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ORIGINAL RESEARCH

An eco-friendly method to enhance optical and electrical properties of conducting polymers by means of carboxymethyl cellulose

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Abstract In this work, an eco-friendly method is proposed for the electro-synthesis of conductive polymers with superior optical and electrical properties by means of CMC in aqueous media. For this purpose, an aqueous dispersion of a water-insoluble monomer namely 4-amino-*N*-[2,5-di(thiophen-2-yl)-1*H*-pyrrol-1-yl]benzamide (TPB) has been prepared by attaching it to CMC via hydrogen bonds and the conductive composite film (PTPB–CMC) has been obtained by electropolymerization. The TPB monomer has been chosen to interact with the CMC via hydrogen bonds which ensures to obtain dispersion with the CMC and also increase the compatibility of its polymer in the composite structure. As a result of the electrochemical, spectroelectrochemical investigation and surface morphology analyses of the obtained conductive polymer, it has been found that anionic CMC makes improvements in the electrical, optical and mechanical properties of the polymer by making the plasticizing effect and acting as a dopant. Furthermore, in the presence of nanocarbon materials on electrode surface, it has been determined that the polymerization potential is reduced and more stable and long-lasting polymeric films which are crucial for technological applications have been obtained.

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Introduction

During the last three decades conducting polymers such as polythiophene, polypyrrole and polyaniline derivatives (Reddinger and Reynolds 1999; Grigoras and Antonoaia 2005; Higashimura 2012) have attracted substantial attention due to their tunable optical and electrochemical properties (Duvail et al. 2003; Trojanowicz 2003). Due to their unique optical and electrical properties, dithienylpyrrole derivatives are one of the most successful polythiophene derivatives that have been developed during this period (Noureen et al. 2012; Chang et al. 2014; Guven and Camurlu 2015; Yigit et al. 2015; Soganci et al. 2016b, c, 2017b, c; Bingol et al. 2017; Dai et al. 2017). However the fact that most conducting polymers are completely insoluble in common solvents has limited their processability and accordingly their use in technological applications. The solubility problem of conducting polymers can be solved by the attaching acidic groups such as carboxylic acid and sulfonic acid to the polymer backbone (Laska and Widlarz 2003; Song et al. 2015). However, these acidic groups lead to a decrease in polymer conductivity. The presence of