UNIVERSITI TEKNOLOGI MARA

NANOSTRUCTURED TITANIUM DIOXIDE THIN FILM FOR DYE-SENSITIZED SOLAR CELL APPLICATIONS

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Candidate's Declaration

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Abstract

Nanostructured Titanium Dioxide (TiO_2) thin film for Dye-Sensitized Solid State Solar Cell (DSSSC) application has been synthesized using sol-gel method and deposited onto silicon and glass substrates using spin coating technique. The optimized annealing temperature and sol-gel concentration were obtained at 500°C and 0.2M, respectively. Basically, there were four properties studied; surface morphology, structural, electrical and optical properties. Field Emission Scanning Electron Microscopy (FE-SEM) / Scanning Electron microscopy (SEM) were carried out to observe the changes in surface morphology whenever there are changes on the parameters. X-Ray Diffractions (XRD) characterization of the samples was taken to examine the TiO_2 crystalline phases and the intensity of nanocrystalline particles in the thin film. I-V measurement using two-point probe equipment was used to observe the electrical properties which include the measuring of the sheet resistance, the resistivity and the conductivity of the TiO_2 thin film. The optical properties were observed using UV-Vis-NIR spectrophotometer. The thin film transmittance and the band gap energy were also observed using this spectrophotometer. At the end of this research, uniform and homogeneous TiO_2 thin film has successfully prepared. By controlling the sol-gel concentration, a transparent TiO_2 thin film has been developed which has high transmittance property of above 80%. The TiO_2 thin films which were annealed at a temperature of 500°C and prepared at 0.2M of sol-gel precursor concentration gave the optimum results. By adding TiO_2 nanopowder, the surface area and porosity of TiO_2 thin film is improved, thus good candidate to use in DSSSC application.

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CHAPTER 1

INTRODUCTION

1.1 Background

The search of new source has started as early as in 1839, where Alexandre Edmond Becquerel [1] a French physicist, first discovered the phenomenon of light in electricity conversion by using the photovoltaic effect. It was extensively studied by many researchers until 1973, where Solarex Corporation was established. At that time, Delaware University was the first institution to develop a photovoltaic system. The system was for domestic application and the price of silicon solar cell was $30 per Watt. Since then, the silicon solar cell has the monopoly in the photovoltaic market until 1991, where O'Regan and Gratzel [2] introduced a very promising alternative inorganic pn-junction solar cell using the concept of nanoporous semiconductor material. Semiconducting material that had been used is called nanocrystalline Titanium Dioxide (TiO_2) material. Solar cell that was introduced by O'Regan and Gratzel is called dye-sensitized photoelectrochemical solar cell.

The research of dye-sensitized solar cell has attracted many researchers around the world. Improving dye-sensitized solar cell is the first agenda in this recent year. There are some problems that occurred in solar cell produced by O'Regan and Gratzel, which will be discussed in Chapter 2. Due to the problem in Gratzel cell, Tennakone et. al [3,4] have discovered a dye-sensitized solid state cells (DSSSC) which could solve the previous problem. Due to its simplicity and low cost production of DSSSC, this solar cell may overcome the fossil source problem.

As for a country like Malaysia, it has a lot of benefits if the solar energy that we have all year round can be used to overcome the problem as mentioned earlier. In order to improve DSSSC, we must know the configuration of DSSSC and then the