UNIVERSITI TEKNOLOGI MARA

PHOTOVOLTAIC CHARACTERIZATIONS OF NANOCOMPOSITED MEH-PPV: TiO_2 ORGANIC SOLAR CELL

FAZLINASHATUL SUHAIDAH BINTI ZAHID

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any academic institution or non-academic institution for any other degree or qualification.

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Name of Student	:	Fazlinashatul Suhaidah binti Zahid
Student's ID No.	:	2010518919
Program	:	Master of Science in Electrical Engineering
Faculty	:	Faculty of Electrical Engineering
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Signature of Student	:	
Date	:	April 2014

ABSTRACT

Recently, interest has been growing in these past few years in incorporating poly [2-methoxy-5-(2-ethyl-hexyloxy)-1,4-phenylene-vinylene] (MEH-PPV) polymer and Titanium Dioxide (TiO_2) nanocomposite based organic solar cell devices. The MEH-PPV: TiO_2 nanocomposite was being studied more closely because it is possible to combine the desirable characteristics between MEH-PPV and TiO_2 within a single composite for organic solar cell application. In this study, several critical parameters were studied regarding the optimum properties of MEH-PPV: TiO_2 for use in organic solar cell including the composition of TiO_2 nanoparticles present in MEH-PPV polymer matrix (0-40wt%), the choice of organic solvent to dissolve MEH-PPV polymer (chloroform,tetrahydrofuran, toluene, xylene and dichlorobenzene) and the influence of nanocomposite thin film's drying temperature (50-125^{0}C). Moreover, synthesize and modification of TiO_2 nanoparticles size to be embed in MEH-PPV polymer matrix has been studied by varied its precursor molar concentrations (0.1-0.5M) and Niobium (Nb) doping concentrations (0-10 at.%) prepared by sol-gel immerse heated method. The deposition and fabrication of MEH-PPV: TiO_2 nanocomposite based organic solar cell has been carried out by spin-coating deposition method. The properties of TiO_2 nanoparticles and MEH-PPV: TiO_2 nanocomposite thin films were analyzed using X-Ray diffraction, energy dispersive X-Ray spectroscopy, field emission scanning electron microscopy ultraviolet-near-infrared spectrophotometer, surface profiler and two-probe current-voltage measurement systems. Through this study, the optimum preparation parameters of MEH-PPV: TiO_2 nanocomposite thin films have been identified. It was found that the nanocomposite thin films which prepared with 20 wt% of TiO_2, dissolved in Dichlorobenzene solvent and being heated at 75°C yielded the highest electrical conductivity, 4.592×10^{-6} $S.cm^{-1}$. Based on this investigation, it can be concluded the optical and electrical properties of MEH-PPV: TiO_2 nanocomposite thin films was closely related to aggregation and dispersion of TiO_2 which affect the phase separation of MEH-PPV polymer chains. Additionally, the conductivity of MEH-PPV: TiO_2 nanocomposite thin films were enhanced up to 6.7987×10^{-6} $S.cm^{-1}$ by controlled the size of TiO_2 nanoparticle. This condition was achieved by prepared TiO_2 nanoparticles with 0.4 molar concentrationss and Nb-doped TiO_2 which produced smaller particle size (14.28 nm) and high electron mobility thus improved the nanocomposite properties. The fabricated MEH-PPV: TiO_2 nanocomposite based organic solar cell using the optimized parameters has been done and characterized using a solar simulator measured with AM 1.5 100mW/cm^2 illumination intensity to obtain the energy conversion efficiency and fill factor value. From the study, the achieved highest performance of MEH-PPV: TiO_2 nanocomposite based OSC was obtained at 20 wt% with short circuit current density (J_{sc}), open circuit voltage (V_{oc}), fill factor (FF) and power conversion efficiency (η) is 0.00482 mA/cm^2, 0.33603 V, 0.23349 and 0.00038% respectively.

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