Graphene from graphite: the "wet" approach

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Graphene, being the youngest extensively studied carbon allotrope, offers unprecedented physical properties for high-performance applications in the field of molecular electronics. From the known graphene production methods, i.e. the "top-down" exfoliation of graphite (mechanical in the solid state or chemical in solution) and the "bottom-up" direct synthesis of extended polyaromatic hydrocarbons, the "wet" chemical approach offers the most promising opportunities for macroscale graphene production, with fineSt tuning of the conditions and, consequently, properties of the material obtained.

Our work is aimed at finding best systems (type of graphite and solvent or surfactant) for graphene solution production, and learning about the nature of the interactions which facilitate and enhance graphene exfoliation.

For the first time, electronic communication involving π-π interactions between graphene and a perylene derivative has been proved to occur in an organic solvent [1] (N-methylpyrrolidone), previously this phenomenon reported for probes deposited on substrates in the solid state only [2]. By a set of titration experiments, the relative quantum yield of the fluorescent dye was shown to decrease to 65% on interacting with graphene. Several complementary characterization methods were used: UV/Vis absorption, fluorescence and Raman spectroscopy, optical (white light and fluorescence) microscopy, and high resolution TEM.

In addition, an overview of different grades of graphite will be presented, regarding their easiness of dispersion and exfoliation in a few solvents (aqueous and organic) by stirring (no ultrasonication). The relation between "carbon uptake" into the solvent and "exfoliation" will be discussed, and whether these two parameters vary simbate. A number of graphite grades characteristics (origin and type of production or post-treatment, grain size, surface area, spectroscopic data, etc.) will be correlated with physical and thermodynamical solvent properties. Problems arising during characterizing graphite/graphene dispersions by common colloidal chemistry techniques will be addressed in the light of the non-equilibrium nature of graphene solutions and dispersions.

[1] N.V. Kozhemyakina, J.M. Englert, G. Yang, E. Spiecker, C.D. Schmidt, F. Hauke, A. Hirsch, *Adv. Mater.* **22**, 5483 (2010).

[2] L. Xie, X. Ling, Y. Fang, J. Zhang, Z. Liu, *J. Am. Chem. Soc.* **131**, 9890 (2009).