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Mechanochemical synthesis and characterization of poly [(aniline-*co*-*N*-(4-sulfophenyl) aniline] nanofibers and its nanocomposite with titanium dioxide nanoparticles and study of their efficiency in hybrid solar cell

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ABSTRACT

The advantages of polyaniline for application in new generation solar cells include its cost-effectiveness, environmentally friendly synthesis, remarkable stability, and the ability to modify the bandgap through the synthesis of its nanocomposites. But a challenge for its nanostructures is the limited solubility in non-toxic solvents, including water, which limits their processability in coating techniques. We overcame this challenge by synthesizing its copolymer with diphenylamine-4-sulfonate and its nanocomposite with titanium dioxide nanoparticles (TiO_2NPs). So through a solid-state and template-free technique and using sodium diphenylamine-4-sulfonate, aniline hydrochloride salt, TiO_2NPs, and $FeCl_3 \bullet 6\,H_2O$ as an oxidant, poly(N-(sulfophenyl)aniline) nanoflowers (**PSANFLs**), poly [(aniline-*co*-*N*-(4-sulfophenyl) aniline] nanofibers (**PAPSANFs**), poly(N-(sulfophenyl)aniline) nanofibers/titanium dioxide nanoparticles (**PSANFs/TiO_2NPs**), and poly (aniline-*co*-*N*-(4-sulfophenyl)aniline nanofibers/titanium dioxide nanoparticles (**PAPSANFs/TiO_2NPs**) were synthesized. Characterization of the synthesized samples was carried out through field emission scanning electron microscopy (FE-SEM), Fourier-transform infrared spectra, ultraviolet-visible spectra (UV-Vis), cyclic voltammetry (CV), and elemental analysis (CHNS). The FE-SEM images clearly illustrate that the synthesized samples are of nanoscale dimensions. The band gap values of 2.23 eV for **PSANFs/TiO_2NPs** and 1.96 eV for **PAPSANFs/TiO_2NPs** nanocomposites were determined through electrochemical calculations based on cyclic voltammetry curves, showcasing the complementary properties of n and p semiconductors. Using doctor blade method to prepare films from synthesized materials and the architectural pattern of **ITO|TiO_2NPs|semiconductor sample|Al**, all hybrid solar cells are fabricated. The I-V characteristics and power conversion efficiency (PCE) of the samples were examined and discussed. The PCE values for the four samples were found to be in the range of 0.20–0.82 %.

1. Introduction

Increasing growth in energy consumption around the world has made it necessary to develop a global energy source based on renewable sources that produce less greenhouse gases in comparison to fossil fuels. In this respect, photovoltaic energy could be a solution to energy supply problems in the future [1–4]. Currently, much attention has been paid to the development of hybrid solar cells, which have had a prominent increase in solar cell productivity over the past decade [5–7]. Research indicates that the use of an inexpensive and efficient semiconductor can have an important effect on the development of a hybrid solar cell. Moreover, the function of solar cells has also had a noticeable increase by using nanocomposites recently [5,8].

A hybrid solar cell is composed of a combination of organic and inorganic materials; therefore, these cells have a combination of mineral and polymer semiconductor features [6,9]. Organic materials are inexpensive, easy to produce, and structurally suitable for solar cells [10–12]. On the other hand, mineral semiconductors can be constructed

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