Non- Hydrostatic Pressure dependence of Raman modes in Monolayer Graphene

J. González [a], R. Valiente [b], F. Rodríguez [a]

[a] Malta-Consolider Team, CITIMAC, Universidad de Cantabria, Santander, Spain
[b]Malta Consolider Team, Departamento de Física Aplicada-IDIVAL, Universidad de Cantabria, Santander, Spain

gonzalezgja@unican.es

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 grapheme 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

[1] J. E. Proctor, E Gregoryanz, K. S. Novoselov, M. Lotya, J. N. Coleman, and M. P. Halsall, Phys Rev B. **80**, 073408 (2009)

[2] Y. W. Sun, W. Liu, I. Hernandez, J. Gonzalez, F. Rodriguez, D. J. Dunstan, and C. J. Humphreys, Phys. Rev. Lett. **123**, 135501 (2019)

[3] E. del Corro, M. Taravillo, J. González , V.G. Baonza, Carbon, **49,** 973 (2011)

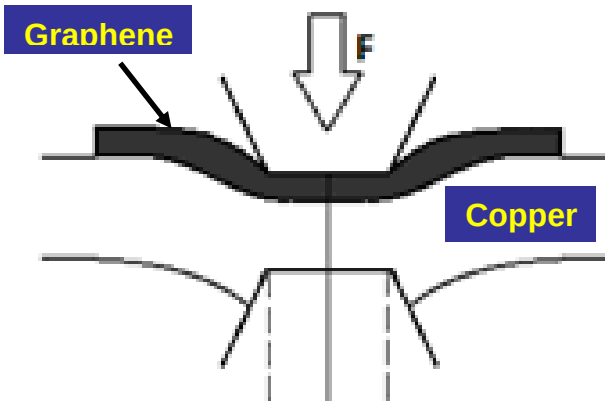

Figure 1: Monolayer Graphene on copper substrate between the sapphire anvils