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Regular Article

Electrosynthesis and pseudocapacitance performance of ionic liquid – Cr (η^6-C_6H_5) complex functionalized reduced graphene oxide/poly ortho aminophenol nanocomposite film

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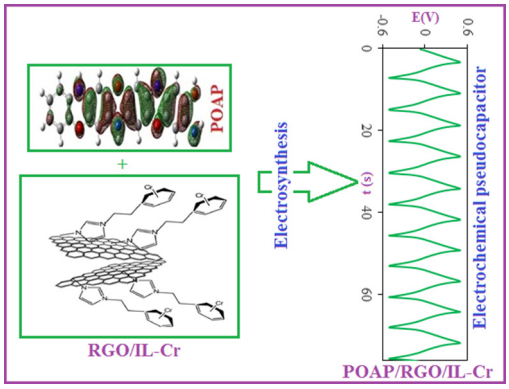
GRAPHICAL ABSTRACT



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ABSTRACT

In present work, RGO/IL-Cr composites were synthesized via chemical routes. The structural and valance state of the prepared samples was characterized by X-ray diffraction, X-ray photoelectron spectroscopy. For improving the electrochemical performance of conductive polymer, POAP/RGO/IL-Cr composite films have been fabricated by POAP electropolymerization in the presence of RGO/IL-Cr as active electrodes for electrochemical supercapacitors. Different electrochemical methods including galvanostatic charge discharge experiments, cyclic voltammetry and electrochemical impedance spectroscopy have been applied to study the system performance. The supercapacity behavior of the composite film was attributed to the i) high active surface area of the composite, ii) charge transfer along the polymer chain due to the conjugation form of the polymer and finally iii) synergism effect between conductive polymer and RGO/IL-Cr.

1. Introduction

Supercapacitors (SCs) due to their unique properties such as high power density, long cycle life have attracted many attentions as a promising energy storage device in last decade [1,2]. To develop electrochemical performance of supercapacitors varied materials have been widely used such as graphene and graphene oxide [3–5], carbon nanotubes (CNTs) and aerogel carbons [6] based on electric double layer mechanism and metal oxides such as V_2O_5 [7], Co_3O_4 [8], RuO_2 [9], Fe_2O_3[10], SnO_2 [11] based on pseudochapacitnce. Graphene based supercapacitors due to flexibility, high surface area, good conductivity, excellent thermal and

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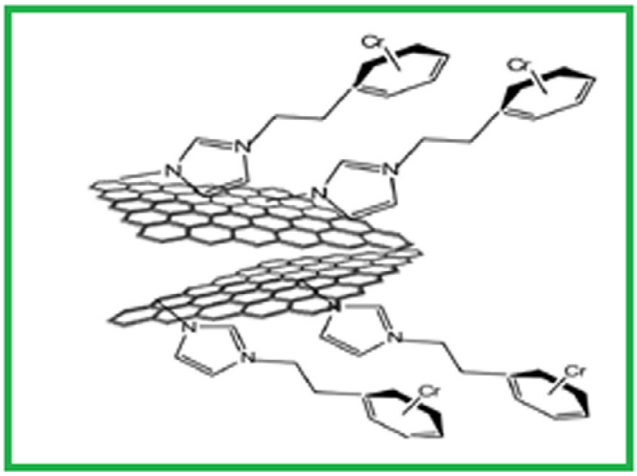

Scheme 1. Molecular structure of RGO/IL-Cr [19].

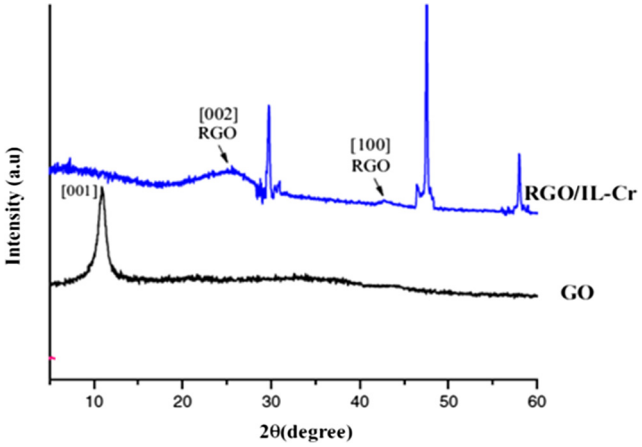

Fig. 1. XRD Pattern of GO and RGO/IL-Cr [19].

stabilities are promising candidate employed with other materials to originate a synergistic effect to improve performance [12].

