Contamination-free suspended graphene structures by a Ti-based transfer method

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Abstract

Since its first discovery in 2004 [1], graphene has attracted great interest because of its exceptional physical and chemical proprieties [2]. Protocols for the production of high quality and large area of layer graphene foils have been developed using Chemical Vapour Deposition (CVD) on metal substrates, such as nickel and copper [3]. However, in order to integrate graphene on functional devices, these layers should be detached from the growth substrate and transferred to the device surface, preserving graphene mechanical and chemical properties and avoiding contaminations. The most diffused methods are based on the use of a thin sacrificial layer of poly(methyl methacrylate) (PMMA), but the removal of PMMA residuals after transfer is an unsolved problem [4], and requires the use of high temperature annealing or other harsh protocols. A sacrificial Titanium layer deposited between graphene and PMMA has been proposed as an efficient approach to improve the cleaning of the surface [5]. Unfortunately, big limitations arise when suspended graphene has to be produced, for the back surface often results contaminated by the dissolved PMMA. Here we present a new PMMA-free method of commercial CVD-grown graphene transfer from Cu to a Silicon substrate, which can be used for the fabrication of both supported and suspended graphene layers. The approach involves the deposition via electron-beam evaporation of a 15 nm-thick Ti layer on graphene growth on a Cu foil. A suitable transfer method of graphene on patterned Si substrates has been performed; this involves an overnight etching of Cu after which graphene is rinsed in DI water and deposited on the substrate by direct fishing into the water. DI water and HF solution allows to remove the Ti obtaining ultraclean graphene structures. X-ray photoelectron spectroscopy measurements performed at BACH beamline at Elettra Syncrotrone was used to prove the surface cleaning of the obtained samples. X-ray absorption spectroscopy confirmed also that traces of Ti and F after metal etching are not present.

References

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Figures

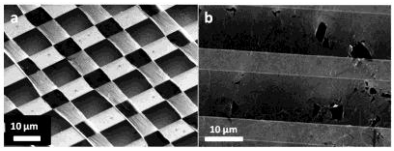

Fig. 1: SEM images of suspended graphene transferred with: (a) polymer; (b) Titanium.

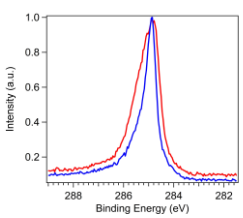

Fig. 2: XPS spectra of C1s of polymer-free graphene (blue curve) and polymer graphene (red curve).