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ZINC OXIDE MICRORODS AND POLY (3-DODECYTHIOPHENE)-P3DT WITH CHLOROPHYLL (ALGAE) FOR A HYBRID SOLAR CELL

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ABSTRACT

In this research, hybrid solar cell was produced with a combination of organic (Chlorophyll and P3DT) and inorganic (ZnO microrods) as precursor materials. The hybrid solar cell fabricated accordingly by layered of ZnO/P3DT/Chlorophyll (Algae). The unique properties of ZnO microrods arrays on ITO glass substrate synthesized by using hydrothermal method. X-ray diffraction (XRD) pattern shows that the zinc oxide microrods are high crystallinity growth along peek [002] direction with a high consistant orientation perpendicular to the substrate and revealed that microrods have wurtzite crystal structure. The surface morphology of ZnO microrods with the range between 0.276 μm − 0.330 μm were observed and analysed using Scanning Electron Microscope (SEM). Electrical characteristic of sheet conductivity this hybrid solar cell are measured by four point probes under four varied layered which are; ZnO, ZnO/P3DT, ZnO/P3DT/5CHLO and ZnO/P3DT/10HCLO. Efficiency of the four varied layer of samples are measure using two point probes with light intensity of 20 Wm^{-1} and 100 Wm^{-1}.

Electric energy is the most desirable energy source in our daily life. Energy is used to make human life become easier. Source of energy can be divided into non-renewable energy and renewable energy. Non-renewable energies are produced by fossil fuel, natural gas and nuclear energy. In the other hand, renewable energies are produced by solar energy, wind energy, biomass, geothermal energy and etc. Awareness to apply renewable energy is projected due to limited sources of non-renewable energy and environmental issue (air pollution and soil pollution). With the various types of renewable energy, it is believe to overcome the depleted issue of non-renewable energy. In this research, renewable energy from solar energy will be study. This solar energy are generated using solar cells (also well known as photovoltaic) [1]. This solar cell operates to convert the solar energy (photon energy) to electric energy (through excitation of electron, and produces a pair of carriers: electron and hole). This electric energy is used to operate/run/on a lots of equipments and machines. This solar cell will be an alternative energy to replace the non-renewable energy. Zinc oxide microrods can be produced using hydrothermal method [2-4].

Solution Preparation. Four solutions have been prepared, there are; Seed solution, Growth solution, Poly 3-Dodecylthiophene solution, Nature dye solution (chlorophyll). Seed solution have been prepared by using 0.1 M of Zinc Acetate Dehydrate powder, 50 ml of distilled water and 50 ml of sodium hydroxide (NaOH). 0.1 M of zinc acetate dehydrate powder, 50 ml of distilled water and 50 ml of NaOH, were mixed and stirred (at 700-1100 rpm) until the entire compound are fully dissolved. Growth solutions were prepared using 0.1 M Zinc Nitrate, 0.1 M hexamethylenetetramine (HMT) and 100 ml of distilled water. 1.487 g of 0.1 M Zinc Nitrate, 1.4019 g of 0.1 M hexamethylenetetramine (HMT) and 100 ml of distilled water are mixed and stirred (at 700-1100 rpm) until the entire compound are fully dissolved. Poly 3-Dodecylthiophene solutions were prepared by diluted of this polymer with chloroform. Between 0.001 g to 0.003 g of Poly 3-Dodecylthiophene was mixed with 100 ml of chloroform, these mixtures are stirred until it is fully dissolved. Chlorophyll has been extract from micro-algae using ethanol.

Fabrication. ITO glass substrate have been cleared and cleaned to prevent any dust or unwanted material/compound on samples prepared. This is because it can affect the growing process of ZnO microrods. Besides, this process is important to avoid unwanted chemical reaction due to unknown material present. ITO glass has been selected to use is 2 cm x 2 cm, with 7 Ω resistance. This glass were cleaned using ultrasonic cleaner machine (US 05 ultrasonic cleaner (5L) 230 VAC, 50/60 Hz ID BDH 53125).

In the hydrothermal method to produce zinc oxide microrods onto ITO glass substrate, two main steps were involved which are seed and growth. First was seed process, where 30 μl of the seed solution was dropped onto the

ITO glass with specific area. Next these samples were dried inside furnaces at 300°C for one hour. Second is growth process, after complete the seed process; sample will be immersed into the growth solution at 90°C for 3 hours.

