

Fabrication of dye natural as a photosensitizers in dye-sensitized solar cells (DSSC)

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Abstract: The purpose of this study was to obtain optical properties (absorption spectrum) and electrical properties (photoconductivity) of organic dyes in DSSC performance. optical and electrical properties were tested by using UV-Visible Spectrophotometer and Elkahfi 1601 PC 100 / IV meter, respectively, while Keithley Type 2600A is used for the characterization of DSSC. This study is a great base to explore and investigate the development of DSSC solar cells using natural dyes (organic). Spectra optimal absorption and photoconductivity produced by natural dyes (organic). The results of this study indicate that the absorption spectrum of natural dyes (organic) in the range of 300-500 nm. electrical characteristics (I-V) of the increase in linear dye under illumination. I-V characteristics of DSSC from organically produced natural dyes to color the biggest-mangosteen obtained Voc of 565 mV; JSC = 1.52 A / m²; FF = 0.12; and η_{ef} is approximately 0.09%, respectively,. The conclusion of this study, natural dyes (organic) can be an attractive alternative as a dye.

Keywords: Dye-Sensitized Solar Cell (DSSC); Dye Organic; Dye Sensitizer.

1. Introduction

The energy is usually derived from fossil presence increasingly diminished and can not be renewed. Therefore, many experts are looking for ways to create a new energy / alternative, and Dye-sensitized solar cell (DSSC) is one of the new and renewable energy. In this study aims to determine the characterization of the electrical properties of extracts from natural organic materials and organic polymers. Knowing the effects of extracts from natural organic materials and organic polymers to increase the efficiency of solar cells based Dye-sensitized Solar Cells (DSSC).

Currently very own photovoltaic technology advancements in the field of solar energy as an alternative and renewable energy. To produce solar cells at low cost, have many models with structures and new materials currently being developed (Hadipour et al., 2008).

The solar panels are often called photovoltaic cells, photovoltaic can be interpreted as a "light-electricity".

Organic photovoltaic is an alternative to replace inorganic photovoltaic solar cells and silicon. Polymer conjunction is interesting in this regard.

Solar cells rely on the photovoltaic effect to absorb solar energy and cause current to flow between two opposite charged layer. Total use of solar panels in the world's electricity production portion is very small because it is constrained by the high cost per watt compared to fossil fuel can be ten times higher, depending on the circumstances.

Right now the cost of solar electric panels makes it impractical for everyday use where electricity "cable" has been provided. Organic Photovoltaics has many attractive features including, potentially to the devices that are flexible, can be produced with simple techniques and inexpensive in terms of cost of manufacture (Brabec.C.J. 2004).

Dye-sensitized solar cell (DSSC) is a photoelectrochemical solar cell, mainly consisting of photoelectrode, electrolyte, and a counter electrode. Titanium dioxide (TiO₂) has become the preferred semiconductors in a variety of studies, unfortunately, due to the band gap is large (3 to 3.2 eV), TiO₂ absorbs only an ultraviolet portion of the sun so it has a low conversion efficiency (Grätzel, M. 2001).

The last two decades have found M.Gratzel Dye-sensitized Solar Cell (DSSC) as a photovoltaic devais. Dye-sensitized Solar Cells has attracted attention as a converter of energy compared to silicon solar cells (Cari, et.al, 2013). DSSC uses three active material, an organic dye as a material which absorbs photons, a layer of metal oxide nanocrystal as an electron transport material and liquid or metal oxide layer as a hole transport material (HTM) (Gren Martin, A. 1982).

DSSC is very attractive for further investigation because they allow producing high efficiency with cheap production costs (Cari, et.al, 2013). Several studies using material from platinum (Pt) as the counter electrode in DSSC. Platinum (Pt) and carbon (C) is a material commonly used as the counter electrode. In this study, using a platinum (Pt) as the counter electrode in order to reduce drag on the FTO glass.

