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Dye-Sensitized Solar Cells(DSSC) Use Natural Organic Sulphur Cosmos Leaves

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Abstract: Energy is a basic need in everyday life so that the need for energy in the world continues to grow. Energy is usually produced from fossils whose existence is diminishing and cannot be renewed. Therefore many experts are looking for ways to make and create some renewable energy, and Dye-sensitized solar cell (DSSC) is one of them. In this study the aim was to determine the characterization of the electrical properties of the Dye Sulphur Cosmos (Kenikir Leaf) material extract. The study conducted absorbance tests using a UV Visible 1601 PC Spectrophotometer and current and voltage tests (I-V) using kethlay. These results indicate that some natural dyes from the extraction of natural organic matter have absorbance spectra in the range of 300-800 nm, which have potential as DSSCs.

Keywords: *Dye Sensitized Solar Cells (DSSC). Natural Organic. Sulphur Cosmos*

Introduction

Solar panels are devices consisting of solar cells that convert light into electricity. They are called solar upper solar or "sol" because the sun is the strongest source of light that can be utilized. Solar panels are often called photovoltaic cells, photovoltaic can be interpreted as "light-electricity". Solar cells rely on the photovoltaic effect to absorb solar energy and cause current to flow between two oppositely charged layers. The amount of solar panels used in the world's electricity production is very small, constrained by their high cost per watt compared to fossil fuels - could be ten times higher, depending on circumstances.

Currently the cost of solar electric panels makes them impractical for everyday use where "wired" electricity is readily available. Currently, photovoltaic technology has made significant progress in the field of solar energy as an alternative and renewable energy. Organic photovoltaic has many attractive features, including the potential to be a flexible device, can be produced using simple techniques and is inexpensive in terms of manufacturing costs. Dye-sensitized solar cell (DSSC) is a photoelectrochemical solar cell, mainly consisting of a photoelectrode, electrolyte and counter electrode. Titanium dioxide (TiO2) has been the preferred semiconductor in various studies, unfortunately due to its large band gap (3 to 3.2 eV), TiO2 absorbs only the ultraviolet part of the sun and so has a low conversion efficiency. In the last two decades, M. Gratzel has discovered Dye Sensitized Solar Cell (DSSC) as a photovoltaic device. Dye Sensitized Solar Cells have attracted attention as an energy converter compared to silicon solar cells.

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DSSC uses three active materials: organic dyes as photon-absorbing materials, metal oxide nanocrystalline layers as electron transport materials and liquid or metal oxide layers as hole transport materials (HTM). DSSC is very attractive for further research because it is possible to produce high efficiency with low production costs. Several studies have used materials made of platinum (pt) as counter electrodes in DSSC. Platinum (Pt) and Carbon (C) are materials commonly used as counter electrodes. In this study, platinum (Pt) will be used as a counter electrode on DSSC made from organic Sulpur cosmos extract (kenikir leaves).
The working principle of DSSC is to convert light energy into electrical energy. When the dye attached to the TiO2 surface absorbs photons from sunlight, the electrons will be excited to the TiO2 conduction band. Electrons will collect in TiO2 dye molecules that are left in an oxidized state. Furthermore, electrons will transfer through the outer circuit to opponent (8). Solar cell performance is the ability of solar cells to convert light into electrical energy. Figure 1 Is an I-V curve that shows the ability of cells to produce voltage and current. The figure shows open circuit voltage (Voc), short circuit current (Iis), maximum voltage, maximum current and fill factor. When the condition is short circuit (Iis), the cell will produce a short circuit current (4). When the condition is open circuit there is no current flowing so that the voltage will be maximum or it is called the open circuit voltage. Fill factor is a measure of the quality of solar cell performance.

