OBTAINMENT OF HIGH CONCENTRATION OF GRAPHENE AND DIRECT PREPARATION OF ITS POLYMER NANOCOMPOSITES

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Nowadays, graphene is certainly the most investigated material for its promising properties and potential applications. This became particularly evident after that Andre Geim and Konstantin Novoselov were awarded the 2010 Nobel Prize in Physics *"for groundbreaking experiments regarding the two-dimensional material graphene"*.

However, the development of graphene-based technologies is dependent on an efficient approach for obtaining graphene sheets in large quantities. In particular, the methods used for its preparation are: mechanical cleavage of graphite [1], epitaxial growth using chemical vapor deposition [2] and thermal fusion of polycyclic aromatic hydrocarbons [3].

On this respect, the exfoliation of graphite in a liquid medium to form single or few-layered graphene sheets may represents an alternative and promising route. Initially, the only way for reaching this goal was to oxidize graphite to graphene oxide (GO), which is much easier to exfoliate in a proper solvent. GO is then reduced to give the desired graphene. [4] However, the number of synthetic steps envisaged by this approach suggested some researchers to find easier alternative routes.

More recently, following the first example of Hernandez et al. [5], other groups succeeded in dispersing graphene obtained directly from graphite without any chemical modification. [6-11] In this communication we show how we succeeded in easily obtaining graphene dispersed in several liquid media. In some of them, the concentrations reached are higher than those reported in literature, thus demonstrating that the technique used is both easy and very effective.

Because of the large concentrations reached also in some reactive media, the so-obtained graphene was also directly used in polymer nanocomposite preparations in which the dispersing medium is also one of the reactive components in the polymer synthesis.

Among the others, the reactive media used are: acrylates, diols, diisocianates and epoxides, which are typically used for the obtainment of polyacrylates, polyesters, polyurethanes and epoxy resins. Furthermore, the use of high concentration graphene dispersions in alkoxysilanes allowed us obtaining graphene-based polymer hybrids by sol-gel synthesis.

The first results on the thermal, mechanical and functional properties of these polymer materials will be also presented.

The method used for preparing high graphene concentrations is the following: graphene dispersions were obtained by mixing the desired amount of graphite (5 wt.-% respect to the weight of a proper solvent or monomer) and solvent or monomer in a tubular plastic reactor (i.d. 15 mm) placed in an ultrasonic bath (0.55 KW, water temperature $\approx 40\ ^{o}$C) for 24 h. Then, they were centrifuged for 30 min at 4000 rpm; the gray to black liquid phase containing graphene was eventually recovered. As an example, the TEGDA based polymer nanocomposite containing graphene was prepared by adding an initiator (trihexyltetradecylphosphonium persulfate, TETDPPS) to the TEGDA/graphene dispersion. The mixture was polymerized in an oven at 80 ^{o}C for 1 h. The concentration of TEGDA used in this graphene-polymer nanocomposite was 4.7 mg/ml.

References

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