HL 60: Graphene: Raman Spectroscopy

Time: Wednesday 15:30–16:45 — Location: ER 164

HL 60.1 Wed 15:30 ER 164

Substrate dependence of the Raman 2D line of graphene — Alejandro Molina-Sanchez[1] and •Ludger Wirtz[1,2] — [1]Institute for Electronics, Microelectronics, and Nanotechnology (IEMN), CNRS, Lille, France — [2]Laboratory for the Physics of Advanced Materials, University of Luxembourg, Luxembourg

We present ab-initio calculations of phonons of graphene on hexagonal boron-nitride which is an example for an ideal flat insulating substrate. The measured double-resonant Raman spectra display shifts of the G and 2D lines comparing, e.g., the spectrum of graphene on silicon dioxide with the spectra of suspended graphene [1] and of graphene on hexagonal boron nitride [2]. In this work, we investigate the influence of the dielectric screening by the substrate on the electron-phonon coupling between the highest-optical phonon branch and the pi-bands of graphene [3]. This enables us to give an explanation for the substrate dependence of the Raman 2D peak position.

References:
[1] S. Berciaud, S. Ryu, L.E. Brus, T.F. Heinz, arXiv:0901.0729v1 [cond-mat.mtrl-sci]
[2] collaboration with F. Forster, A. Meier, K. Watanabe, T. Taniguchi, and C. Stampfer
[3] M. Lazzeri, C. Attaccalite, L. Wirtz, and F. Mauri, Phys. Rev. B 78, 081406(R) (2008).

HL 60.2 Wed 15:45 ER 164

Spatially resolved Raman spectroscopy of graphene on hexagonal boron nitride — Florian Forster[1], Anton Maier[1,2], Kenji Watanabe[3], Takashi Taniguchi[3], and •Christoph Stampfer[1,2] — [1]JARA-FIT and II. Institute of Physics B, RWTH Aachen, 52074 Aachen, Germany — [2]Peter Grünberg Institut (PGI-9), Forschungszentrum Jülich, 52425 Jülich, Germany — [3]Advanced Materials Laboratory, National Institute for Materials Science, 1-1 Namiki, Tsukuba, 305-0044, Japan

Graphene, an one-atom thick hexagonal carbon membrane with unique electronic properties is a promising candidate for high frequency devices and spintronics. However, graphene's ultimate surface to volume ratio makes also the substrate material highly crucial for accessing its full potential. Extensive research on graphene on SiO_2 has shown that the substrate introduces significant disorder, limits carrier mobilities and influences the operation of graphene nanodevices. More recently hexagonal boron nitride has been identified as a promising candidate to overcome some of these limitations. Here we present spatially resolved Raman spectroscopy measurements of single-layer graphene on hexagonal boron nitride substrates, which are compared with measurements of graphene on SiO_2. We show that at micrometer length scales fluctuations of local doping domains are significantly suppressed in graphene on hBN and that the average doping level of as-prepared graphene is reduced on hBN as compared to graphene on SiO_2. Finally we show that graphene flakes on hBN exhibit a significantly increased thermal coupling to the substrate as compared to SiO_2.

HL 60.3 Wed 16:00 ER 164

Resonant Raman scattering profiles and micro-photoluminescence of single- and bilayer molybdenum disulfide — •Nils Scheuschner[1], Oliver Ochedowski[2], Marika Schleberger[2], and Janina Maultzsch[1] — [1]Technische Universität Berlin, Institut für Festkörperphysik, Hardenbergstr. 36, 10623 Berlin — [2]Universität Duisburg-Essen, Fachbereich Physik, Lotharstrasse 1-21, 47057 Duisburg

Due to their intrinsic band gap of approximately 1.9 eV and the lack of dangling bonds, atomically thin layers of molybdenum disulfide appear to be a good complement to graphene. For instance molybdenum disulfide could be used in graphene/molybdenum disulfide heterostructures for energy harvesting to create novel extremely thin photovoltaic devices. For this purpose it is a key requirement to understand the electronic structure and possible excitonic effects of single- and bilayer molybdenum disulfide. We present Raman resonance profiles of first-order Raman modes in the energy range of the first optical transition. Furthermore we present micro-photoluminescence of molybdenum disulfide samples covering a wide range of layer numbers. We will discuss the influence of different substrates on the properties of molybdenum disulfide.

HL 60.4 Wed 16:15 ER 164

Symmetry of phonon modes in functionalized carbon nanotubes — •Christoph Tyborski, Matthias Müller, Janina Maultzsch, and Christian Thomsen — Institut für Festkörperphysik, TU Berlin, Hardenbergstraße 36, 10623 Berlin, Germany

Polarization dependent Raman spectroscopy is used to analyse the symmetry of phonon modes participating in the scattering process of functionalized CNTs on unoriented samples.

In pristine CNTs the Raman signal mainly originates from the (z,z)-matrix element of the A_{1_g} mode. Contrary to unfunctionalized tubes, we found that the contribution of modes with E-symmetry in the Raman signal is slightly higher in functionalized tubes. We attribute this to a break in the high symmetry of CNTs due to functionalization.

HL 60.5 Wed 16:30 ER 164

Interlayer coupling in graphene — •Felix Herziger, Patrick May, and Janina Maultzsch — Institut für Festkörperphysik, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

Raman spectroscopy has reveiled itself as a very versatile tool to investigate the properties of graphene. It is often used to distinguish a monolayer region from regions with more layers by the shape of the 2D band. Without optical contrast or topography measurements, this method is only reliable for layer number identification up to three layers.

Here we report Raman measurements of interlayer vibrational modes in graphene layers with varying thickness. These modes show a clear dependence on the number of graphene layers due to interlayer coupling. Therefore, Raman measurements can be used to identify the number of graphene layers and additionally investigate the interlayer interactions. For more than two layers, the distinction between the number of layers using interlayer modes can be more precise than the usual approach of analyzing the 2D mode.