planar bipolar nanoelectronics. We investigated these contacts by angle-resolved photoemission at high resolution using noble-metal intercalation. We observe that doping level and band gap depend strongly on which noble metal is intercalated. As predicted from first principles, strong electron doping is provided by Cu (ΔEF ≈ −310 meV) and Ag (≈ −560 meV) but also unexpected large gaps appear (EG = 180 and 320 meV, respectively). Au affects the neutral state of graphene much less than predicted moving the Dirac point ED by only ΔEF ≈ +55 meV above the Fermi level. In order to investigate whether or not graphene/Au is gapless also above ED, we adsorbed potassium and gadolinium on top of the graphene. Both act as efficient donors but potassium opens a substantial band gap due to symmetry breaking while ED is well below EF and gapless after doping by gadolinium. We propose that the large 9 × 9 unit cell of the graphene/Au interface amplifies via quantum interference the decoupling of the graphene from its substrate which leads to the quasifreestanding electronic structure of graphene.

Resonant Raman scattering of chemically functionalized graphene — Nils Schuschnig1, Dimitrios Tasis2, Kostas Papageelis2, and Janina Maultzsch1 — 1Institut für Festkörperphysik, TU Berlin, Germany — 2Materials Science Department, University of Patras, 26504 Patras, Greece

We present resonant Raman scattering of graphene functionalized with polyvinylalcohol (PVA). Raman spectroscopy is a powerful tool for characterization of carbon nanostructures. Functionalization of graphene is a promising way to modify its electronic structure, for example in order to open a band gap. To study the interaction between PVA and graphene with respect to their electronic and vibrational structure, we analyse the Raman spectra of the G mode and the double resonant defect mode. Furthermore, we use tip-enhanced Raman spectroscopy (TERS) for structural and spectroscopic information with high spatial resolution of the sample.