Decomposing strain and doping in graphene

J. Parthenios, C.Galiotis and K. Papagelis

[1]Foundation of Research and Technology Hellas, Institute of Chemical Engineering and High Temperature Processes, P.O. Box 1414, GR-26504 Patras (Greece)
[2]Department of Materials Science, University of Patras, GR-26504 Patras (Greece)
[3]Department of Chemical Engineering, University of Patras (Greece)
jparthen@iceht.forth.gr

Abstract

Following its first isolation in 2004, graphene has shown huge potential in both fundamental studies and industrial applications. Vast research efforts have revealed a great deal of the unique electronic, optical and mechanical properties of graphene. Typically, graphene is tested and characterized on graphene-coated substrates. These are made by either mechanically exfoliated of graphite crystals onto various substrates or synthesizing graphene in a furnace using chemical vapour deposition (CVD) on a copper foil, which acts as a catalyst, and then transferring the as- prepared graphene sheet to the target substrate using wet chemistry. Normally, biaxial strain and unintentional doping is imposed to the transferred graphene flake due to the substrate interaction, various adsorbents, and resist/process residuals. Raman spectroscopy has proven to be a versatile analytical tool in graphene metrology for measuring thickness, stacking, defect density, charge density, mechanical strain, temperature, etc. Such sensing functionality, however, turns into difficulty when more than a single parameter has to be determined [1]. For instance, upon uniaxial strain both G and 2D bands frequencies decrease [2,3]. On the other hand, G band frequency increases for either p or n doped graphene due to the modification of phonon dispersion close to the Kohn anomaly. On the contrary, for p doped graphene the 2D band upshifts in an almost linear fashion, while for n-doped is highly nonlinear.

In this work, a methodology based on the correlation of Pos(2D) *vs* Pos(G) for decomposing strain and unintentional doping in supported single layer graphene is presented. It is found that for pure mechanically loaded and undoped single layer graphene the slope in the Pos(2D) – Pos(G) correlation diagram is 2.2-2.5 independent of the substrate and the origin of the stress field (Fig. 1). It is, finally shown, that the methodology can be successfully applied even in supported graphene under uniaxial loading and strains higher than 0.2%, where G band splits.

References

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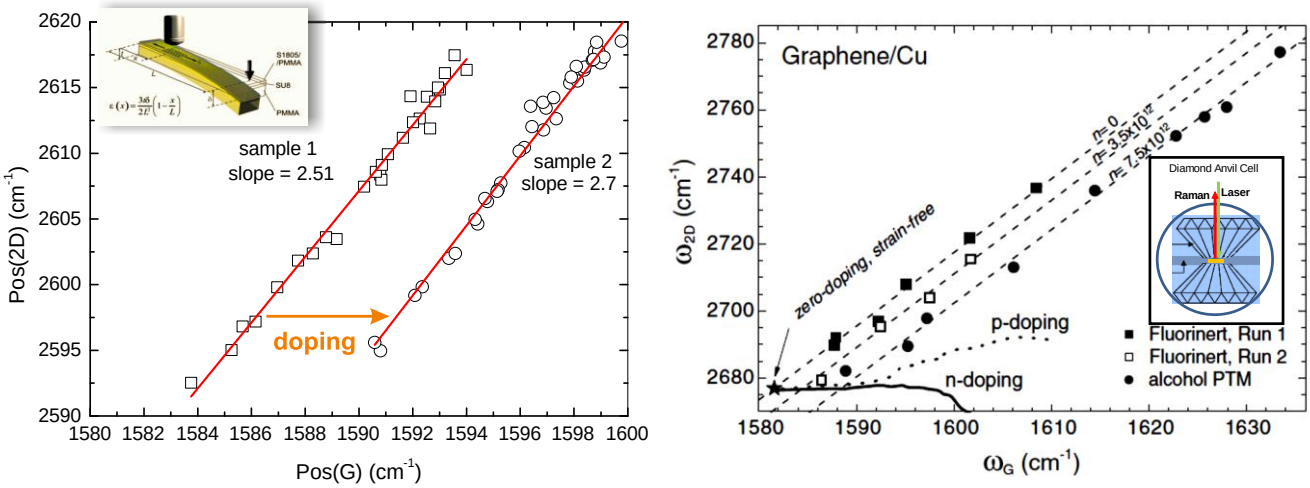

Fig. 1 Pos(2D) vs Pos(G) for single layer graphene under (a) uniaxial compression and (b) hydrostatic pressure[4]