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CONDUCTING POLYMER COMPOSITE BASED SUPERCAPACITOR

Chemistry

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ABSTRACT

The current study investigates the use of composites of polyaniline (PANI) and carbon nanotube (CNT) as electrode materials for supercapacitor devices. The PANI-CNT composite was prepared by in situ chemical oxidative polymerization method. Ultrasonication was done for complete dispersion of CNT in the solution. The surface morphology of the composite was characterized by using scanning electron microscopy (SEM). The capacitive property of the composite electrode was investigated by means of cyclic voltammetry (CV).

INTRODUCTION

Carbon nanotubes (CNTs), after their discovery by Iijima and Ichihashi [1], have attracted considerable interest because of their application in fabricating new classes of advanced materials due to their unique structural, mechanical and electronic properties. They have potential for use in field emitters [2], nanoelectronic devices [3, 4], probe tips for SPMs [5] and nanotube-based composites [6, 7]. Recent application of CNT as electrode material for supercapacitor has ignited significant worldwide investigation. However the small specific surface area of CNTs leads to a fairly low specific capacitance value. It is necessary to improve the capacitance of the CNTs for practical applications.

On the other hand conducting polymers have been intensively studied in the fields of fundamental and applied research, because of their potential for commercial applications. They have relatively high conductivity, are light in weight, inexpensive, flexible, air stable etc [8]. But they have the disadvantage of low cycle life. The deposition of conducting polymers on the surface of CNTs (conducting polymer-CNT composites) is a simple and cheap method to enhance the specific capacitance of CNTs and also the cycle life of conducting polymers. This composite can be used as electriode material for supercapacitor with increased conductivity and cycle life. Among various conducting polymers, polyaniline (PANI) has potential uses in synthesizing polymer- CNT composites owing to its environmental stability, good processability and reversible control of conductivity both by protonation and charge-transfer doping [9, 10]. Present study explains the formation of PANI-CNT composite and its application as electrode material for supercapacitor.

SYNTHESIS OF PANI-CNT COMPOSITE:

For the preparation of PANI-CNT composite, a 100 ml solution containing 0.15g CNT, 20% Methanol and 0.0275M concentrations of Aniline monomer in 1M HCl was soaked overnight and then ultrasonically dispersed for 30 minutes. After ultrasonication the solution was magnetically stirred. To the magnetically stirred solution freshly prepared (ice cooled) 1M APS (20ml) solution was added slowly drop wise for 25-30 minutes. Slow addition is required to prevent the warming of solution. Stirring continued for 6 hrs. to ensure complete polymerization. The complete reaction was carried out at 0-50C. After 6 hrs. of continuous stirring the oxidized monomers were found to polymerize on to MWNT leading to the formation of PANI-CNT composites. The PANI-CNT precipitates formed was separated by suction filtration. The product was washed with deionized water to remove the residual oxidant. Finally the prepared composites were washed with methanol to remove the oligomeric impurities and then dried at 60oC overnight.

RESULTS AND DISCUSSION

The deposition of layer of PANI over CNT was confirmed by FTIR and XRD studies of the PANI-CNT composite. Figure 1(a) shows the SEM image of the PANI-CNT composite which clearly explains the deposition of PANI on the surface of CNT as compared with SEM image of pure CNT (figure 1b). The cyclic voltametry was performed on an AUTOLAB electrochemical workstation in the potential range of 0-0.8V with a scan rate of 5mV/s in 4M sulphuric acid. Figure 2 represents the cyclic voltametric behaviour of CNT and PANI-CNT composite.

The cyclic voltammograms of the CNTs electrode is in the form of rectangular shape, which is the characteristic of an ideal double-layer capacitor. From the cyclic voltammogram of the PANI-CNT composite it can be said that high current is flowing through the electrode and it has sharp oxidation and reduction peaks. This result indicates that the PANI-CNT composite shows high capacitance value as compared to CNT and simple PANI. This can be achieved because of mechanical strength provided by CNT to the polymeric backbone and better electrolytic access in the PANI-CNT composite.

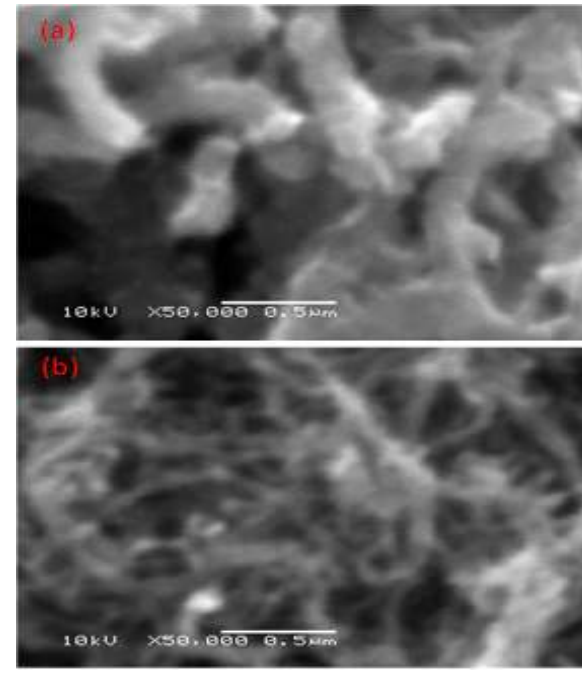

Figure 1: (a) SEM micrograph of PANI-CNT Composite and (b) CNT

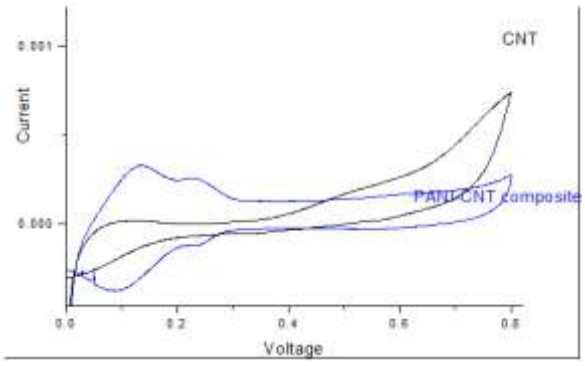

Figure 2: Cyclic Voltammogram of CNT and PANI-CNT Composite

CONCLUSIONS

The PANI-CNT composite was prepared by in situ chemical polymerization of monomer. FTIR and XRD studies confirm the formation of composite. Cyclic voltammogram shows that the PANI-CNT composite have higher specific capacitance than CNT and pure PANI. The current PANI-CNT composite can be used as electrode material for high performance supercapacitor devices.

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