Nobel Photocatalytic Method to observe grain boundaries of large-area graphene on Copper by optical microscopy

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Abstract

It is well known that CVD graphene films grown on copper are polycrystalline in nature and that its properties depend on grain boundaries and defects. Several methods and techniques have been applied to study the presence of graphene grain boundaries and resulting domain sizes. Atom resolution complex techniques like STM and TEM allow visualization of individual atom placement inside graphene lattice but are in practice limited to areas under 1 micrometer. There is still a lack of a convenient detection technique for simple large-area graphene grain boundary observation that allow straightforward graphene crystal size quality control. In 2012 two methods were reported to reveal domains and grain boundaries of graphene on copper by optical microscopy: (i) Thermal oxidation [1] in air at 160ºC followed by H_2O_2 treatment; (ii) Photo-oxidation [2] by UV light through grain boundaries in a humidity controlled chamber. Thermal oxidation it is particularly useful to reveal graphene coated areas, but it has a poor resolution for grain boundary analysis. Photo-oxidation successfully reveals grain boundaries and defects, however causing excessive damage to copper substrate.

Our group have developed a photocatalytic oxidation method using TiO_2 suspensions in water at room temperature to produce a highly controllable mild oxidation of copper through graphene defects. Fig 1 shows optical microscope images of original CVD graphene on copper and graphene grain boundaries revealed by different oxidation techniques. It can be observed that photocatalytic technique yields a controlled oxidation of copper, better suited for grain size statistical analysis.

References

[1] C. Jia, J. Jiang, L. Gan, and X. Guo, Sci. Rep., “Direct optical characterization of graphene growth and domains on growth substrates.,” **2**(2012) 707.

[2] D. L. Duong, G. H. Han, S. M. Lee, F. Gunes, E. S. Kim, S. T. Kim, H. Kim, Q. H. Ta, K. P. So, S. J. Yoon, S. J. Chae, Y. W. Jo, M. H. Park, S. H. Chae, S. C. Lim, J. Y. Choi, and Y. H. Lee, Nature, “Probing graphene grain boundaries with optical microscopy.” **490**(2012) 235–239.

Figures

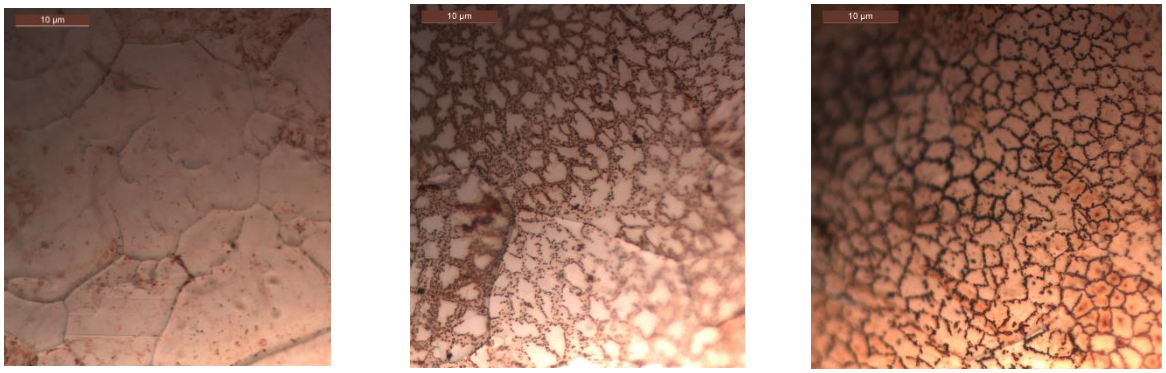

Fig 1. From left to right: (i) Original graphene on copper, (ii) thermal oxidation of copper through graphene, (iii) catalytic photo-oxidation of copper through graphene.