Mechanism of pristine graphene stabilization via polymer physisorption in water media for graphene content enhancement

Ying HUO
Bérangère TOURY, Sheng YUAN, Stéphane BENAYOUN, Bernard NORMAND
Université de Lyon, 20 avenue Albert Einstein, 69621 Villeurbanne cedex, France
Ying.huo@ec-lyon.fr

Abstract

Compared to chemically modified graphene, pristine graphene displays better properties especially in electric and mechanic fields. However, due to the hydrophobic surface of graphene and Van der Waals forces occurring between layers, graphene can be only slightly dispersed in high boiling point solvents and aggregation can be easily formed during storage.[1] Instead of using environmentally disastrous organic solvent or surfactant, polymer stabilizers can assist the layered materials to disperse in low boiling point solvents with a higher nanosheet concentration and a better stability. [2] Appropriately, exfoliated graphene stabilized by polymers is an ideal starting material for composite preparation. In this study, we chose water, an eco-friendly solvent in which graphene is almost insoluble and polyvinyl alcohol (PVA) as stabilizer for its good solubility in water. By a simple liquid phase exfoliation (LPE) of graphite in PVA solution, a high content of dispersed graphene can be obtained. The experimental results also show that graphene concentration is variable with polymer concentration. In optimized conditions, a dispersion at molecular scale with a graphene content in polymer matric can reach up to 80wt.%. We provided a better understanding in the stabilization mechanisms of graphene solution by polymer intermediates. Here the interaction parameter of polymer-surface and the molar weight of polymer are two parameters determining the facility of the polymer adsorption. These parameters can be used to select the suitable combination of 2D materials/ polymer/ solvent. We believe that this work establishes a theoretical support and a principle in materials choice for 2D materials-polymer composite application.

References

[1] J. Kim, S. Kwon, D.-H. Cho, B. Kang, H. Kwon, Y. Kim, S. O. Park, G. Y. Jung, E. Shin, W.-G. Kim, H. Lee, G. H. Ryu, M. Choi, T. H. Kim, J. Oh, S. Park, S. K. Kwak, S. W. Yoon, D. Byun, Z. Lee, C. Lee, Nature Communications 2015, 6.
[2] Y. T. Liang, M. C. Hersam, Journal of the American Chemical Society 2010, 132,

Figures

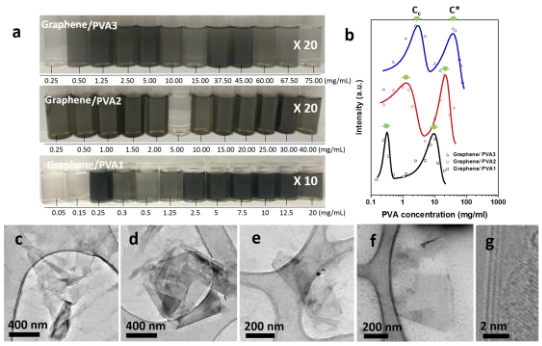

Figure 1: Graphene stabilized by PVA in water media. (a) Images of the colloid of graphene in PVA1, PVA2 and PVA3 solution after dilution 10 (x10) and 20 times (x20). (b) UV-visible light absorption of graphene at = 660 nm curve versus PVA concentration. (c-f) TEM images of typical graphene obtained for Cp = 0.25, 1.25, 5 and 20 mg/ml. (g) Flodden graphene flake with 3 atomic layers.