Growth of Few Layer Single Crystal and Coalesced Graphene Grains on Platinum by Chemical Vapour Deposition

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Abstract

Graphene, one atom thick sp2-bonded graphite, received the attention of different disciplines of physics because of its marvelous properties [1–4]. To fully utilize the graphene in industry, fabrication of high quality graphene is essential. The most promising method to grow large area graphene on metal catalysts is chemical vapour deposition (CVD) [5-7]. The problem widely faced by the scientific community in the CVD growth is the presence of crystallographic graphene domains. The growth of graphene is initiated at different nucleation sites on the metal catalyst which give full coverage with the increase in growth time but also promote the growth of few layer grains having different crystallographic orientation. During the growth procedure, nucleation density of graphene played an important role because it controls grain boundaries which would affect the quality of graphene. The material properties like mechanical strength, mobility, doping percentage and thermal transport are greatly affected by these grain boundaries [8]. A lot more still needs to understand about the growth parameters and the nucleation of domains.

The present work is about the growth of few layer single crystal graphene grains on Pt foil via chemical vapour deposition. The optical microscope images of the graphene grains show Bernal and twisted layer stacking. Grain boundaries of Pt provide low energy sites to the carbon species and the nucleation of grains are more at the boundaries. The stacking order and the number of layers in grains can be seen more clearly with scanning electron microscopy. 2D Raman peaks show dispersive nature for Bernal stacked grains and were fitted with four Lorentzian peaks. The shift in the 2D Raman peak clearly indicates the different stacking sequences in different grains. Atomic force microscopy analysis showed an increasing trend in grain height profile with an increase in the number of layers. Moreover, different coalesced grains showed clearly different stacking sequences and merging of different nucleation sites of different grains. We observed Bernal AB and twisted layer stacking in the grains when they were combining together in order to grow into a bigger size. The full width at half maximum (FWHM) value of 2D Raman peaks appeared in the range of 52-69 cm^{-1} which showed an increase from the value of single layer graphene (30.18 cm^{-1}) and identify Bernal stacking in grains. In twisted stacking, FWHM values lie in the range of 19 -32 cm^{-1}. Raman contour mapping also helps in understanding the number of layers.

References

[1]. Novoselov K, et al., Science 306 (2004)666–9

[2]. Geim A K, Science 324 (2009)1530–4

[3]. Novoselov K, Rev. Mod. Phys. 83 (2011)837–49

[4]. Bonaccorso F, et al., Nature Photon. 4 (2010) 611–22

[5]. Reina A, et al., Nano Lett. 9 (2009) 30.

[6]. Li X et al., Science, 324 (2009) 1312.

[7]. Kim KS et al., Nature 457 (2009) 706.

[8]. Vlassiouk I, et al., Nanotechnology 22 (2011) 275716