Raman study of $^{12}C/^{13}C$ Double Layer Graphene

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Graphene is one of the most promising materials for revolutionizing contemporary technology. Growth of large area single layer graphene (SLG) has been facilitated by the use of copper substrates. [1] Double layer graphene (DLG) differs from SLG as a gap opens in the electronic structure, crucial for nanoelectronic applications. In this context, the properties of the constituent layers of DLG and interlayer interaction are of particular interest. Raman spectroscopy is the tool of choice for the identification and study of graphene through the most prominent G and 2D Raman bands. [2] Here, we present our Raman study of DLG/Cu grown by chemical vapour deposition in a chamber operating at 1273 K, resulting in DLG regions with the lower layer consisting of ^{13}C and the upper of ^{12}C isotope atoms. [3] The isotopically marked carbon layers enable their optical spectroscopic discrimination. Four characteristic sample areas are identifiable by mapping and careful analysis of the frequencies and line shapes of the Raman bands: SLG and DLG solely consisting of ^{13}C as well as DLG $^{12}C/^{13}C$ layers with turbostratic (t) or AB (bernal, b) stacking (Fig. 1).

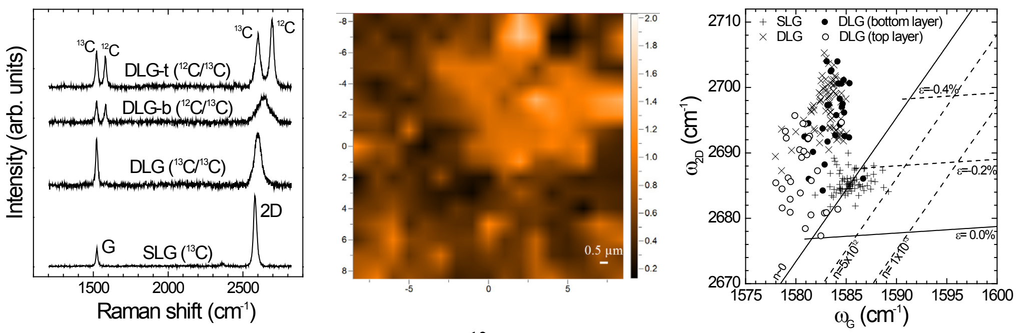

Figure 1: Indicative Raman spectra, $I_G(^{12}C)/I_G$ map and mass normalized ω_{2D}-ω_G plot.

The ω_{2D}-ω_G plot has been proved very useful in deducing the local strain and doping state of SLG. [4] Although such a diagram is not appropriate for quantitative data interpretation for DLG, it can provide a qualitative picture of the interactions involved. Our Raman data can be introduced in the plot by appropriate mass normalization of the ^{13}C peak frequencies. The SLG appears compressively strained with small-to-zero doping. As for the DLG data, they lie outside the strain/doping grid, which should be interpreted as a consequence of the interlayer interaction. They group in two distributions with their relative position indicating a higher strain of the bottom layer that can be understood as a consequence of the substrate-graphene interaction. Further, isotopic marking permits to separately follow the pressure evolution of the two layers. Their G band pressure slopes are similar to each other and to that of the SLG (~10 cm^{-1}/GPa), suggesting that it is the substrate that determines the pressure response in both systems.

References

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