Combined Raman spectroscopy and reflectance measurements to define a standardized method to determine the number of graphene layers for few-layer graphene

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Abstract

Raman spectroscopy of graphene-related materials (GRM) is considered as a fast, versatile, powerful and non-destructive characterization technique. Raman signal is sensitive to the number of layers, their stacking order, the nature and density of defects, the charge carrier density and in-plane strain variations. However, the positions, linewidths, profiles, intensities of the graphene/few-layer graphene (FLG) Raman bands are not only affected by all these perturbations but also depends on the uniformity across the probed area and on the substrate (through optical interference effects, dielectric screening…). An accurate interpretation of Raman spectra becomes then extremely complex and deserves the combined use of complementary diagnosis.

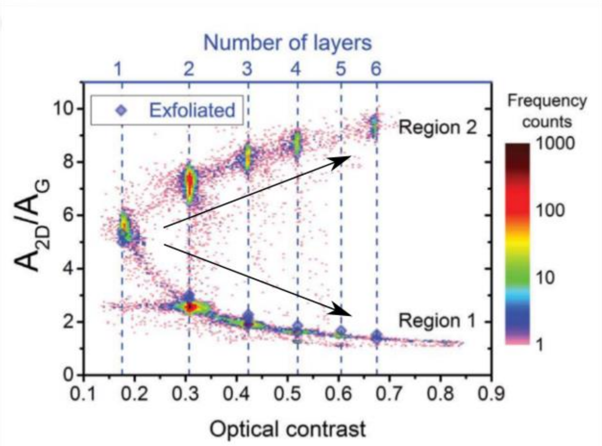
In this work, we present studies carried out with a home-made set-up combining optical contrast and micro-Raman mapping experiments. Typical sample map consist of about 70k spectra and can be obtained with up to 5 different laser wavelengths covering the visible range, allowing us to obtain statistically robust results.

FLG samples prepared by two methods (chemical vapor deposition (CVD) followed by transfer onto SiO_2/Si substrate and mechanical exfoliation) have been analyzed to discuss the relevant parameters for standardization concerns. In particular, we will discuss, for different stacking orders, the validity domain and the behavior of the integrated intensity ratio of the 2D and G bands (A_{2D}/A_G), of the 2D band width and of the normalized G-band integrated intensity (A_G/HOPG) as a function of the number of layers (N) which was determined independently.[1] The current status of measurements of the A_G/HOPG and optical contrast in various experimental configurations (wavelengths, numerical aperture…), for FLG produced by different methods (mechanical exfoliation, CVD, SiC sublimation…) and different substrates (SiO_2/Si, glass, SiC, Cu…) will be presented and compared to theoretical models.

References

[1] Bayle, M., Reckinger, N., Huntzinger, J.-R., Felten, A., Bakaraki, A., Landois, P., Colomer, J.-F., Henrard, L., Zahab, A.-A., Sauvajol, J.-L. and Paillet, M. (2015), Phys. Status Solidi B. doi: 10.1002/pssb.201552204

Figures



2D bivariate histogram of the (A_{2D}/A_G) ratio plotted as a function of the number of layers, presenting two opposite behaviors in different regions of the same sample.