Spin Coater Model WS-400B-6NPP-LITE were used to fabricate/placed P3DT and chlorophyll onto samples. P3DT and chlorophyll were dropped onto the sample using micro syringe, every single layer of P3DT is equal to 20 ml of solution. A machine used for spin coating is called a spin coater, or simply spinner. Rotation is continued while the fluid spins off the edges of the substrate, until the desired thickness of the film is achieved. The applied solvent is usually volatile, and simultaneously evaporates. So, the higher the angular speed of spinning, the thinner the film. The thickness of the film also depends on the concentration of the solution and the solvent. Therefore, to have same thickness for all the samples fabricate, the number of small droplet to the substrate ITO/ conducting polymer, angular speed, and spinning time has to be set and constant. This spin coater has set on four different speeds that run continuously. The speeds has set on; 1000 rpm for 15 s, 1500 rpm for 25 s, 2000 rpm for 30 s and 2500 rpm for 30 s.

Sample Characterization and Results. Optical characteristic of zinc oxide microrods was observed by using Scanning Electron Microscope (SEM) model JEOLJSM-6360LA at 20 kV. Morphology of the sample is analysis using RigakuMiniFlex II Destop X-ray Diffractometer (XRD). Phase of scanning angle was set up in range 20° to 80°. Sheet conductivity of the sample was measure by layered using four point probes under the ranges of 0 Wm^{-2} to 200 Wm^{-2}.Conductivity of each layer are measure with different intensity. Results are show in table 1.0. Efficiency of sample that characterize using two point probes. Measurements are run with two different intensities, which are; 20 Wm^{-2} and 100 Wm^{-2}.

Optical of zinc oxide nanorod; From the Figure 1 it shown the range diameter for ZnO microrod bertween 0.276 μm-330 μm, with the average diameter size are 0.3042 μm. Morphology; Figure 2 shows the very strong peak (4740 arbs./unit) with orientation of 002 in wurtzite crystal structure reveals that c-axis. Conductivity; Sheet conductivity (σ) increased with the increase of the light intensity (Wm^{-2}). Intensity 0 Wm^{-2} recorded as the lowest sheets conductivity (σ), while intensity of 200 Wm^{-2} recorded as the highest sheets conductivity (σ). This data (Figure 3) showed the directly proportional relationship between the intensity and sheet conductivity. These phenomena have been obeyed photoelectric effect theory [1]. Efficiency; In this study, chlorophyll that extract from micro-algae are used to enhance the absorption of photon energy. Samples are varied by the chlorophyll layered which are; without chlorophyll, five layers of chlorophyll and 10 layers of chlorophyll. Every layered of chlorophyll represented 20 μl of chlorophyll solution. Chlorophyll solution was tested using UV-Vis to indicate the absorption of ultraviolet-visible spectrum. Efficiency of samples is represented by Figure 4.