In DSSC, natural coloring (dye) as a sensitizer play an important role to absorb photons from sunlight and convert it into electric current. The types of dyes such as metal complexes, natural and organic materials typically used as a sensitizer.

The working principle of DSSC is conversion light energy into electrical energy. When a dye is attached to the surface of TiO₂ absorbs photons of sunlight, electrons are excited into the conduction band of TiO₂. Electrons will be collected in TiO₂, dye molecule that is left in a state of oxidized. Furthermore, the electron will transfer through the external circuit to the counter electrode.

Performance solar cells are the ability of solar cells conversion light into electrical energy. Figure 1. An I-V curve which shows Traffic cells in producing voltage and current. In the image shown in the open circuit voltage (Voc), short circuit current (Iis), maximum voltage, maximum current and fill factor. When short circuit condition (Iis), the cell will produce a short circuit current. When open circuit condition no current flows so that the voltage will be the maximum, or so-called open circuit voltage. Fill factor is a measure of the quality of the performance of solar cells.

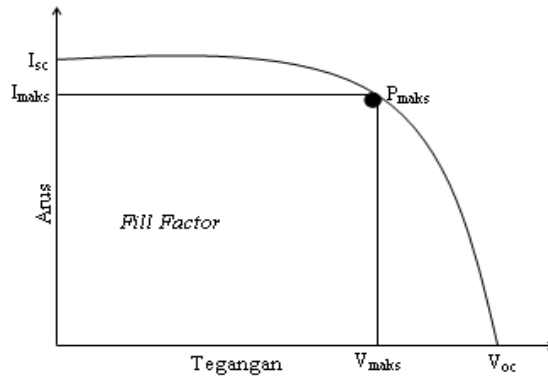


Figure 1. Curve I-V DSSC

Fill Factor (FF) is a quantitative measure of the quality of a solar cell, as well as the size of the square outside the I-V curve, fill factor can be obtained using the equation 1.

$$FF = \frac{V_{maks} I_{maks}}{V_{oc} I_{sc}} \quad (1)$$

The maximum power produced by the solar cells can be obtained from the equation 2.

$$P_{maks} = V_{oc} I_{sc} FF \quad (2)$$

$$\eta = \frac{P_{MAX}}{P_{cahaya}} \quad (3)$$

The efficiency of solar cells is a quantitative comparison of the maximum power generated cells (P_{max}) with the power of the incoming light (P_{light}) can be determined by the equation 3.

2. Research Methods

TiO₂ used in this study is Titanium dioxide (nanopowder) with a size of 21 nm. TiO₂ as much as 0.5 grams dissolved in 2 ml of ethanol is stirred for 30 minutes using a vortex stirrer.

TiO₂ is coated onto a conductive glass Fluorine Tin Oxide (FTO) by the deposition area of 1.5 cm x 2 cm using methods Coating spin. TiO₂ layer that has been deposited is heated to a temperature of 500C for 60 minutes on a hot plate. This study used a dye of the extract organic material pulverized using a mortar until smooth. Organic material is finely dissolved in 35 ml of ethanol while stirring for 60 minutes and allowed to stand for one day in order to extract dye organic material produced homogeneous. Construction DSSC used is a sandwich system. Working electrode FTO conductive glass coated TiO₂ that has been soaked with dye organic material.

The counter electrode in the form of the FTO conductive glass that has been coated a thin layer of Pt (Hexachloroplatinic (IV) acid 10%). Electrolytes are made from sodium 3.3 g, Iodine 0.528 gr, HPA 0.005481 gr, Acetonitrile 30 ml which spilled between the

counter electrode and the working electrode is given a barrier to use a keyboard protector to prevent short circuiting.

The working electrode and the counter electrode and the electrolyte that has been poured between them in the pile are then clamped using the clipboard. DSSC then characterized using current and voltage Keithley. As shown in Figure 2.

