The correlation between electrical conductivity and second-order Raman modes of laser-reduced graphene oxide

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Graphene, a two-dimensional (2D) sheet of sp^2-hybridized carbon, has fuelled the interest of the scientific community especially considering that it has been intensively investigated since 2004 due to its unique and useful properties. In this regard, graphene oxide (GO), has also attracted the interest of the community working on these novel 2D materials. In particular, since graphene oxide has several advantages over graphene such as: easy and inexpensive production and water solubility. One of the most significant benefits that GO has over graphene is the possibility to easily control the electrical conductivity, hydrophilicity, and degree of transparency by tuning its level of oxidation. The so-called reduced graphene oxide (rGO) is made after a chemical, thermal, or light irradiation treatment. rGO has inspired a significant number of graphene-based devices including transistors and various types of the sensors. Raman spectroscopy is the tool of choice in the analysis of carbon nanomaterials. In particular, the degree of reduction of rGO by Raman spectroscopy was previously investigated by Claramunt et al. They reported that there are three other bands D*, D', D'', that need to be considered in the analysis of the Raman spectra from rGO samples. It was reported the correlation between the oxygen content and the positions of D* and D''. The dependency of these bands on the degree of reduction reflected by the oxygen content was verified by X-ray diffraction. However, we found that in many cases such analysis is not sufficient, due to the large uncertainties in the fitting of interbands for the analysis of rGO made by laser reduction. In this work, we report a systematic investigation of laser-reduced rGO patterns by Raman spectroscopy. Using different laser irradiation allowed us to control the degree of reduction in the rGO patterns. The electrical conductivity of the different rGO patterns was evaluated by sensing current atomic microscopy (CSAFM). A further step will be presented correlating the different laser irradiation parameters, degree of reduction, and electrical conductivity. This work opens the door to the fast and accurate investigation of rGO micropatterns made by laser irradiation using an alternative analysis based on Raman spectroscopy.

References

[1] S. Claramunt, A. Varea, D. López-Díaz, M. M. Velázquez, A. Cornet and A. Cirera, J. Phys. Chem. C, 2015, 119, 10123–10129.

Figures

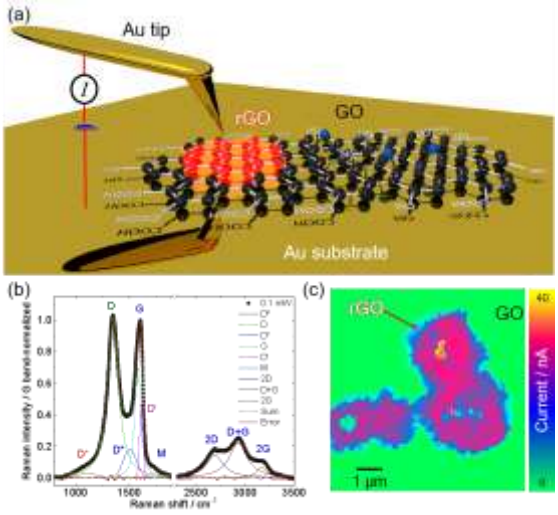

Figure 1: (a) Schematics of the laser patterning reduction of GO. (b) Raman and (c) One CSAFM result on GO film