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Tri-Solvent Mediated Probing of Ultrasonic Energy towards Exfoliation of Graphene Nanosheets for Supercapacitor application

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Abstract

High quality graphene nanosheets were prepared using simple triple solvent system and probe assisted ultrasonication technique for the first time. Structural and morphological evidences confirmed the formation of high quality, hexagonal crystal structured and sheet like architectures of graphene. Electrochemical analysis confirmed the phenomenal capacitor characteristics in 1 M H_2SO_4 electrolyte with better electrochemical stability and with a specific capacitance of 36.26 F/g at the sweep rate of 10 mV/s that was achieved for the graphene nanosheets. Moreover, the stable electrochemical activity was mainly due to the non-aggregation effects of graphene nanosheets and it is believed that such a nanostructure prepared by this simple approach would be a promising candidate for supercapacitors.

Keywords: Graphene; high quality; triple solvent system; ultrasonication; non-aggregation effects; supercapacitors

Introduction

Graphene based supercapacitors are thought to be an attractive topic because of its superior resistance towards corrosion in aqueous electrolytes [1], large specific surface area [1] and good electronic conductivity [2]. At present, the spotlight of research has been directed towards the liquid-phase exfoliation of graphite into graphene due to the relative benefits such as low cost and high quality [3]. Several researchers had implied this technique to prepare graphene and studied its unique properties. The use of polymers such as polyvinyl alcohol or polyurethane as stabilizers significantly facilitates composite formation [4, 5] and the use of surfactants such as sodium dodecyl benzenesulfonate and sodium cholate produces graphene of larger flakes which is very difficult to decrease the flake size even in ultrasonication conditions [6, 7], so the use of organic solvents in liquid phase exfoliation method can overcome this difficulty. A few highlighted works for instance, exfoliation of pristine graphite in N-methyl-2-pyrrolidone (NMP) solvent by simple ultrasonication method, resulting in high quality graphene sheets with a yield of only 1 wt% and through further processing the yield increased to 7−12 wt% [8]. Preparation of monolayer, bi-layer graphene sheets from graphite in organic nitrile solvent, acetonitrile through a well established solvothermal assisted exfoliation method and the yield reported was around 10 wt% [9]. A long time ultrasonication process of more than one day was directed for the exfoliation of graphite into single, few and multilayered graphene flakes with the help of 1-