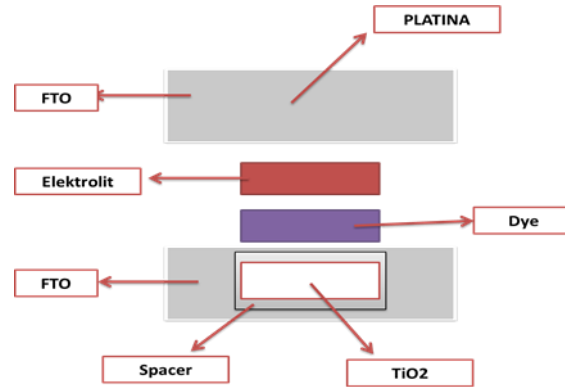


Figure 2. Structure DSSC

3. Results and Discussion

The dye solution is made from extracts of organic material that can absorb and pass on the visible light spectrum. The dye serves as Dye-sensitized Solar Cells using extraction of organic materials as a dye sensitizer has been carried out, testing the extraction of organic materials using UV-Visible spectrophotometer 1601 PC to know the power of the absorbance of the extraction of organic material to the visible wavelengths.

Absorbance is measured in the range of 200-800 nm. Results characterization absorbance spectrum in Figure 3 shows that the absorption spectrum extracts organic material contained in the range of 300-800 nm.

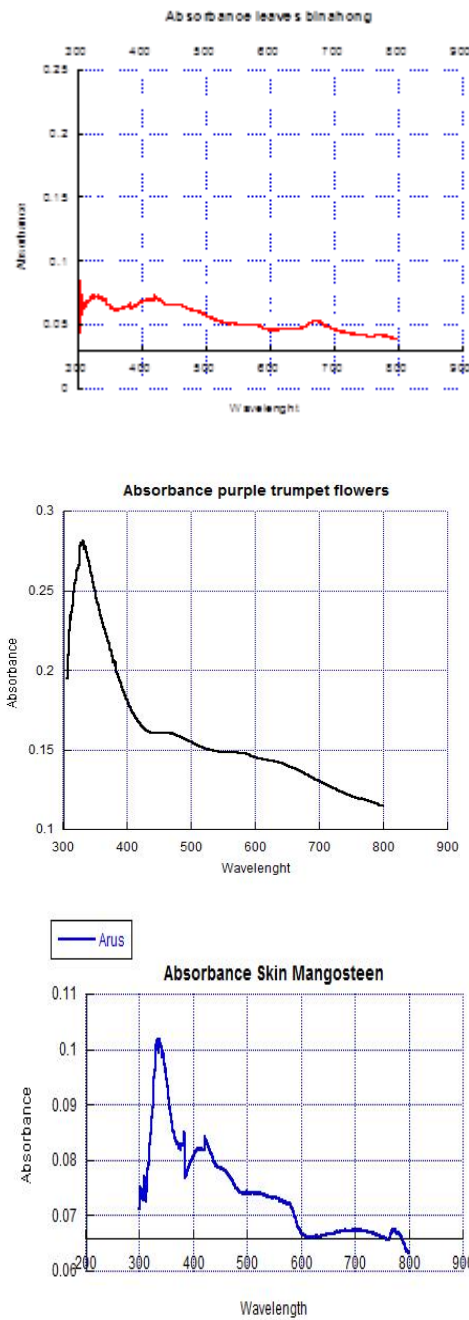


Figure 3. Graph Absorbance extract organic material

Characterization current-voltage (I-V) is a method to determine the performance of Dye-sensitized Solar Cells is how much ability DSSC can convert light into electrical energy measurement of I-V performed under dark and light conditions is under irradiation of halogen lamp with the intensity of 1000 W/ m^2 . To value the characteristics of DSSC can be seen in Figure 4.