Ionic liquids introduced as an effective materials in different energy devices such as batteries, dye synthesized solar cells (DSSCs) and supercapacitors [13] . ILs have been used in SCs widely as an alternative electrolytes. ILs actually originate several features such as, electrochemical, chemical and thermal stability with high safety. Ionic liquids showed electrochemical stability (4.5 v) accompanied with high ionic conductivity. Ionic liquids, usually made of a large asymmetric organic cation mixed with an inorganic or organic anion, with fused or molten salts behavior and no voltage-limiting solvents in charge transportation. Practically in many investigations several anions such as $TFSI^-$, BF_4^- and PF_6^- conjugated with the salts of pyrrolidinium, aliphatic quaternary ammonium and imidazolium to form efficient IL to introduce in supercapacitors. It should be noted that preparing an efficient ionic liquid with high conductivity, broad working temperature and wide potential window indicate a main role in SC devices[14]. 1-Methyl-3-methylimidazolium bromide ionic liquid investigated to develop the electrochemical behavior and CV curves, indicated specific capacitance reached to 489 $F.g^{-1}$ with wide potential window due to an almost rectangular shape and the and after 1000 cycles lost near 94% of initial capacitance [15]. Meanwhile Nanocomposite of p-type conductive polymer/functionalized graphene oxide (rGO) nanosheets has been introduced as a new hybrid electrodes for highly capacitive pseudocapacitors. The POAP/FGO showed a specific capacitance of 251 $F.g^{-1}$ and after 1000 cycles the initial capacitance obtained 88%. Compared to pure POAP functional graphene oxide (FGO) possesses a main role that provide more active sites for faradic reaction with better specific capacitance. This composite increased electric conductivity, reduced the resistance, and facilitates the charge transfer of the composites and ease synthesis [16]. In another work, magnetic functional graphene oxide (MFGO) has been employed as novel and hybrid electrodes for highly capacitive pseudocapacitors with specific capacitance of 383 $F.g^{-1}$ at a current density of 1 A/g and after 1000 cycles 93.5% of initial capacitance retained [17]. All these investigations showed that functional graphene oxide particularly through ionic liquids indicates higher potential in electrochemical behavior and it is clear that they can be used efficiently in supercapacitors.

In this work, room temperature electrochemically synthesized POAP/RGO/IL-Cr electrode is presented as an efficient potential candidate in supercapacitor application. Our goals in this paper were increasing the capacitance of POAP electrode by using RGO/IL-Cr (Scheme 1) to form a composite electrode and moreover increase the cycle ability of the electrode. The capacitive behavior of composite was tested by cyclic voltammetry, galvanostatic charge discharge and impedance spectroscopy techniques.

2. Experimental

2.1. Reagent and materials

All the chemical reagents were from their analytical grades. Inorganic salts such as $LiClO_4$ with >99% purity percentage were

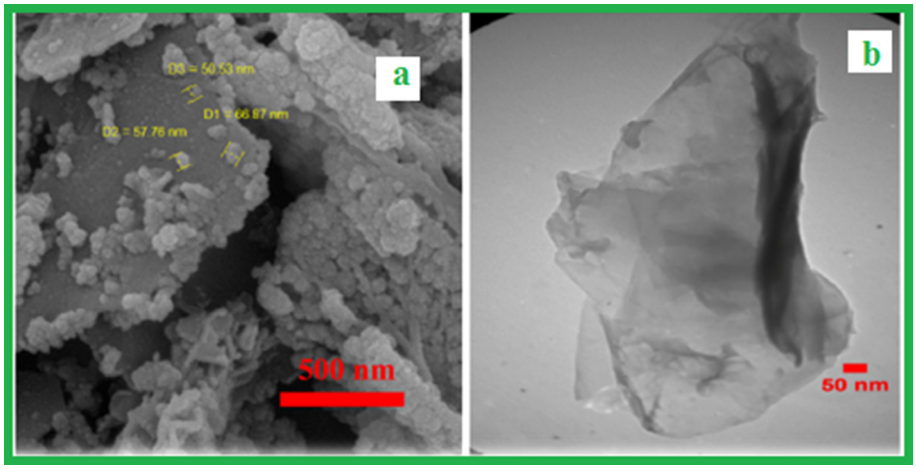

Fig. 2. (a) FESEM image RGO/IL-Cr and (b) TEM image of RGO/IL-Cr [19].