CVD synthesis of graphene from acetylene catalyzed by a reduced CuO thin film deposited on SiO_2 substrates

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Abstract

Chemical vapor deposition (CVD) synthesis is a technique widely used to grow graphene on metallic substrates such as Copper (Cu) and Nickel (Ni). Copper, unlike nickel, allows better control of the growth of graphene due to the low bulk carbon solubility. Copper has been extensively researched in the last decade as a substrate for graphene (mono- and poly-crystalline), in the form of foil or thin film grown in High Vacuum (HV) or Ultra High Vacuum (UHV) conditions [1-3]. Direct deposition of graphene on dielectric surfaces is of great interest given their potential use in sensor fabrication and electronic or optical applications [4-8].

In this study direct growth of graphene or few-layer graphene (FLG), without any transfer process onto a silicon dioxide (SiO_2) substrate by CVD was used. An intermediate thin film of cupric oxide (CuO), pre-deposited by DC sputtering was applied as catalysts. Unlike e-beam evaporation or resistive evaporation, DC sputtering is fast and easy to implement at industrial level. Figure 1 represents a schematic picture of the surface after growth is completed, revealing the possibility of finding a complex structure at the surface interface

CuO was used as a catalyst precursor and acetylene as the carbon source for growth using chemical vapor deposition. By raising the temperature the CuO thin layer was partially reduced to Cu in a H_2 environment. The oxide is reduced preferentially on the surface, generating a metallic layer on top of the oxide. During graphene growth, oxygen from the metal oxide may diffuse to the surface thus changing the catalytic properties of the metallic layer. After graphene growth, the reduced Cu layer is almost completely evaporated from underneath the graphene layer. When the process is completed, graphene lies mostly in contact with the SiO_2 dielectric layer. Raman spectroscopy (λ= 633 nm) was used to characterize and confirm the presence of a single and/or few-layers of graphene. This procedure has the advantage of not requiring any post processing to transfer the thin film onto a dielectric substrate or the use of ultra-high vacuum during synthesis.

The growth and deposition of graphene on SiO_2 by CVD, has been carried out without any additional chemical or transfer procedure.

References

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Figures

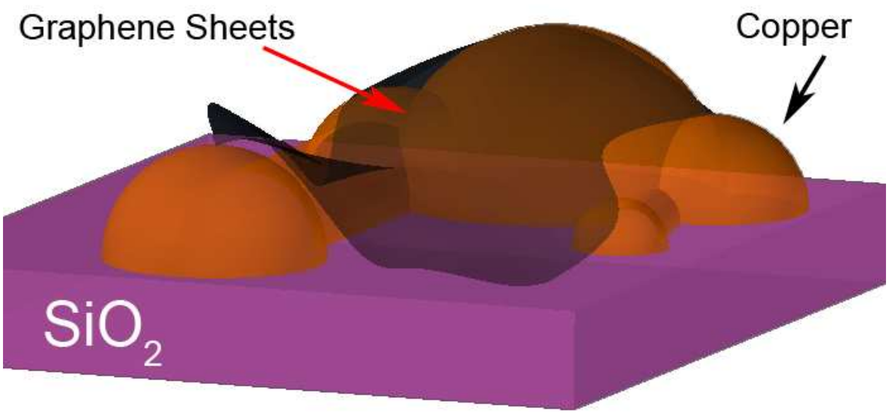

Figure 1. The schematic image of a graphene sheet grown on SiO_2 partially covered by Cu. Magenta, brown and the black transparent surface represent respectively SiO_2, the Cu agglomerates and the graphene sheets.

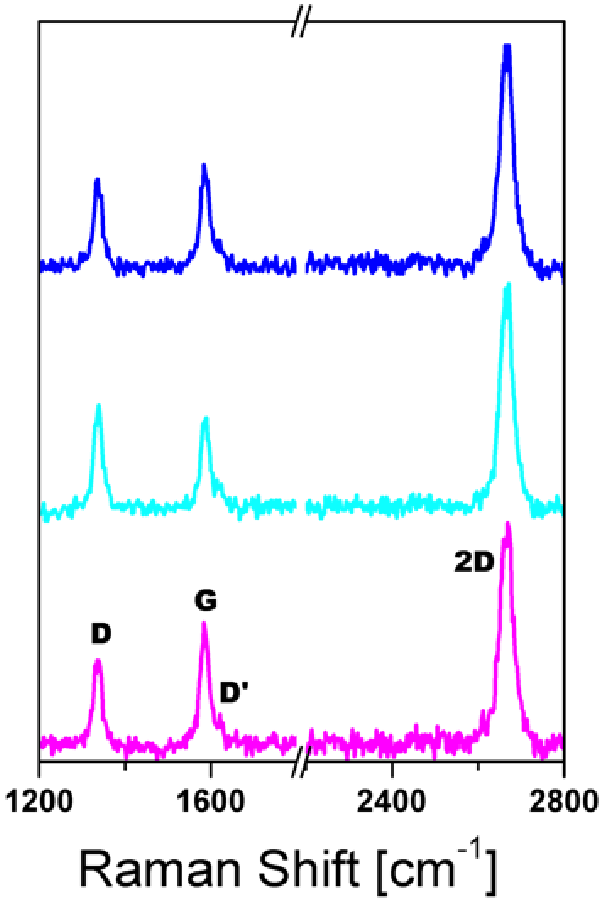

Figure 2. Graphene Raman shift on SiO_2, recorded on different sections of the surface The first spectrum is consistent with a bilayer graphene. The last two spectra corresponded to single layer graphene.