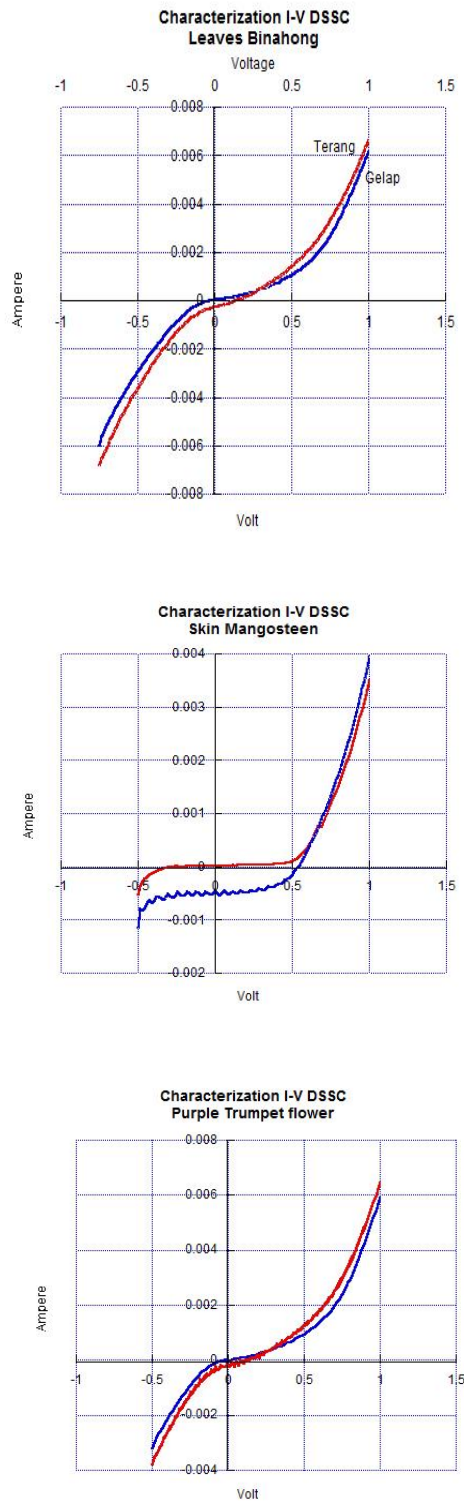


Figure 4. Curve I-V organic materials

From Figure 4 shows the I-V curve values characterization of organic matter in the light of current is greater than the dark current. DSSC efficiencies generated by the use of extracts of organic materials with a treatment difference in TiO_2 are presented in Table 1. In this study using Pt counter electrode (Hexachloroplatinic (IV) acid 10%).

Table I. DSSC Efficiency

Dye	Voc (mV)	Isc (μA)	FF	Pmax	η (%)
Skin Mangosteen	0.5×10^{-3}	0.3×10^{-6}	1.26×10^{-7}	0.2×10^{-3}	0.9×10^{-1}
Leaves Binahong	0.17×10^{-3}	0.38×10^{-9}	5.09×10^{-8}	2.3×10^{-5}	1×10^{-2}
Purple Trumpet Flower	0.14×10^{-3}	0.27×10^{-9}	0.8×10^{-2}	1.52×10^{-5}	0.7×10^{-2}

This study used a liquid electrolyte, where the electrolyte is the longer used increasingly depleted due to evaporating and produce less than the maximum transfer catalyst. In accordance with the function of the electrode/charge. If electrolyte depleted or nonexistent, the electron transfer activity will be reduced/no.

4. Conclusion

Dye-sensitized Solar Cells (DSSC) using organic materials extraction material with a time difference of immersion has been manufactured. With the current and voltage generated. The area of the curve shows a DSSC from extracts of organic materials by soaking method produces I-V curves well. The counter electrode is one important component of unusual released at DSSC structure.

Giving Pt (Hexachloroplatinic (IV) acid 10%) on the counter electrode provides better performance in DSSC. Pt (Hexachloroplatinic (IV) acid 10%) to function as a catalyst in accelerating the redox reaction with the electrolyte. The efficiencies generated by each of the organic material showed good improvement.

Thank-you Note

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