

Pressure dependence of Raman modes in Graphene Oxide (GO)

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GO is a water-soluble nanomaterial prepared through extensive chemical attack of graphite crystals to introduce oxygen-containing defects in the graphite stack. In GO, a large fraction (0.5–0.6) of carbon is sp³ hybridized and covalently bonded with oxygen in form of epoxy and hydroxyl groups. The remaining carbon is sp² hybridized and bonded either with neighboring carbon atoms or with oxygen in the form of carboxyl and carbonyl groups, which predominantly decorate the edges of the graphene sheets. GO is therefore a 2D network of sp² and sp³-bonded atoms, in contrast to an ideal graphene sheet, which consists of 100% sp²-hybridized carbon atoms. This unique atomic and electronic structure of GO, consisting of variable sp²/sp³ fractions, opens up possibilities for new functionalities. The most notable difference between GO and mechanically exfoliated graphene is the optoelectronic properties arising from the presence of a finite band gap [1]. In this work we have used a solution of GO prepared by GRAnPH Nanotech (Spain). The samples are characterized by high resolution transmission electronic microscopy, photoluminescence and Raman spectroscopy. In the Raman spectrum of graphene oxide the G band is broadened and shifted to 1594 cm⁻¹ whereas the D band at 1363 cm⁻¹ becomes the prominent feature in the spectrum indicating the creation of sp³ domains due to the extensive oxidation (see figure 1). The intensity ratio of the D and G bands is a measure of the disorder, as expressed by the sp²/sp³ carbon ratio. In order to investigate their structural stability unpolarized room temperature Raman spectra excited with 514 nm were studied at high pressures. Typical diamond anvils used in high pressure experiments have been substituted by moissanite (6H-SiC) anvils to allow the observation of the D band (around 1360 cm⁻¹) and the second-order Raman scattering without interference [2] (figure 2). Up to 15 GPa we found a pressure coefficient of 6.2 cm⁻¹GPa⁻¹ for the tangential G band and 4.1 cm⁻¹GPa⁻¹ for the D band (figure 3). No pressure-induced structural phase transition was observed in the studied pressure range.

References

1. D. W. Boukhvalov, M. I. Katsnelson, J. Am. Chem. Soc. **130**, 10697 (2008)
2. E. del Corro, M. Taravillo, J. González, V.G. Baonza, Carbon. **49**, 973 (2011)

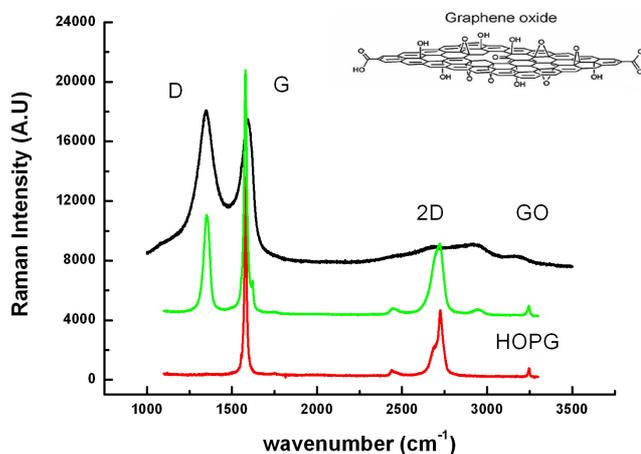


Figure 1: Raman spectra of GO at normal pressure

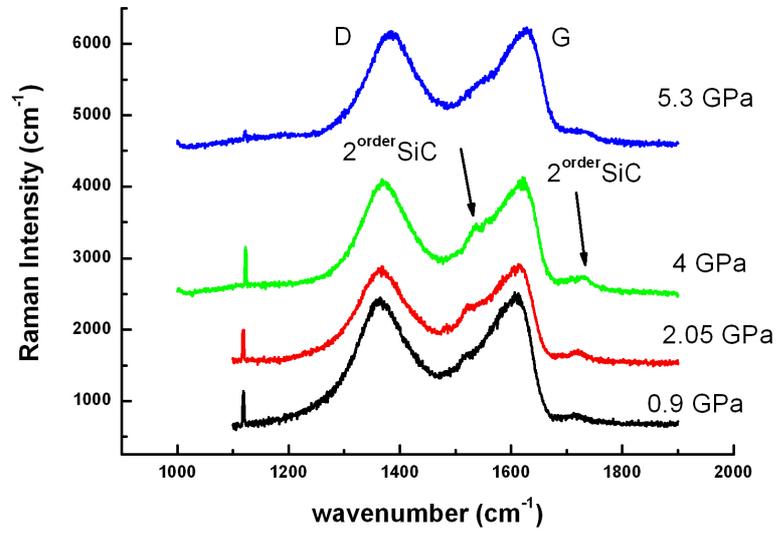


Figure 2: Raman spectra of GO at different pressures

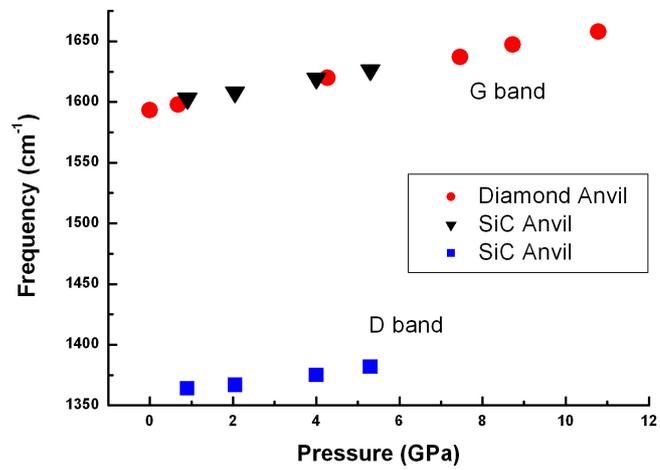


Figure 3: Pressure dependence of D and G bands of GO