Improvement of the transfer process of CVD graphene

Sergi Claramunt[a], Qian Wu[a], Marc Porti[a], Narcis Mestres[b], Montserrat Nafría[a], Xavier Aymerich[a]

[a]Electronic Engineering Department, Universitat Autònoma de Barcelona, 08193 Bellaterra, Spain
[b]Institut de Ciència de Materials de Barcelona, ICMAB-CSIC, Campus de la UAB, 08193 Bellaterra, Spain
sergi.claramunt@uab.cat

Abstract

From the very beginning, graphene has shown incredible electrical properties [1]. Different electronic devices, like radiofrequency transistors, actuators, sensors, etc. may benefit of the inclusion of graphene as a material in the device. There are different approaches for the synthesis of graphene, but, for electronic applications, one of the preferred methods is the chemical vapor deposition (CVD) process [2]. Its main drawback is that it is necessary to separate the graphene layer from the Cu foil that acts as a catalytic seed. Nowadays various methods exists to do this process, and the most common used at laboratory scale is the spread of a PMMA layer over the graphene and then etch away the Cu foil [3]. Afterwards, the PMMA/Graphene stack can be deposited over the substrate objective. Finally, the PMMA layer is dissolved using acetone to uncover the graphene layer that will be ready for further treatment. Although with this method of separation we may obtain fairly good graphene layers, we detected some issues that affect its final quality and the reproducibility of the graphene layer transference. For example, the flexibility of the PMMA/graphene stack may favor the formation of wrinkles during the transference process that can prevent the contact between the graphene layer and the substrate, increasing the chances of the generation of defects and holes (Fig. 1a). Moreover, we also found that another source of defects is the PMMA cleaning. Usually, the PMMA is eliminated using acetone, which is very effective for this polymer. But because of the fast reaction, chunks of the graphene layer can be stripped out, especially if the contact with the substrate is not good. Also, it is known that acetone cannot eliminate completely PMMA, leaving a residue that in some cases can be detected by Raman spectroscopy (Fig. 2a).
In this work we propose the addition of several steps to the standard process in order to improve the transference of a CVD graphene layer. First of all, after the PMMA/graphene stack is deposited over the substrate, the system is heated in order to relax the PMMA layer. In this way, the number of wrinkles will be decreased, assuring an intimate contact between the graphene layer and the substrate. After that, the PMMA layer is eliminated using acetic acid instead of acetone. With this solvent we achieve two things: first, a slower reaction, lowering the possibility of the stripping of the graphene during the layer dissolving process (Fig. 1b) and second, using acetic acid we ensure a good cleaning of the graphene layer (Fig. 2b), avoiding any additional annealing step. By adding and combining these two simple steps, the quality of the final graphene layer is improved and the repeatability of the process assured. Optical microscopy, Raman spectroscopy and Atomic Force Microscopy analysis show that the final graphene layer is almost continuous, with all the defects concentrated on the edges of the graphene layer.

References

[1] K.S. Novoselov et.al., Science, **306** (2004) 666.
[2] Li, X. S. et al., Science **324**, (2009) 1312.
[3] Reina A. et. al, J Phys Chem C **112** (2008) 17741.

Figures

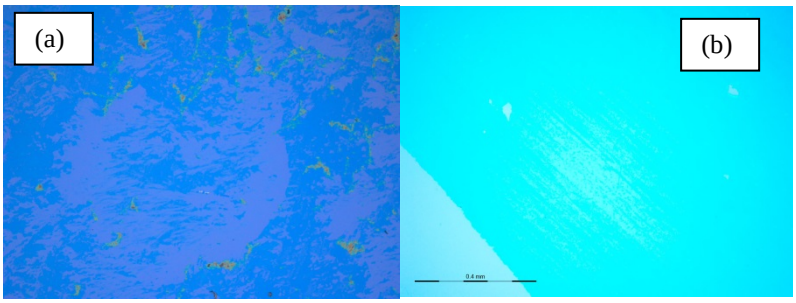

Fig. 1. Optical images of a graphene layer transferred using the standard method (a) and with our proposed additional steps (b)

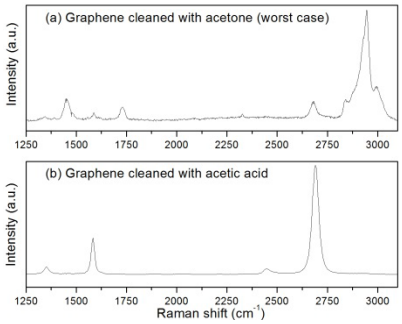

Fig 2. Raman spectra of graphene cleaned with (a) acetone and (b) acetic acid.