

Non- Hydrostatic Pressure dependence of Raman modes in Monolayer Graphene

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Abstract

Raman spectroscopy studies performed in graphene under hydrostatic pressure with diamond anvil cell have shown a great dispersion of the G and 2D pressure coefficients modes [1,2]. Moreover, the information related to the D-band is not accessible due to the presence of the first-order Raman mode (T_{2g}) of diamond in the pressure cell. This dispersion can be attributed to: 1) the different types of substrates used in the experiments; 2) the distinct pressure transmitting media inducing different charge-transfer mechanisms, and 3) the existence of a non-homogeneous distribution of the number of graphene layers in the sample to be analyzed.

Raman spectroscopy experiments on monolayer graphene films subjected to non-hydrostatic conditions have been carried out on anvil pressure cells up to 7 GPa to studying the effect of the pressure/stress on the D, G, D' and 2D graphene bands. In this work we have used single-layer graphene films grown by CVD on copper foil substrate prepared by Graphenea (Spain). Raman images constructed from the spatial distribution of the G and 2D band frequencies and the I_{2D}/I_G intensity ratio have been used to verify the homogeneous distribution of monolayers. Diamond anvils have been substituted by sapphire ones to allow the observation of the D-band and the second-order Raman scattering without signal overlaps [3]. In this experiment the

sample is placed directly between the sapphire anvils without optical pressure sensor (figure 1). The pressure/stress is estimated from the axial (σ_z) and radial (σ_r) stress coefficients, which are calculated from the phonon A_{1g} (417 cm^{-1}) of sapphire. From the results we can obtain the coefficients of axial stress $d\omega/d\sigma_z$ of the different bands of monolayer graphene and have evidences of the formation of nano-domains in the recovered samples at ambient pressure after a cycle of extreme pressure/stress.

References

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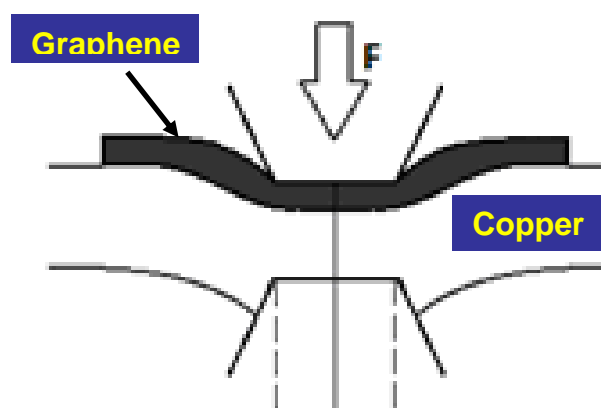


Figure 1: Monolayer Graphene on copper substrate between the sapphire anvils