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One pot synthesis, characterization of polyaniline and cellulose/polyaniline nanocomposites: application towards in vitro measurements of antibacterial activity

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Abstract

The development of novel polymeric composites has attracted a great deal of attention due to their wide applications in various fields. In this investigation, we report on the synthesis of Polyaniline (PANI) and its cellulose nanocomposites via insitu oxidation polymerization method using aniline and cellulose with ammonium persulfate as oxidizing agent and thoroughly characterized using different analytical techniques. The polymer and its nanocomposites are characterized by Fourier Transform Infrared (FT-IR) and Ultra Violet (UV)-visible spectroscopy. The structure, morphology and size of the nanocomposites are analyzed using X-ray diffraction method (XRD) and Scanning Electron Microscopy (SEM). The thermal stability has been investigated by Thermogravimetry-Differential Thermal (TGA/DTA) analysis. The electrochemical responses of the prepared polymer and its composites have been studied by cyclic voltammetry. Also, the pure polyaniline and its nanocomposites are screened for their invitro antibacterial activity against three types of bacterial stain. The result showed that minimum inhibitory concentration (MIC) of the novel PANI-Cellulose (PANI-C) nanocomposite is relatively lower than that of the pristine PANI. This confirms the enhanced activity of PANI-Cellulose nanocomposite than the pure PANI.

Keywords: SnO_2; Thin films; Spray pyrolysis; Texture

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1. Introduction

Nowadays, paper coated with a conducting polymer has great attention in new functional papers and packaging applications, such as anti-static and electro-magnetic shielding papers and antibacterial papers[1,2] .Among the known conducting polymer used for coating fiber, micro/nano structured Polyaniline (PANI) conductive polymeric composites have received considerable attention because of unique characteristics ,including chemical and electrical properties ,simple preparation, low cost and excellent environmental stability[3].These characteristics have led to the application of PANI in various micro/nano materials and devices[4]. The optical, microwave absorption and magnetic functions of PANI micro/nano structures have also drawn significant research interest because of their potential to meet the needs of various technological applications. Polymer modification by surfactants is an attractive and interesting method of preparing polymer composites. Polymer has been widely studied in solution and in solid states because of their interesting physical properties, including easy solubility morphology and reversible fusibility[5-7].

Sugarcane bagasse is an agro-industrial residue comprised of cellulose, hemicelluloses and lignin. Cellulose is the most abundant organic chemical on earth. Composites employing sugarcane bagasse fibers have attracted an increasing interest in the scientific and industrial communities. Cellulose fiber derivatives from wood, annual plants, agricultural byproducts, are abundant renewable resources [8-10]. Cellulose is a straight carbohydrate polymer chain consisting of several thousand β1-4glucopyranose units and the chains link with each other via a mass of intermolecular and intramolecular hydrogen bonds. This structure gives cellulose unique properties like chemical stability, mechanical strength, biocompatibility and biodegradation [11,12]. Cellulose is modified to form various cellulose esters, cellulose ether and other cellulose derivatives. These cellulose derivatives exhibit as excellent physical properties as the petroleum products. For instance, cellulose acetate (CA), cellulose acetate propionate (CAP) and cellulose acetate butyrate (CAB) have already taken place of petroleum feedstock in making plastic in the commercial market. Among these cellulose esters, CA has been long used in preparation of Pani composite [13-15]. Additionally, the use of viscose and lyocell (regenerated cellulose) in combination with conductive polymers for the preparation of conductive materials has been reported previously [16]. Either CA or viscose (lyocell) is obtained by mean of preparing with homogeneous procedure, the effective synthesis or cellulose products with desired degree of reaction, reproducible substitution patterns and the targeted properties both in laboratory or industry scale are permitted. To the best of our knowledge, however, the disadvantages of their stiff molecules and close chains packing via numerous intermolecular and intramolecular hydrogen bonds is the extreme difficulty to dissolve cellulose in water and most common organic solvents. Cellulose –PANI nanocomposite have been prepared in heterogeneous reaction. In view of heterogeneous reactions, the accessibility and reactivity of the OH groups are clearly determined by hydrogen bond-breaking activation steps through various acids, alkaline compounds, steam explosion process, radiation technology, ultrasound wave, microwave treatment and biological method [17-20].Cellulose is advantageous in fabricating eco-friendly polymer materials through grafting modification[21-22]. PANI is considered to be the most promising agents in the field of biomedicine and biotechnology; only limited studies were dealt with the antibacterial property till date. Thus, an attempt has been made to explore the antimicrobial activity of the novel composites PANI-C and also the minimum inhibitory value for PANI and PANI-C was estimated.

The progress of the polymerization and its nanocomposite formation was monitored by UV-visible and FT-IR spectroscopy. The structure, morphology and size of the nanocomposites were analyzed using X-ray diffraction pattern; Scanning Electron Microscopy and its thermal stability have been investigated by TGA/DTA analysis. The electrochemical responses of the prepared composites have been investigated by cyclic voltammetry. Furthermore, the pure polyaniline and their nanocomposites are screened for their invitro antibacterial activity against two types of bacteria. The result shows that the cellulose/PANI nanocomposites have more reactive then the pure PANI.

2. Experimental

2.1. Materials and Methods

Cellulose was extracted from raw material Sugarcane bagasse (agro-waste).After drying in sunlight, it was ground and sieved under 30mesh sieves. Bagasse was dried in oven at 105^0 C for 3h and stored at room temperature