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Investigation of rGO and chitosan effects on optical and electrical properties of the conductive polymers for advanced applications

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ABSTRACT

A simple and fast method for preparing chitosan (CH)/conducting polymer (CP) composite film with and without reduced graphene oxide (rGO) was realized to investigate the effect of rGO on an optoelectrochemical system. For this purpose, firstly rGO was successfully dispersed in the acidic aqueous solution of CH by ultrasonic agitation. One by one CH and CH/rGO blend deposited on an indium tin-oxide (ITO) coated glass electrode by drop-casting method. After that, N^1,N^4-bis(2,5-di(thiophen-2-yl)-1H-pyrrol-1-yl)terephthalamide (m(BT)) electroactive monomer was deposited onto CH and CH/rGO modified ITO electrode surfaces via electrochemical polymerization. Electrochemical and optical properties of the composite structures were investigated by cyclic voltammetry (CV) technique and UV–vis spectroscopy. The surface characterizations of nanocomposites have been performed by scanning electron microscopy. It was observed that, chemical functionalities of CH, rGO and p(BT) provide excellent compatibility. Therefore, the CH/rGO/p(BT) electroactive nanocomposite has better conductivity, stability, charge density, electrochromic switching kinetics and electrochemical properties than the CH/p(BT) and p(BT)/rGO composites. This is due to more efficient synergistic effect between CH, rGO and p(BT) which provide larger active surface area and ease ion transport. This method for producing composite films with novel optical, electrical and stability properties has been gaining a new perspective in the material world, which enables smart and advanced material design in various practical applications especially for designing molecular detection systems.

1. Introduction

In recent years, conducting polymers are one of the most attractive advanced materials for electronic, sensor and electrochromic material world. Due to the unique optical and electrical properties of conductive polymers, they have the potential to be used in many different applications such as batteries, optical and sensor devices [1–6]. Conductive polymers such as polyaniline, polypyrrole, polythiophene, poly(*p*-phenylene) and polycarbazoles are widely used in these areas due to their good electrical conductivity, stability, unique optical properties and their feasible production [7–11]. Especially, 2,5-di (2-thienyl) pyrrole derivatives have distinct electrochemical and electrochromic properties. Therefore, a large number of investigations have been conducted about this class of conductive polymers [12–18].

Chitosan produced from the deacetylated chitin is a natural, hydrophilic, biocompatible, biodegradable biopolymer that has functional amino and hydroxyl groups. It has attracted many researchers interest due to its antibacterial property, ionicity, nontoxicity and easily film forming ability. On the other hand, chitosan shows poor mechanical stability and electrical conductivity. Therefore many methods have been attempted to eliminate this drawback. One of these methods is the production of the chitosan based composites consisted of conducting polymer, metal nanoparticles, graphene oxide or nanotubes [19–26].

Since graphene has unique optical, electrical and thermal features, it is uses several applications such as sensors, electronic and optoelectronic devices, transparent conductors, supercapacitors and drug diagnostics etc. [27–31]. Graphene oxide (GO) and reduced graphene oxide (rGO) have been synthesized by means of chemical surface modification of graphene. Especially GO and rGO have residual functional groups resulting faster heterogeneous electron transfer on the surface and it provides better biocompatibility, dispersibility and charge transfer ability than graphene. The

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