Exfoliation of graphite using pyrene and perylene derivatives

Eunice Cunha[1], M. Conceição Paiva[1], M. Fernanda Proença[2], Rui Araújo[2]

[1] Instituto de Polímeros e Compósitos/I3N, Universidade do Minho, Campus de Azurém, 4800-058 Guimarães, Portugal

[2]Centro de Química, Universidade do Minho, Campus de Gualtar, 4710-057 Braga, Portugal

eunice.cunha@dep.uminho.pt

Abstract

Since the isolation of graphene by mechanical exfoliation of graphite in 2004 [1] this material has been the focus of research among the scientific community. The excellent electronic, mechanical, thermal and optical properties of graphene [2] have reveled huge potential applications in various fields such as energy storage, [3,4] composite materials [5] and sensor technology [6]. However, the production of graphene in large scale, with controlled quality and reasonable cost, is still a goal to achieve and became an important target and research topic.

The large scale graphene production processes are based on the conversion of SiC (silicon carbide) to graphene via sublimation of silicon at high temperature, chemical vapor deposition (CVD) growth, oxidation of graphite followed by exfoliation and reduction of the oxidation products, and exfoliation of graphite in organic solvents with high surface tension. These methods lead to large scale production, but present some disadvantages namely the high cost, or the production of graphene with structural defects or contaminants which are difficult to remove. [7]

Some aromatic compounds such as pyrene and perylene derivatives, functionalized to render them amphiphilic, have been reported to effectively stabilize carbon nanotubes in aqueous suspensions. [8,9] Recently, the production of graphene based on graphite exfoliation through non-covalent interactions between graphene/pyrene and graphene/perylene derivatives was also reported.[10] This approach promotes the exfoliation and stabilization of graphene in water, leading to the production of few- and single- layer graphene without damaging its structure.

The present work reports the preparation of stable aqueous suspensions of few-layer graphene using low concentration solutions of pyrene and perylene derivatives. The suspensions were analyzed by UV-Visible spectroscopy. The graphene-based materials deposited on surfaces were analyzed by Raman spectroscopy, showing the effectiveness of the exfoliation of pristine graphite. TEM images of the suspensions illustrate the formation of few layer graphene. Figure 1a presents the Raman spectra of graphite and few-layer graphene obtained by exfoliation with a pyrene derivative (Py-XGnP), and Figure 1b illustrates the TEM observation of the Py-XGnP.

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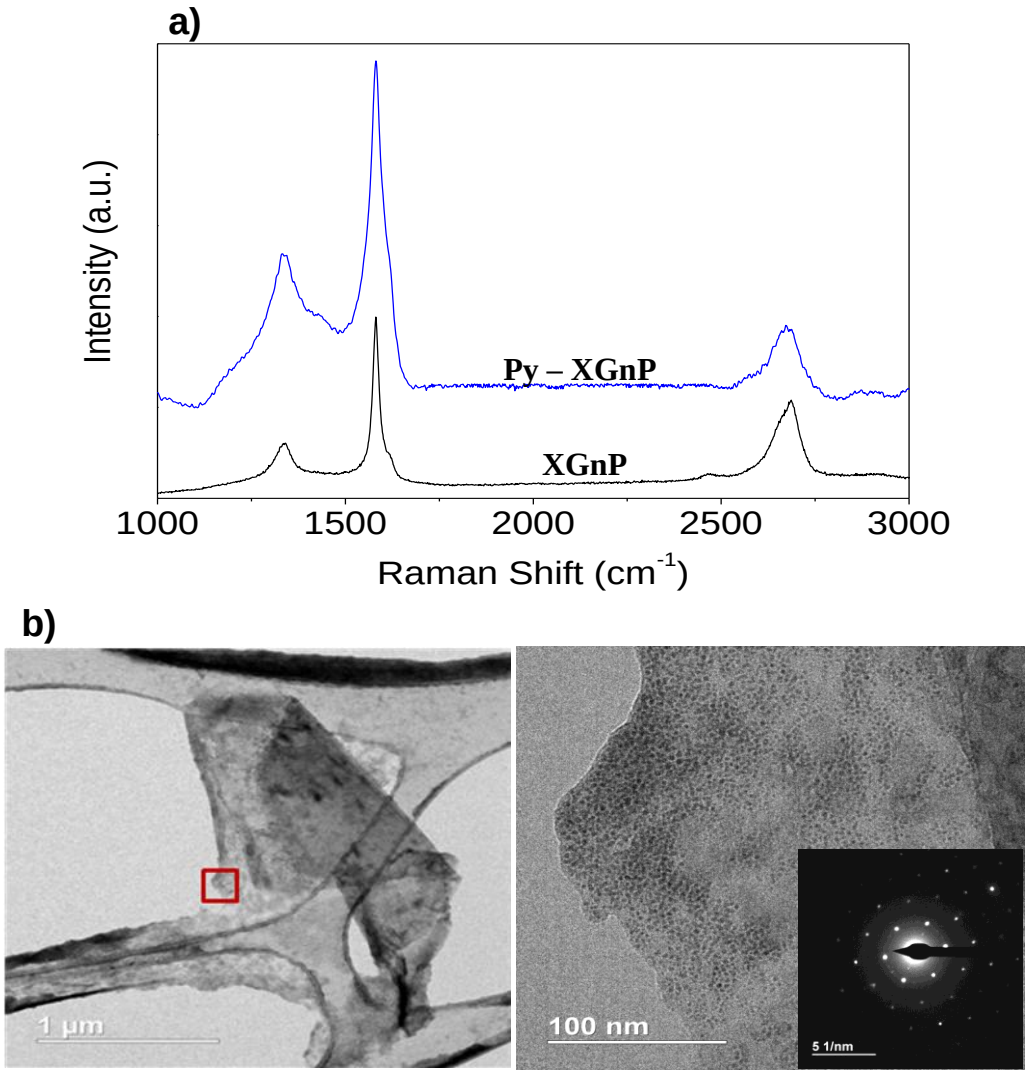

Figure 1: a) Raman spectra of pristine graphite (XGnP) and exfoliated graphite using pyrene derivative (Py-XGnP); b) TEM image of Py-XGnP (on the left), magnified TEM Image (on the right) and XRD pattern of magnified Py-XGnP TEM image.