NANOSCOPY
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Low Temperature Raman Measurements on Layers of Graphene using the attoCFM I.

In this report, we present Raman measurements on layers of Graphene performed with a modified atto**cube** attoCFM I setup. Appropriate laser line filtering as well as an additional spectrometer were used in order to resolve the Raman spectra. The optical resolution of the setup is well below 1 µm, whereas the spectral resolution is better than 1 cm^{-1} at 633 nm.

The Graphene sheets were prepared by micromechanical cleavage, using scotch tape to peel off thin layers from a crystal of natural Graphite. Those layers were transferred to a Si wafer covered with 300 nm SiO_2. The sample was mounted into the attoCFM I and cooled down in a bath cryostat to T = 4.2 K with approx. 10 mbar of Helium as exchange gas. Fig. 1 shows a confocal scan in reflection mode of the sample. Different regions with the bare SiO_2-substrate, or covered with single or bilayer Graphene can clearly be seen due to the optical contrast and can be distinguished using their different Raman spectra. Furthermore, the sheets are partly covering 20 nm deep holes, which were etched into the surface of the wafer. Fig. 2 shows Raman spectra taken of the Graphene 2D band around $1/\lambda \approx 2650$ cm^{-1} at low excitation powers. A HeNe Laser was used as excitation source. The figure shows data from the single and bilayer regions of the sample. Clearly visible is the symmetric line shape of the single layers in contrast to the asymmetric line of the bilayer region allowing for a clear identification of the thickness of the sample. While staying in the single layer region, a spatial scan across one of the holes was performed (see red line in Fig. 1) and the peak position of the respective Raman signal was recorded. The presence of the hole causes a very pronounced shift in the spectrum of about 12 to 14 cm^{-1}, consistent with strain induced Raman shift in the sheet [1].

In summary, Raman spectroscopy is a sensitive tool to distinguish between single and double layer sheets of Graphene. Additionally, a shift of the position of the single layer Raman peak has been shown in regions where the Graphene sheet covers the 20 nm deep holes. As a consequence it is concluded that this shift is due to mechanical stress in the layer, identifying regions with biaxial strain in the graphene sheet.

The data was generously provided by C. Metzger and S. Rémi from the Nanophotonics group of Prof. Bennett Goldberg, Physics Department / Photonics Center, Boston University, USA.

[1] C. Metzger, et al., to be submitted.

RELATED PRODUCTS	
attoCFM I	highly flexible and stable, low temperature confocal microscope
ANPxyz101/LT	high precision, piezo electric,inertial positioner
ANC150	piezo step controller

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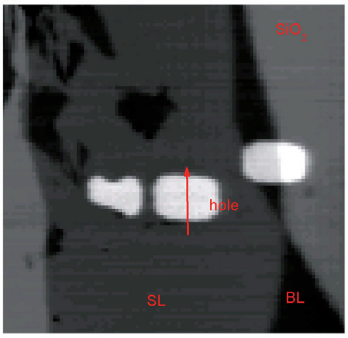

Fig. 1: Confocal scan of a sheet of Graphene on 300 nm SiO_2. The optical contrast allows identifying different regions as substrate (SiO_2), single layer (SL) and bilayer Graphene (BL), as well as three partly covered holes. Scan size: 30 x 30 µm², T = 4.2 K, Excitation = 632.8 nm.

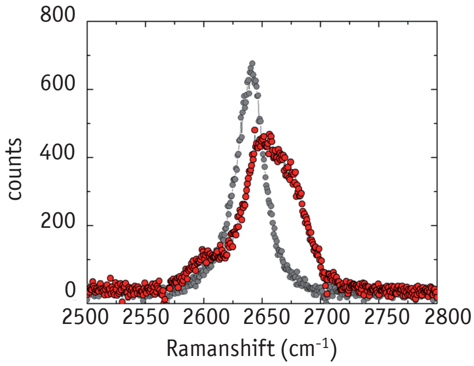

Fig. 2: Raman spectra of the Graphene 2D band for a single layer (black) and a bilayer (red). A HeNe laser was used for excitation, excitation power was P ≈ 200 µW.

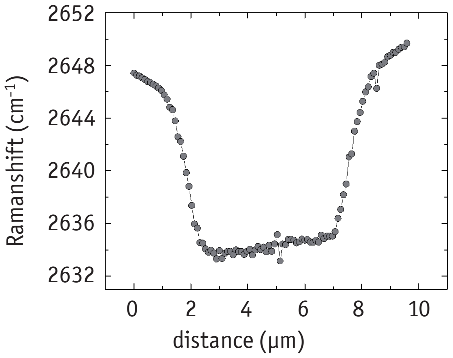

Fig. 3: Position of the 2D Raman band measured along the red line in Fig. 1. There is a clear shift in the position of the Raman peak indicating e.g. stress in the sheet.

Data courtesy of C. Metzger, S. Rémi, and B. Goldberg.

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