Journal of Advances in Applied Sciences and Technology

ISSN : 2393-8188 (print)
2393-8196 (online)
www.milliyasrcollege.org.journal.php

ORGANIC CONDUCTING POLYMER (OCP)/SINGLE WALLED CARBON NANOTUBE (SWNTs) NANOCOMPOSITE: ELECTROSYNTHESIS AND ELECTROANALYSIS

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ABSTRACT:
In the present investigation, we have studied the electrochemical behavior of the organic conducting polymer (OCP) films on incorporation of single walled carbon Nanotubes (SWNTs). The nanocomposite was synthesized employing potentiodynamic electrochemical technique viz. cyclic voltametry on platinum as working electrode utilized in three electrode setup occupying single compartment electrochemical cell. Polyaniline (PANI), most appreciable conducting polymer possessing good electronic, thermoelectric and optical properties as well as environmental stability is been involved. The study revealed that in comparison with the OCP films OCP/SWNTs nanocomposite exhibit enhanced oxidation and reduction peaks. The morphology of the PANI and PANI/SWNT films was examined using Atomic Force Microscopy (AFM).

KEYWORDS: Electrosynthesis, Electroanalysis, Nanocomposite.

1. INTRODUCTION

Conducting polymers are the materials which have grabbed attention of research society proving its potential capability in device applications that can be inexpensively synthesised and processed [1-8] .These conducting polymers were extensively studied after the successful experimental demonstration of the polyacetelene showing metallic conductivity by MacDirmid [9]. The prospective toward the advancement of materials is always been a thrust for the reinforcement such that materials will be rewarding the more and more potential applications. Carbon Nanotubes have been proved to be the best filler materials improving physicochemical properties exhibiting its applicability various fields such as photovoltaic devices, electron emitting flat-panel displays, electromechanical actuators, light emitting diodes, sensors, supercapcitors, etc. [10]. Conducting polymers can be synthesized via chemical or electrochemical polymerization. Electrochemical polymerization is the prominent technique where the parameters could be controlled like thickness of the film deciding the morphology. It also provides cleaner polymer in comparison with the chemical oxidation. Electrochemical polymerization is performed by the anodic oxidation of the corresponding monomer, deposited on the working electrode in presence of the electrolyte solution. Electrochemical route includes various techniques such as potentiostatic (constant potential), galvanostatic (constant current) and poentiodynamic (potential scanning). These techniques are easy to describe the quantitatively and are commonly been involved for the investigation of nucleation mechanism and microscopic growth. The insertion of cationic or anionic species results in electrically conducting polymer films by the oxidation or reduction. Due to the double bond alteration in the conjugated polymer backbone , the charged species formed upon doping are able to delocalize along the carbon chain allowing electron transport and hence proving the ability to have electronically conducting nature of the materials [11]. Present investigation illustrates the electrochemical synthesis and characterization, describing the more electroactive PANI/SWNTs films.

Atomic Force Microscope (Park XE 7) was used to record topographical images of the PANI & PANI/SWNT nanocomposite. The electrochemical

polymerization and characterization was performed utilizing CH 600C electrochemical workstation. A single compartment three electrode cell assembly was employed for the synthesis. Platinum plates of 20*10*0.5 mm^3 dimension were used as working & reference electrodes and saturated Ag/AgCl as reference electrode. In the electrolyte preparation all reagents such as sulphuric acid (H2SO4) and sodium dodecyl benzene sulphonate (SDBS) used are of laboratory grade. Prior to use, aniline monomer was distilled once and stored in cold environment, purchased from Sigma Aldrich. The COOH functionalized SWNTs (>98%) were purchased from Nanoshel LLC (Wilmington DE, USA). In the electrolyte 0.1 M aniline monomer and 0.2 M H_2SO_4 were added drop by drop with continuous stirring. For the suspension of SWNTs, SDBS was used as a surfactant. SWNTs to SDBS weight ratio taken was 1:10. SWNTs was taken 20 wt% w.r. t. aniline. For the uniform SWNTs suspension, SDBS and SWNTs in 2 ml deionised water were kept for ultrasonication for continuous four hours and further suspension was mixed in electrolyte and kept stirred for another 20 min. This electrolyte solution was used for the electrochemical deposition of the nanocomposite. The process synthesis and characterization were carried at normal room temperature.

2. RESULTS AND DISCUSSION

Potentiodynamic such as Cyclic voltammetry is a Electrochemical technique which corresponds to the repetitive application of the triangular potential wave forms on the surface of the working electrode. The oxidation and reduction can be monitored in the form of current and potential diagram. Fig. 1 (a) & (b) are the voltammograms of the PANI and PANI/SWNTs recorded during the deposition. The potentiograms were recorded applying dynamic potential in the range 0.1 V to 1 V with the scan rate of 0.1 V/S.