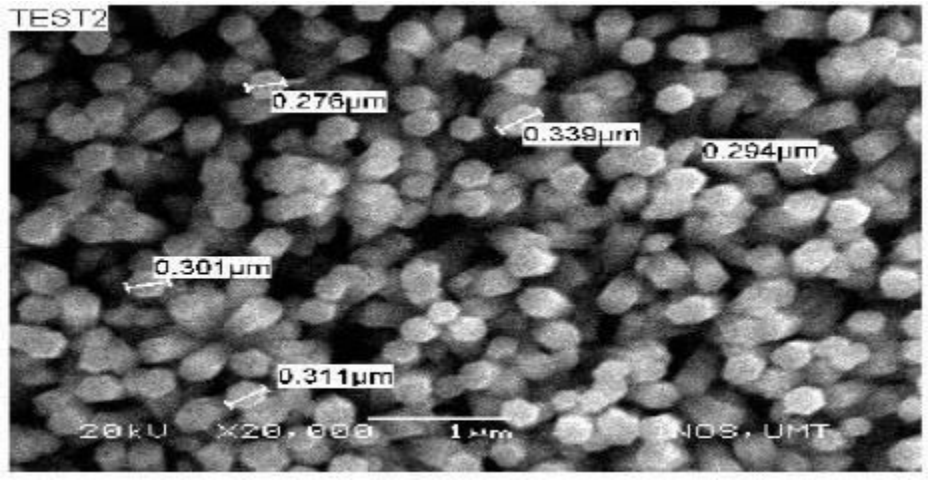

Figure 1. Diameter of Zinc Oxide

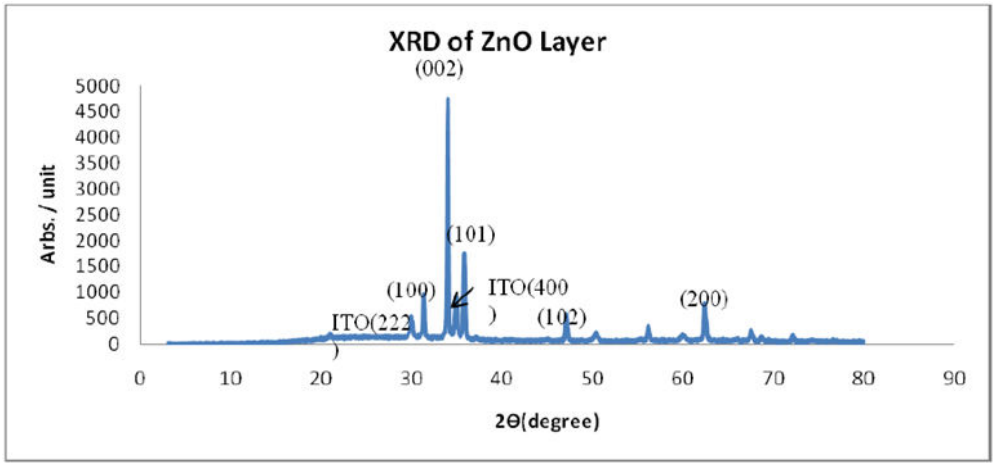

Figure 2. XRD pattern observation for ZnO nanorod and ITO

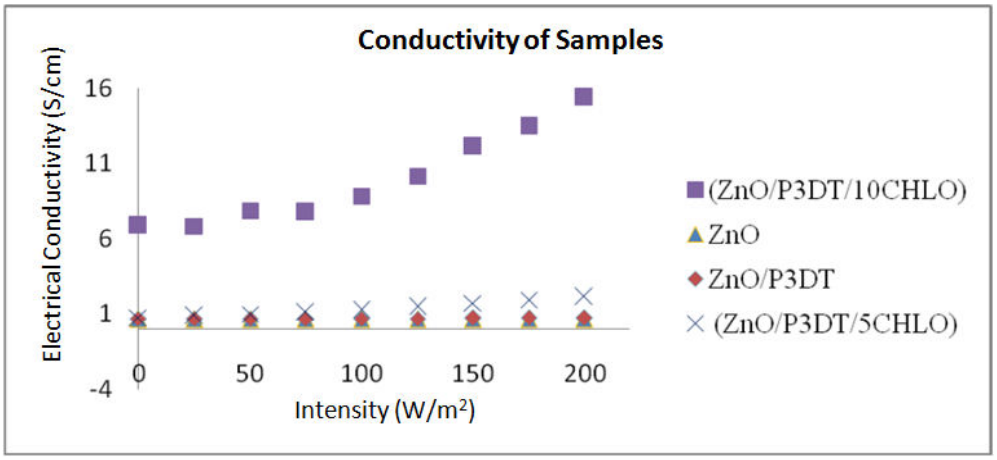

Figure 3. Sheets conductivity by layered

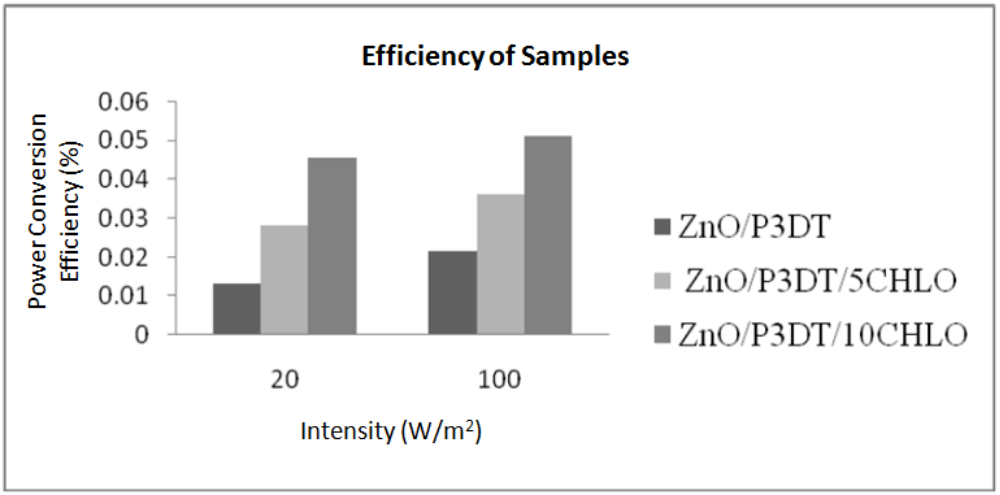

Figure 4. Efficiency of samples for 20 and 100 intensity of light

Observations by SEM are done using magnification of ×10000, ×15000 and ×20000. Composition and crystal morphology structure of ZnO had been visualized using XRD. Sharp peek of the XRD shows the sample is highly crystallites. Through the sheet conductivity study, it has been observed that the conductivity is increase due to the increment of layer of dye and light intensity. Conductivity value of every samples is as follow; ZnO<ZnO/P3DT<ZnO/P3DT/5CHLO< ZnO/P3DT/10CHLO and with respect to light intensity. Efficiency of the sample also follows the same pattern with sheet conductivity characteristic.

Through this research, correlation between conductivity and efficiency can be concluding as directly proportional to the light intensity and amount of layers. The highest efficiency of this sample is 0.05% (ZnO/P3DT/10CHLO-at 100 V/m).

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