Graphene on Conducting and Insulating substrates by Mechanical Beating Method

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Abstract

Graphene is nothing but an atomic thick sheet of sp^2-hybridized carbon atoms densely arranged in a hexagonal lattice. Even though graphene is an extremely thin material, the wonderland of this thinnest material has a variety of unique properties such as high electron mobility, large surface to volume ratio, high transparency to visible light, high thermal and electrical conductivity. The existence of multifunctional properties makes graphene as an incredible candidate in research domain with many potential applications range from electronics, optoelectronics, energy storage devices and biological studies.

At first, research grade graphene has been fabricated on dielectric substrates using mechanical exfoliation method. By days, the field of synthesis of graphene has been branched vastly such as exfoliation and epitaxial growth. The methods of fabrication of graphene have their own pros and cons with respect to the need of applications. The exfoliation the top-down approach which can be achieved by both physical and chemicals methods such as mechanical exfoliation and liquid-phase exfoliation. The innovation of new methods to modernize and simplify the fabrication process of graphene is still in the developing state.

With this in mind, we have come up with another mechanical exfoliation approach namely graphite beating. Mechanical beating is one of the oldest methods which has been followed for making thin gold leafs. Here, we have mechanically beaten the graphite powder that kept on the molybdenum and cellulose acetate polymer sheet and then beaten for various time durations. This mechanical force given to graphite powder on the foresaid substrates result in the formation of thin layers of exfoliated graphene flakes. The effect of mechanical beating on the exfoliation of graphene has been analyzed by optical, atomic force and field emission scanning electron microscopic techniques as shown in figures 1, 2 & 3 respectively. Further, the defect levels have been investigated using XRD and Raman spectra. Graphene on flexible substrate shows ohmic I-V characteristics after the coating of graphene through mechanical beating method. Graphene layers can occur due to the dislocations/defects introduced in the graphite by mechanical pressure. The energy delivered during beating can be enough to slide down the graphene layers which has been hold by weak van der Waal forces and the *ab*-plane sp^2 bonding (σ_C-σ_C) can also be broken by this mechanical pressure. This covers the whole substrate uniformly even graphite powder placed at the centre. The mechanism involved in graphite beating and its characteristics will be presented in detail.

References

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2. A. K. Geim, K.S. Novoselov, *Nat. Mater.* **6** (2007) 183.
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Figures

Fig.1. Optical images of graphene and graphite flakes directly coated on Mo substrate by mechanical beating method.

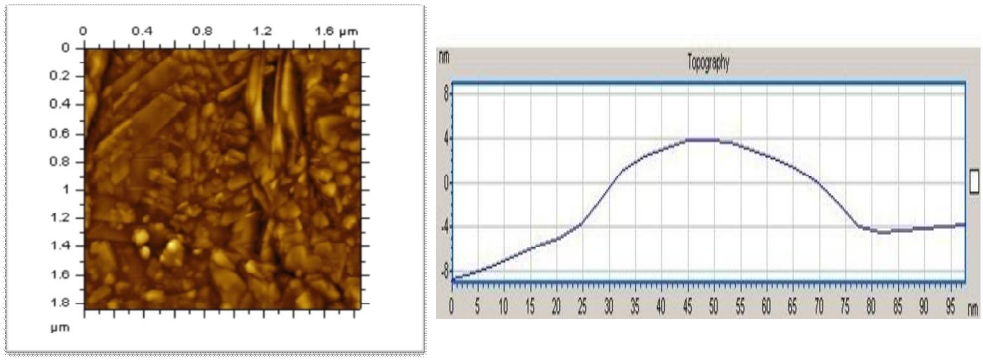

Fig.2. Atomic force microscopic image of graphene sheets directly coated on Mo substrate by mechanical beating method.

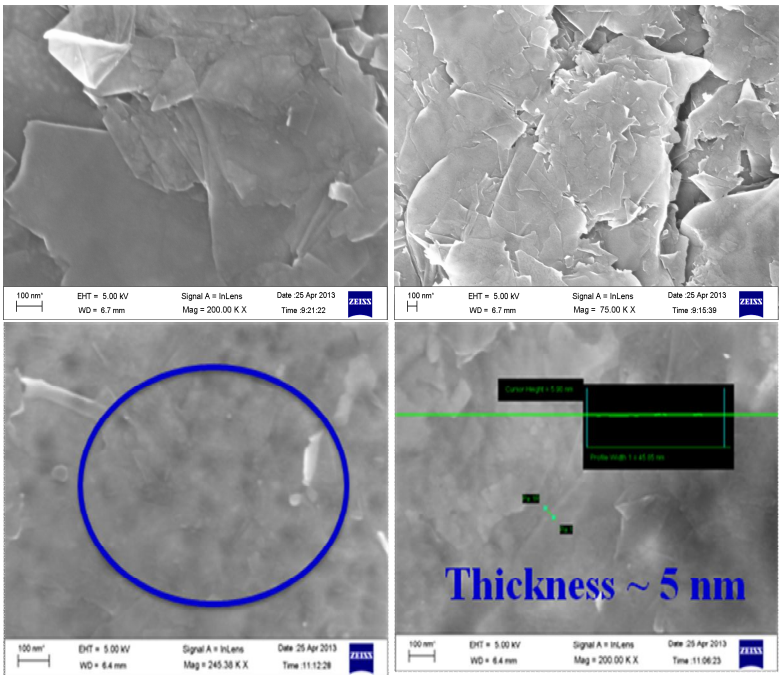

Fig.2. FESEM images of graphite flakes and graphene sheets directly coated on Mo substrate by mechanical beating method.