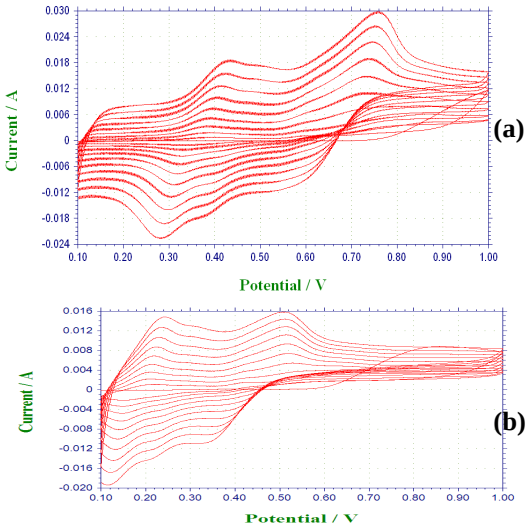

Fig. 1: *Voltammograms recorded during electrochemical polymerization of (a) PANI and (b) PANI/SWNTs nanocomposite*

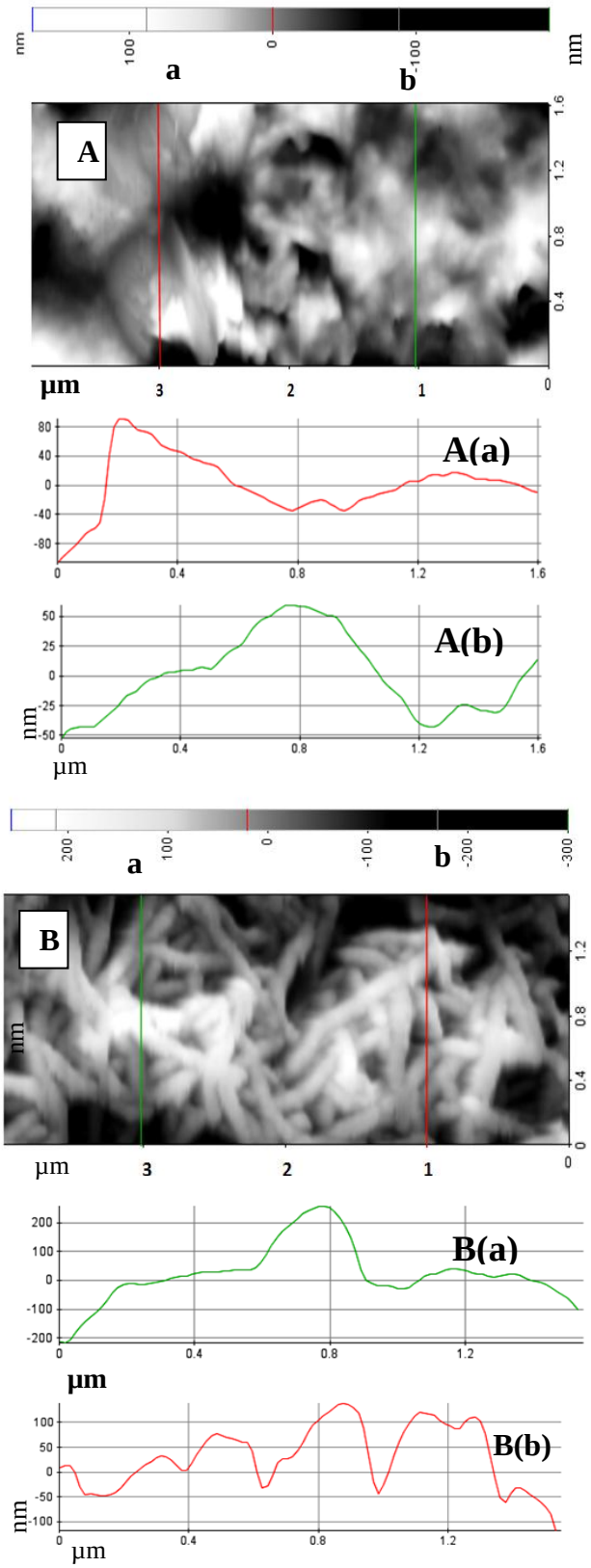

Fig. 2: *Topographical Images: A (a & b) PANI, B (a & b) PANI/SWNTs*

The electropolymerization voltammograms of PANI and PANI/SWNTs shown enhanced changes in the polymerization occurred at the redox potentials. The redox potentials observed. The onset potentials of polymerization are observed higher for the first cycle in both cases indicating nucleation and growth process during stages of electrodeposition. However, there is increase in the current as number of cycles are increasing, the current enhancement in the PANI/SWNTs film indicates the presence of the SWNTs and explain the effect that since the SWNTs are getting deposited onto the surface of the electrode there is increase in the electroactive area [12].

Fig. 2 A (a&b) and B (a&b) illustrates the morphology of the PANI and PANI/SWNTs nanocomposite.

Topographical images recorded using AFM of scan area 4.0*1.6μm^2 in non contact mode for PANI and PANI/SWNTs film, the line profile indicates in both A (a & b) and B (a & b) the substantial changes in terms of the roughness parameter. This evaluates the successful synthesis of the nanocomposite.

3. CONCLUSIONS

The effect of incorporation of SWNTs has been resulted in the enhancement of elecrtopolymerization current, resulting in more elecrtoactive conducting polymer films. AFM topographical image has confirmed that the morphology too is affected by the presence of the SWNTs.

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