Few-layer Graphene Sheets by Liquid Phase Exfoliation in a Low Boiling Point Solvent: A Comparative Study of Three Different Graphite-based Starting Materials

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Graphene is a promising material in many applications due to its unique electrical, thermal and mechanical properties. However, these properties and the yield of graphene show variations depending on which graphene production route is used. Liquid phase exfoliation routes may allow one to produce graphene in large scale for applications such as nanocomposites, thin films and conductive inks. The critical point in liquid phase exfoliation is to be able to increase graphene concentration as much as possible while maintaining the quality of graphene flakes. Graphite can be exfoliated into high-quality graphene sheets (with <5 layers) in 1-methyl-2-pyrrolidone (NMP) due to well matched surface energy between graphene and the solvent [1]. Therefore, it is one of the most widely preferred organic solvent for sonication assisted liquid-phase exfoliation of graphene from graphite. However, high boiling point (~204°C at 760 mm Hg) of NMP makes it difficult to be completely removed from the system and the residual solvent can be detrimental for composites. Moreover, this may cause problems during flake deposition onto a substrate, since agglomeration tends to occur during the slow solvent evaporation [2]. Hence, exfoliating graphite in a low boiling point solvent to give graphene dispersions with a concentration as high as possible would facilitate incorporation of graphene into composites and deposition onto substrates.

In this study, three different graphite-based materials (expandable graphite and two different nano-graphite powders) were investigated as starting powders for the liquid phase exfoliation in isopropyl alcohol (IPA) (82.5°C boiling point) within relatively short sonication times (up to 120 min). The prepared dispersions were analyzed and compared in terms of their graphene concentration, stability, number of graphene layers, quality and the electrical conductivity of the prepared graphene-

based materials using techniques such as UV-Vis absorption spectroscopy, Raman spectroscopy, transmission electron microscopy (TEM) and Four Point Probe method.

References

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