Conversion of pencil Graphite to Graphene Nanoribbons and its green fabrication for supercapacitor application

M. Selvakumar* and Y. N. Sudhakar

Department of Chemistry, Manipal Institute of Technology, Manipal, India
*chemselva78@gmail.com

Abstract

Graphene has attracted much attention recently due to the possibility of tailoring their dimensionality and structure to facilitate a change in their fundamental properties including conductive and electron transfer characteristics in comparison with similar behavior of their 1D, 2D and 3D analogues [1-4]. The availability of solution-processable graphene oxide (GO) and edge-functionalized graphene's (EFG) has not only facilitated functionalization of graphene materials but also allowed for the formation of large-area graphene films through various solution processing methods, followed by reduction of GOs will give reduced graphene oxide (rGO).Chemical modification of electrodes with electronically conducting polymers (CP) with carbon has received a great deal of attention due to their potential applications in the area of electrochemical capacitors. The conducting polymer-carbon nanocomposites realize a large capacitance, by combining the electric double layer capacitance of the carbon and the redox capacitance of the conducting polymer. The nanostructure conducting polymer serves as the active sites of redox reactions, which result in high specific capacitance. As a result, the GO-conducting polymer composite not only exhibits the pesudocapacitive behavior but also posses good electron transport capability. Further, the porosity and the surface area of polymer/electrolyte greatly depends on the redox state of polymer and this feature can be exploited to produce high energy density, high charge density, cycle life and thermal stability electrodes for supercapacitor. Morphology of the deposited conducting polymer can be controlled by three different types of electrolytes used namely, p-toluenesulphonic acid, benzene sulphonic acid, and sulfuric acid. The methods used in electrochemical polymerization can occur at constant potential (potentiostatic/ chronoamperometry, CA), at constant current (galvanostatic/ chronopotentiometry, CP) or at different potential (potentiodynamic). In this paper I will describe mechanistic aspects of the transformation of pencil graphite to graphene nano ribbons (GNRs) using electrochemical data collected by in situ experiments to their size dependent features. Spectroscopic techniques such as X-ray photoelectron spectroscopy (XPS), with electrochemical techniques to demonstrate their unique electronic structure from high resolution transmission electron spectroscopy and Atomic force microscopy. Further to improve the supercapacitor ability and store very high energy, nanostructure conducting polymer was deposited by galvanostatic technique on the surface of graphene coated on stainless steel (SS) electrode. The preparation of graphene/conducting polymer composites using as in situ polymerization method, aimed to achieve a homogeneous dispersion of individual graphene sheets within the polymer matrix. Supercapacitors were fabricated, using CP/Graphene composite electrodes. Their properties have been evaluated by cyclic voltammetry, AC impedance spectroscopy and charge-discharge techniques. Specific capacitance of fabricated supercapacitor using graphene/conducting polymer electrodes is as high as 232 F g^{-1} at 10 mV s^{-1}.

References

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Figures

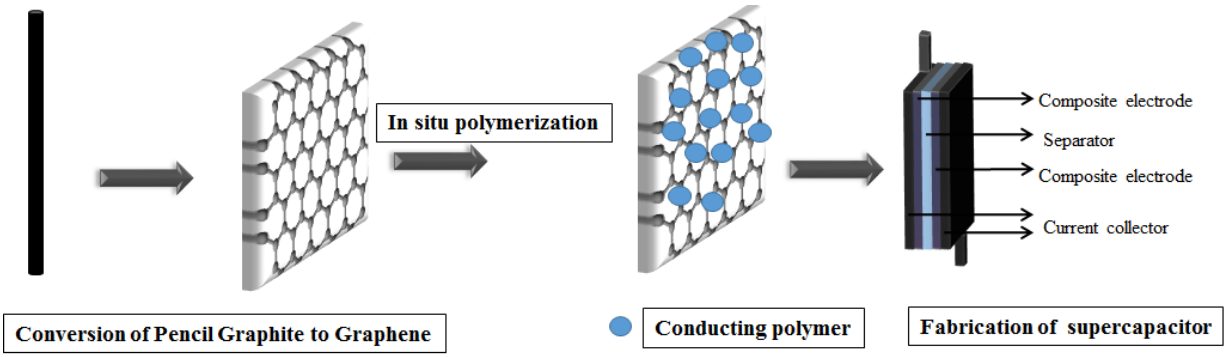

Fig.1. Fabrication of Supercapacitor using Graphene/Conducting polymer composite

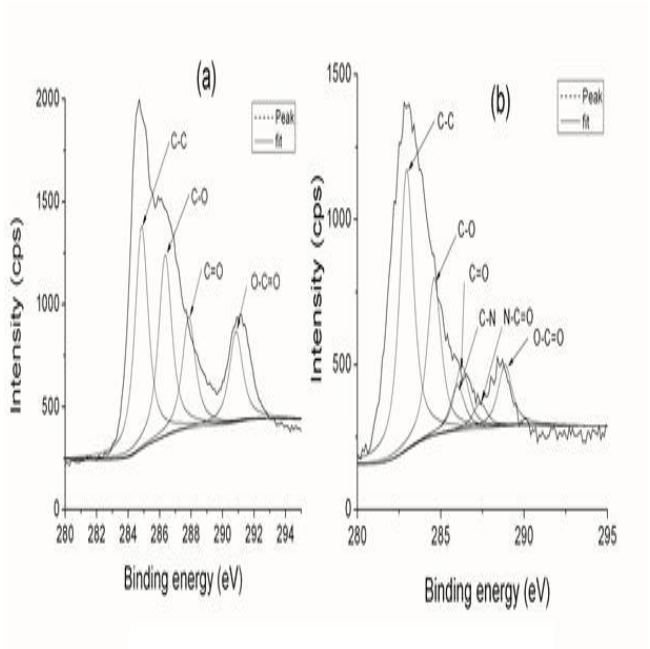

Fig. 2. XPS Spectrum for (a) Graphene (b) Graphene and conducting polymer composite

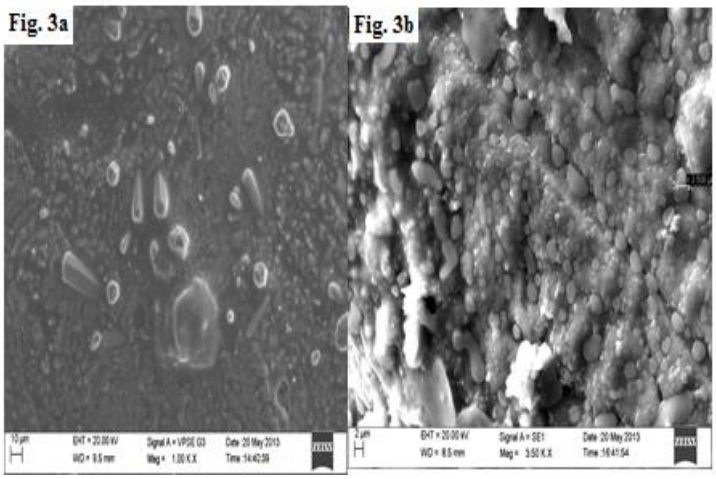

Fig.3. SEM for (3a) Graphene (3b) Graphene and conducting polymer composite