

**UNIVERSITI TEKNOLOGI MARA**

**PHOTOVOLTAIC  
CHARACTERIZATIONS OF  
NANOCOMPOSITED MEH-PPV: TiO<sub>2</sub>  
ORGANIC SOLAR CELL**

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of the requirements for the degree of  
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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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## 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 ( $\text{TiO}_2$ ) nanocomposite based organic solar cell devices. The MEH-PPV:  $\text{TiO}_2$  nanocomposite was being studied more closely because it is possible to combine the desirable characteristics between MEH-PPV and  $\text{TiO}_2$  within a single composite for organic solar cell application. In this study, several critical parameters were studied regarding the optimum properties of MEH-PPV:  $\text{TiO}_2$  for use in organic solar cell including the composition of  $\text{TiO}_2$  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 $^\circ\text{C}$ ). Moreover, synthesis and modification of  $\text{TiO}_2$  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:  $\text{TiO}_2$  nanocomposite based organic solar cell has been carried out by spin-coating deposition method. The properties of  $\text{TiO}_2$  nanoparticles and MEH-PPV:  $\text{TiO}_2$  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:  $\text{TiO}_2$  nanocomposite thin films have been identified. It was found that the nanocomposite thin films which prepared with 20 wt% of  $\text{TiO}_2$ , dissolved in Dichlorobenzene solvent and being heated at 75 $^\circ\text{C}$  yielded the highest electrical conductivity,  $4.592 \times 10^{-6} \text{ S.cm}^{-1}$ . Based on this investigation, it can be concluded the optical and electrical properties of MEH-PPV:  $\text{TiO}_2$  nanocomposite thin films was closely related to aggregation and dispersion of  $\text{TiO}_2$  which affect the phase separation of MEH-PPV polymer chains. Additionally, the conductivity of MEH-PPV:  $\text{TiO}_2$  nanocomposite thin films were enhanced up to  $6.7987 \times 10^{-6} \text{ S.cm}^{-1}$  by controlled the size of  $\text{TiO}_2$  nanoparticle. This condition was achieved by prepared  $\text{TiO}_2$  nanoparticles with 0.4 molar concentrations and Nb-doped  $\text{TiO}_2$  which produced smaller particle size (14.28 nm) and high electron mobility thus improved the nanocomposite properties. The fabricated MEH-PPV:  $\text{TiO}_2$  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:  $\text{TiO}_2$  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 ( $\eta$ ) is 0.00482 mA/cm $^2$ , 0.33603 V, 0.23349 and 0.00038% respectively.

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