Chemical and electrochemical grafting of polyaniline onto nanodiamond: Preparation of robust conducting materials

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Nanodiamond (ND) stands out as a unique substance in various applications because it possesses several crucial properties such as good biocompatibility, hardness and excellent photostability. Several potential applications for ND in biology, medicine, catalysis and electrode materials have been testified. ND attracts research interest due to the combination of unique properties inherent to diamond and the specific surface structure of the particles facilitating its functionalization. It is therefore of great interest, and high feasibility, to modify the surface of NDs using organic entities or biomolecules or polymers to expand the applications. Nevertheless, only a limited number of studies on ND surface modification have been reported in the literature. The surface properties of nanodiamonds play a decisive role and the surface functional groups largely determine the interactions between ND and other chemical substances. This feature opens up wide possibilities to explore range of applications in composites, biological systems, electronics, and surface technologies. To the best of our knowledge, studies on the functionalization of ND with a conducting polymer are scarce.

Among conducting polymers, polyaniline (PANI) finds versatile applications that include optical and microelectronic devices, sensors, catalysts, drug delivery, energy storage systems owing to its diversified properties. PANI nanostructures have been prepared by blending, mixing, dispersing and grafting PANI with carbon nanotubes and other nanomaterials. PANI nanocomposites carry extraordinary properties such as conductivity, thermal, mechanical, optical and magnetic from the individual components and occupy a pivotal position in major research areas. Also, PANI is an ideal matrix for the deposition of metal nanoparticles and used as catalysts. A unique combination of hard, inert diamond with PANI as surface functional groups would generate new and useful nanocomposite for variety of applications.

In this study, we report on the preparation of new ND-PANI based nanomaterials by grafting PANI chains on to the surface of ND. PANI chains were grafted onto functionalized ND using "graft-from" method. PANI chains grafted ND (ND-g-PANI) were prepared with different extend of PANI loading via chemical as well electrochemical routes. ND-g-PANIs nanomaterials were characterized by Field emission scanning electron microscopy (FESEM), X-ray diffraction analysis (XRD), Raman spectroscopy, Fourier transform infrared spectroscopy (FTIR), X-ray photo electron spectroscopy (XPS) and UV-visible spectroscopy (UV-vis). The correlation of morphologies, structural and electrotronic behavior of ND-g-PANI provides basis for understanding on the surface changes occurring on ND at various stages. The electrochemical properties of ND-g-PANI were evaluated by cyclic voltammetry and electrochemical impedance spectroscopy. Further, ND-g-PANI was deposited with metal nanoparticles and metal nanoparticles coated ND-g-PANI electrode was tested for the electrocatalysis.

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