Surface doping of exfoliated and CVD graphene on Si/SiO_2 substrate

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Graphene is a very special material, since it has the advantage of being both conducting and transparent. It has received much interest due the combination of extremely high mobility of carriers up to $2.5x10^5$ $cm^2V^{-1}s^{-1}$ and Young's modulus values up to 1 TPa. There are mainly two approaches to produce large area (<50x50μm^2) graphene membranes, namely the mechanical exfoliation method where graphene can be detached from an already existing graphite crystal ("HOPG" or "graphenium flakes") and the chemical vapor deposition (CVD) method where the graphene membrane can be grown directly on the top of a metallic substrate. In contrast to traditional semiconductors, the two-dimensional structure of graphene confines the doping process to surface adsorption or edge decoration. Dyes, polymers as well as fused aromatic systems have been used to realize *n*-type and *p*-type doping in the liquid phase [1, 2].

In this work, we present the gradual *p*-type doping of large area exfoliated flakes (Monolayer(1LG), Bilayer(2LG), Trilayer(3LG)) and CVD graphene transferred onto Si/SiO_2 wafers. In this approach, HNO_3 molecules are thermally deposited to form self-assembled charge transfer complexes. The charge transfer mechanism is experimentally interrogated by Raman spectroscopy. Raman spectroscopy, owing to its sensitivity on the structural and electronic characteristics of graphene, has been proven to be a valuable non-destructive tool to detect, among the others, the doping state of graphene by probing the changes of the so-called G and 2D Raman active bands [3].

Figure 1(Left panel) shows the optical microscope image of large bilayer graphene onto Si/SiO_2 substrate, which has an area of about 100x50μm^2 indicated by the closed red line. In figure 1(Right panel) the frequency position and the full width at half maximum (FWHM) of the G band for untreated and doped CVD graphene is presented. As can be clearly inferred from the figure the G band characteristics are position dependent and show a clear trend as a function of the doping level.

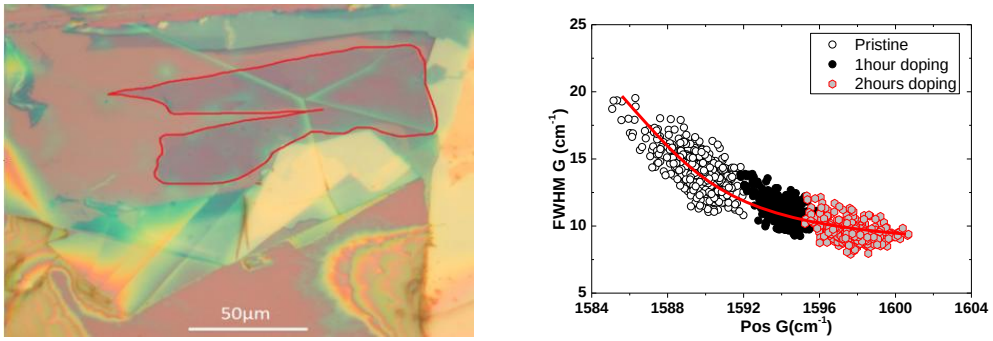

Figure 1: (Left panel) Optical micrograph of large area bilayer graphene(~85μm) laying on the top of Si/SiO_2 substrate. (Right panel)Pos(G) as a function of FWHM(G) for CVD graphene before and after two doping steps (λ_{exc} = 514 nm).

References

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