Graphene synthesized by Atmospheric Pressure Chemical Vapour Deposition

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Our investigation is concentrated on the growth of graphene by atmospheric pressure chemical vapour deposition (APCVD) technique. This method is technologically more attractive for large scale production of graphene because it is inexpensive and readily accessible way for the growth of reasonably high quality graphene on the different metal substrates [1-3]. Most of the CVD growth methods use polycrystalline Ni or Cu films/foils, but Cu seems to be the best candidate for making large-area graphene films. Because of a low solubility of carbon in Cu (in comparison with Ni), the growth is restrained to the surface of the catalyst, thus allows the formation of single layer graphene (SLG) [3]. Under atmospheric pressure, methane and hydrogen gas mixtures at various ratios are used in the CVD process with a temperature ranged between 800-1000°C [3-4]. Mainly all of successful results were obtained for graphene deposited onto the Cu foils [5-6]. Another promising approach is to use metal films heteroepitaxially deposited on conventional single crystalline substrates as reported for the Co and Ni [7-8]. Using epitaxial Cu(111) deposited on c-plane sapphire, high quality SLG can be synthesized [9-10].

The proposed route of making graphene is based on the combination of plasma vapour deposition (PVD) and APCVD synthesis. The PVD technique is used to tailor the catalysts in order to allow the formation of uniform Cu films with required properties for graphene film grown on it. The APCVD technique implies the controlled synthesis of such film with fixed number of graphene layers. The effect of different parameters during the preparation of catalysts or/and the synthesis of graphene investigated using optical and electron microscopies (SEM and TEM), AFM, X-ray photoelectron spectroscopy (XPS) and Raman spectroscopy characterizations.

Our studies are focused on adjusting APCVD for graphene growth on Cu catalysts. First of all sputtering route of catalyst preparation allows us to control the size and the shape of graphene films deposited on it. Additionally, this method allows the flexibility of transferring as-produced film to alternative substrates by wet-etching of the Cu catalysts. Based on our experience acquired in the past on the APCVD growth of carbon nanotubes, we tried to adjust CVD parameters for graphene formation. But actually, a key challenge for as-synthesized graphene concludes not only in finding the CVD conditions but also in tailoring the catalyst deposition. For the synthesis of graphene, catalyst deposition must be tuned to formation of uniform SLG film which should save continuity, flatness and homogeneity even after high temperature CVD process. To reach so, the best catalysts could be heteroepitaxial metal films.

References

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Figures

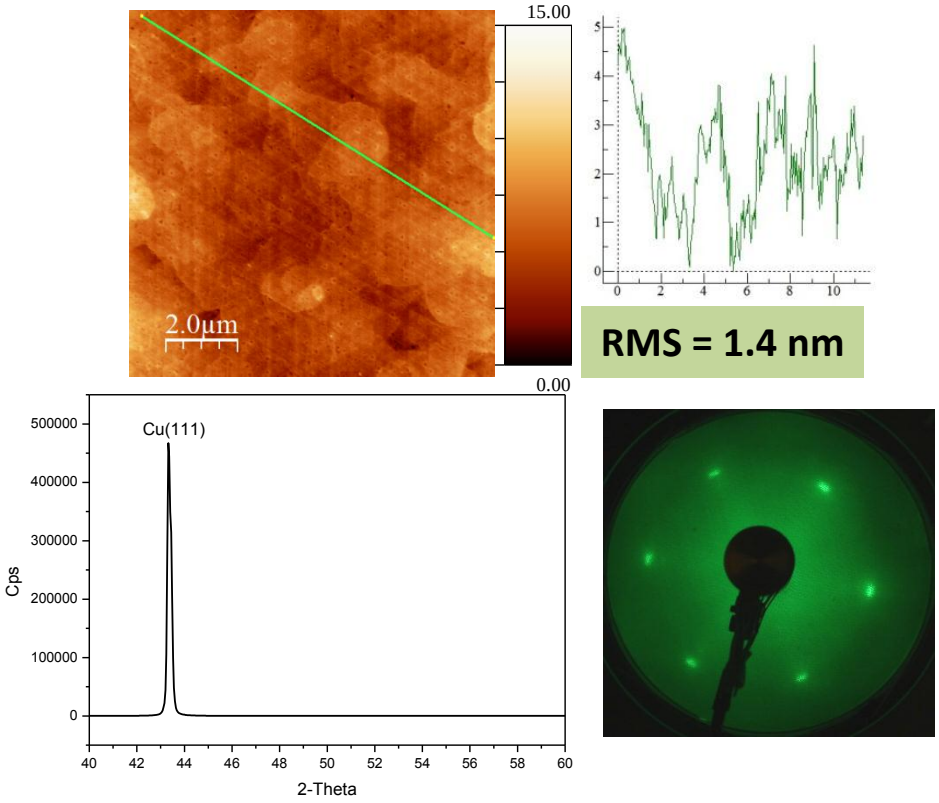

Fig. 1. AFM image and Roughness, XRD pattern and hexagonal LEED pattern of epitaxial Cu(111) on sapphire.

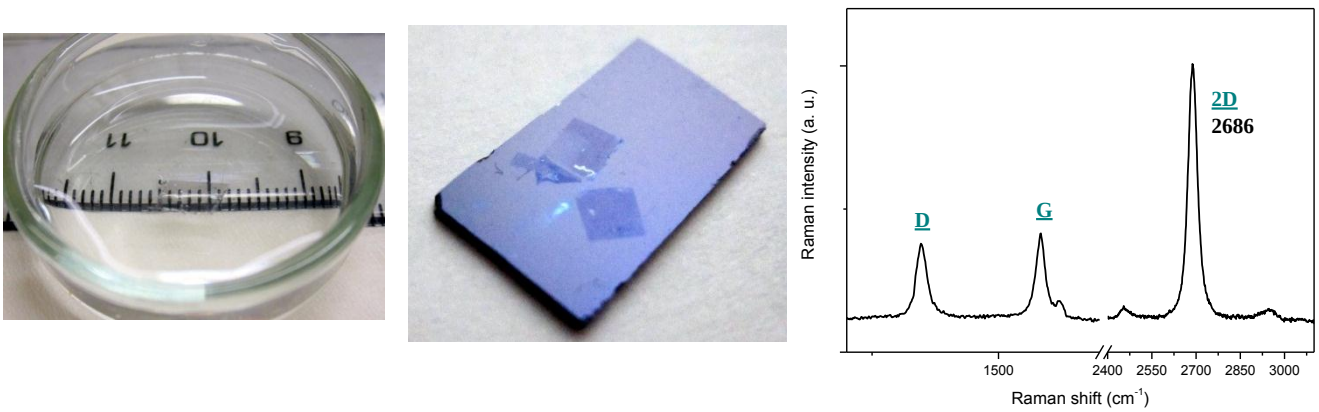

Fig. 2. Optical images of etching solution with graphene film supported by PMMA in it, transferred film onto the Si/SiO_2 and Raman spectrum of as-transferred graphene.