HL 37: Symposium Graphene

Time: Thursday 10:00–12:30 Location: H15

Invited Talk HL 37.1 Thu 10:00 H15

Photoelectron spectroscopy of graphene on SiC: growth, interface, and electronic structure — A. Bostwick[1], K.V. Emtsev[2], K. Horn[3], E. Huwald[4], L. Ley[2], J.L. McChesney[2], T. Ohta[1,3], J. Riley[4], E. Rotenberg[1], •Th. Seyller[2], and F. Speck[2] — [1]Advanced Light Source, Lawrence Berkeley National Laboratory, Berkeley, California, USA — [2]Lehrstuhl für Technische Physik, Universität Erlangen-Nürnberg, Germany — [3]Fritz-Haber-Institut der Max-Planck-Gesellschaft, Berlin, Germany — [4]Department of Physics, La Trobe University, Bundoora, Victoria, Australia

The possibilty to grow well ordered, ultra-thin graphite on SiC{0001} surfaces with thicknesses down to a single graphene layer is promising for future applications. Photoelectron spectroscopy (PES) is a versatile technique for investigating a variety of properties of this system which are of fundamental and technological interest. The talk will survey results from recent PES studies with a focus on the growth of ultrahin graphitic layers, the electronic and structural properties of the interface to the SiC substrate, and the electronic structure of the layers.

Invited Talk HL 37.2 Thu 10:30 H15

Raman Imaging of Graphene — Davy Graf, Francoise Molitor, •Klaus Ensslin, Christoph Stampfer, Alain Jungen, and Christopher Hierold — Physics Department, ETH Zurich

We present Raman spectroscopy measurements on single- and few-layer graphene flakes. Using a scanning confocal approach we collect spectral data with spatial resolution, which allows us to directly compare Raman images with scanning force micrographs. Single-layer graphene can be distinguished from double-and few-layer by the width of the D* line: the single peak for single-layer graphene splits into different peaks for the double-layer. We investigate the D-line intensity and find no defects within the flake. We also present transport measurements through few layer graphene systems. The inelastic scattering length is estimated from measurements of universal conductance fluctuations to be of the order of several micrometers at low temperatures.

INVITED TALK

Invited Talk HL 37.3 Thu 11:00 H15

Electronic confinement and coherence in high mobility epitaxial graphene — •Claire Berger — Georgia Institute of Technology, Atlanta, GA-30332, USA — CNRS-Institut Louis Néel, BP166, 38042 Grenoble cedex 9, France

Transport in ultrathin graphite films grown on single-crystal silicon carbide is dominated by the electron-doped epitaxial graphene layer at the interface and shows graphene characteristics. Epitaxial graphene provides a platform for studying the novel electronic properties of this 2D electron gas in a controlled environment. Shubnikov-de Haas oscillations in the magnetoresistance data indicate an anomalous Berry's phase and reveal the Dirac nature of the charge carriers. The system is highly coherent with phase coherence lengths beyond 1 micrometer at cryogenic temperatures, and mobilities exceeding 2.5 square meters per volt-second. In wide structures, evidence is found for weak anti-localization in agreement with recent graphene weak-localization theory. Patterned narrow ribbons show quantum confinement of electrons. Several Hall bar samples reveal anomalous magnetoresistance patterns consisting of large structured non-periodic oscillations that may be due to a periodic superlattice potential.

Invited Talk HL 37.4 Thu 11:30 H15

News from the quantum Hall effects in graphene — •Uli Zeitler — High Field Magnet Laboratory, Institute for Molecules and Materials, Radboud University Nijmegen, NL-6525 ED Nijmegen

Single-layer and bilayer graphene, only recently synthesized truly two-dimensional crystals [1], display two totally new classes of quantum Hall effects (QHEs). Single-layer graphene can be characterized by chiral massless charged Dirac fermions, leading to a half-integer QHE of four-fold degenerate Landau levels [2,3]. In high magnetic fields (30 T) the QHE persists up to room temperature [4] which may open up new vistas for high temperature quantum metrology. For bilayers, a new-type of integer QHE appears [5] where the $N = 0$ quantum Hall plateau is missing. These observations can be tracked down to relativistic particles with a finite mass. They display an eight-fold degenerate Landau level at zero energy containing both electrons and holes simultaneously.

This work was done in collaboration with Kostya Novoselov, S.V. Morozov, D. Jiang, F. Schedin, and A.K. Geim (University of Manchester); E. McCann and V.I. Fal'ko (Lancaster University) and M.I. Katsnelson and J.C. Maan (Radboud University Nijmegen).

[1] K.S. Novoselov et al., Science 306, 666 (2004). [2] K. Novosolov et al., Nature 438, 197 (2005) [3] Y. Zhang et al., Nature 438, 201 (2005). [4] K. Novosolov et al., to be published. [5] K. Novosolov et al., Nature Physics 2, 177-180 (2006).

Invited Talk HL 37.5 Thu 12:00 H15

The structure of suspended graphene membranes — •J. C. Meyer[1], A. K. Geim[2], M. I. Katsnelson[3], K. S. Novoselov[2], T. Booth[2], D. Obergfell[4], S. Roth[4], C. Girit[1], A. Kis[1], and A. Zettl[1] — [1]Materials Science Dept. Lawrence Berkeley National Laboratory, and Physics Dept. University of California, Berkeley, USA — [2]Manchester Centre for Mesoscience and Nanotechnology, University of Manchester, UK — [3]Institute for Molecules and Materials, University of Nijmegen, Netherlands — [4]Max Planck Institute for solid state research, Stuttgart, Germany

Graphene is a monolayer of carbon atoms that can be viewed as an individual atomic plane extracted from graphite. The charge carriers mimic massless Dirac fermions, and this peculiar electronic structure has been at the focus of the recent interest in this material. But already the structure of graphene is intriguing. The notion of an isolated graphite plane implies a two-dimensional crystal, which can not exist in a free state according to theory. We have now prepared prepared freely suspended graphene monolayers that are not confined in the third dimension, and are attached only at the edges. We investigate structural or mechanical effects of these atomically thin membranes by transmission electron microscopy. Indeed, we observe structural effects that are not found in bulk crystals but are unique to the 2D membrane. The membranes do not remain flat but exhibit random variations in the surface normal of several degrees. This is in qualitative agreement with theoretical predictions for a 2D membrane in a 3D space, however, a rigid theoretical treatment for this particular system is still needed.