Synthesis and Characterization of Chitosan-Poly Vinyl Alcohol-Graphene Oxide Nanocomposites

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ABSTRACT
In this article, nanocomposites based on Chitosan (CS)/ poly vinyl alcohol (PVA) and graphene oxide (GO) nanoparticles were prepared by casting the stable aqueous mixture of the components in a mold. The prepared nanocomposites were characterized using Fourier-transform infrared spectroscopy (FTIR), X-ray diffractions (XRD) and viscosity measurement. Scanning Electron Microscopy (SEM) results indicated that the GO was uniformly dispersed in the polymer matrix. The water uptake ability of nanocomposites increased with an increasing the PVA content. While, the addition of GO to CS/PVA lead to a decrease in the degree of water absorption. According to the rheological analysis the viscosity of the samples decreased with increasing the GO weight percent in CS/PVA mixture.

KEYWORDS
Chitosan, Graphene Oxide, Nanocomposites, Viscosity Test, Water Uptake

1. INTRODUCTION
Graphene a single atomic layer of graphite, has attracted much attention owing to its enhanced electrical, mechanical and thermal properties (Novoselov et al., 2004; Goenka, Sant, & Sant, 2014). Low weight and excellent thermal and mechanical stability of graphene have made it to be a suitable filler/reinforcing material for most of polymers (Lim, Huang, & Loo, 2012). A wide variety of graphene-based composites have been reported with applications in biosensors (Lu et al., 2012), wound healing (Kasry et al., 2011), adsorption (Liu et al., 2012), bone tissue engineering (Goenka et al., 2014) and corrosion resistance (Gao et al., 2015).

Chitosan (CS) is a linear, semi-crystalline polysaccharide composed of (1→4)-2-acetamido-2-deoxy-b-D-glucan (N-acetyl D-glucosamine) and (1→4)-2-amino-2-deoxyb- D-glucan (D-glucosamine) units (Rinaudo, 2006). The presence of amino groups in the CS structure differentiates CS from chitin, and gives this polymer many peculiar properties. Indeed, the amino groups of the D-glucosamine residues might be protonated providing the higher solubility in diluted acidic aqueous solutions (pH < 6) (Leedy et al., 2011).

PVA, is a non-toxic, water-soluble synthetic polymer and has good physical which chemical properties and film-forming ability (Sharma & Chandy, 1992). The use of this polymer is important

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in many applications such as con-trolled drug delivery systems, membrane preparation, recycling of polymers and packaging. Studies on the mechanism of dissolution and changes in crystallinity and swelling behavior of PVA and its physical gel-forming capabilities, have been carried out (Paradossi, Lisi, Paci, & Crescenzi, 1996). PVA has bio inertness and it has many uses in medical applications such as artificial pancreas, hemodialysis, nanofiltration, synthetic vitreous and implantable medical device. Cell compatibility and blood compatibility of PVA have been studied extensively (Paradossi et al., 1996; Peppas, Mallapragada, & N.A., 1996; Lee & Jegal, 1999).

Composite blends of PVA and CS have been reported previously (Yang et al., 2004; Costa-Junior, Pereira, & Mansur, 2008, Hideto, Takashi, & Yoshiro, 1999). Composite films offer advantages due to improvements in stability, biocompatibility, and mechanical strength compared with the properties of the single components (Costa-Junior et al., 2008).

By combining a biopolymer such as CS with PVA some of the CS drawbacks are overcome. However, the extent of properties improvement was not as high as expected. Our approach in the present paper is to take advantage of complementary properties of the three materials, biocompatibility associated with CS, processability and versatility associated with PVA and exceptional physical properties of graphene oxide (GO) in order to obtain a composite material which merges the above-mentioned properties (Pandele et al., 2014).

In fact, the inherent chemical structures of GO and CS have the potentials for the cross-linking reactions similar to the curing of epoxy resin (Meng, Zheng, Li, Liang, & Liu, 2006) because GO bears with epoxy groups and CS has amino groups. If the above-mentioned cross-linking reaction can be produced, the enhanced interface can be anticipated in GO cross linked CS nanocomposites. The first report on the fabrication of GO cross-linked CS nanocomposite has been disclosed and the basic properties of GO cross-linked Chitosan nanocomposites have been examined through various methods (Shaoa, Chang, & Zhang, 2013).

In this paper, we report a simple and effective method for the fabrication of a nanocomposite based on chitosan-polyvinyl alcohol and graphene oxide. The as-synthesized samples were characterized by Fourier Transform Infrared Spectroscopy (FT-IR), X-Ray Diffraction analysis (XRD), rheological, water uptake measurement and Scanning Electron Microscopy (SEM).

2. EXPERIMENTAL

2.1. Materials

CS (Aldrich Chemical) powder, of medium molecular weight, MW = 161,000 g/mol, and degree of deacetylation, DD equal to 75.6%, and viscosity of 1406 m.Pas (1% in 1% acetic) were used without further purification. Acetic acid was purchased from SD Fine Chemicals. Poly vinyl alcohol (PVA) supplied from Sigma–Aldrich Chemical (Milwaukee, Wisconsin, USA) (Cat.# 363138) with 98-99% degree of hydrolysis and molar weight MW= 31,000-50,000 g/mol. The GO was produce by Hammers method with 4 g/lit concentration.

2.2. Synthesis of CS-PVA Hybrid Polymers with 1: 1 Stoichiometric Ratio

About 1g of CS was weighted and dissolved in 1% Acetic acid (100 ml). Simultaneously 100 ml of PVA aqueous solution was obtained by dissolving PVA powder in distilled water at 80 °C in an autoclave. Blends were prepared by mixing different ratio of the two polymer solutions.

The CS/PVA solutions were poured onto a transparent Petri glass dish and left undisturbed at room temperature for 72 h in order to evaporate the solvent and form the film. After that the films were peeled off from the mold and thermal treated in vacuum oven.
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