Graphene and graphene-based multifunctional nanocomposites obtained as thin, transparent and conductive films: from preparation to applications

Aldo J.G. Zarbin
Eduardo G.C. Neiva, Rodrigo V. Salvatierra, Marcela M. Oliveira, Victor H.R. Souza, Jessica E. Fonsaca, Lais C. Lopes, Elisa S. Orth.

Department of Chemistry, Federal University of Paraná (UFPR), Curitiba-PR, Brazil.

aldozarbin@ufpr.br

We are reporting during the last years that liquid-liquid (L/L) interfaces are suitable confined medium to stabilize unprocessable materials as thin and transparent films, easily transferable to several ordinary substrates, enabling their studies in thin films-based devices. Here we will demonstrate the chemical (bottom up) synthesis of graphene starting from its simplest monomer (benzene), yielding the largest graphene sheets chemically synthesized ever reported (> 1 μm^2) [1]. The use of benzene as precursor is an important breakthrough in the chemical synthesis of graphene, due the simplicity, cheapness and availability of benzene (compared to the sophisticated molecules usually employed as precursor). Also, we will demonstrate the first total chemical synthesis of graphene/polymer nanocomposites (graphene/polythiophene and graphene/polyaniline) [2,3], in which both the components are synthesized together, in one-pot, from their individual monomers, directly processed as thin films at the L/L interface.
The innovative synthetic approach to achieve complex through the L/L route will also be demonstrated in the preparation of graphene-based nanocomposites thin films with i) conducting polymers [2,3,4], ii) metal nanoparticles [5], and iii) nickel hydroxide [6], yielding complexes and multifunctional materials. The transference of the obtained films to different kind of substrates (plastics included), the control of the film characteristics (thickness, transparency, conductivity, adhesion to substrate) and the fully characterization of the materials (using microscopic, spectroscopic and electrochemical techniques) will be discussed.
Besides the fully preparation and characterization details, we will demonstrated the application of these materials as: i) transparent electrodes [7]; ii) electrodes for alkaline and ion-Li batteries [6]; iii) electrochromic materials [2,6]; iv) sensors [6]; v) active layers in photovoltaic devices [2]; vi) SERS substrates [5]; vii) supercapacitor [3] and vii) catalysts [5], with improved and unusual performances.
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