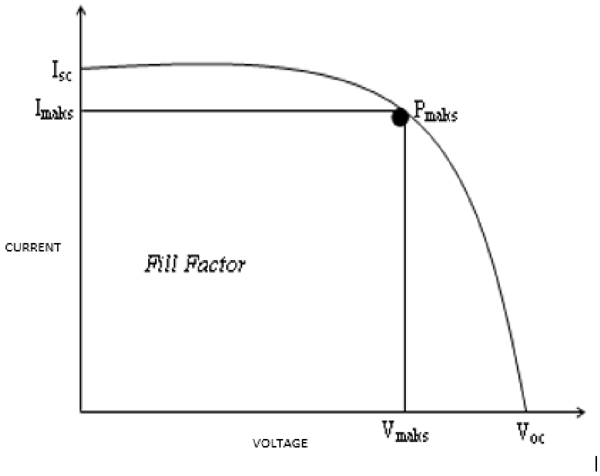


Figure 1. DSSC I-V Curve.

When the cell is in a short circuit condition, it will produce a maximum current or short circuit current (Isc). In an open circuit condition, the resulting current is zero, so that it will produce the maximum voltage or open circuit voltage (Voc)(10). Pmax is a point where the maximum power generated by a solar cell. Fill Factor (FF) is a quantitative measure of the quality of a solar cell, as well as a measure of the outer square of the I-V curve, Fill Factor can be obtained using equation 1.

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

The maximum power generated by solar cells can be obtained through equation 2.

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

The efficiency produced by solar cells can be obtained through equation 3.

$$\eta = \frac{P_{maks}}{P_{in}} \text{ ....(3)}$$

This efficiency value is a global measure in determining the performance quality of a solar cell. The efficiency of a solar cell depends on the temperature of the cell and more importantly the quality of the illumination. For example, the intensity of the light and the intensity of the distributed spectrum. The efficiency of a solar cell, which is a quantitative ratio of the maximum power produced by the cell (Pmax) to the power of the incident light (Plight) can be determined by equation (3).

Method

In this study, nano size TiO2 was used, namely Titanium (IV) Oxide, anatase Titanium dioxide powder, 99.8% trace metals base. 0.5 gram of TiO2 dissolved in 2 ml of ethanol stirred for 40 minutes using a vortex stirrer. TiO2 was coated onto Fluorine Tin Oxide (FTO) conductive glass with a deposition area of 2 cm x 2 cm using the Slip casting and Spin coting method. The deposited TiO2 layer was heated at 0 - 5000C for 60 minutes on a hot plate. In this study, 4.5 grams of dye was used from kenikir (Sulfur Cosmos) leaf extract. Kenikir leaves are mashed using a mortar until quite smooth. The mashed kenikir leaves were dissolved in 25 ml of ethanol while stirring for 60 minutes.

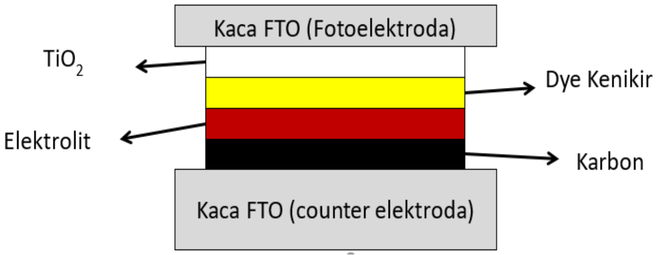


Figure 2. Structure of Kenikir dye DSSCs

The DSSC construction used is a sandwich system. The working electrode is an FTO conductive glass which has been coated with TiO2 which has been soaked with kenikir leaf dye. The counter electrode is an FTO conductive glass which has been coated with a thin layer of activated carbon. The electrolyte is made of I2/KI (Iodine/Potassium Iodide) which is mixed with PEG by dripping it between the opposing electrode and the working electrode, and is given a barrier using a keyboard protector to prevent short circuits. The working electrode and counter electrode as well as the electrolyte that has been dripped between the two are stacked and then clamped using a clipboard. Then DSSC is characterized by its current and voltage.

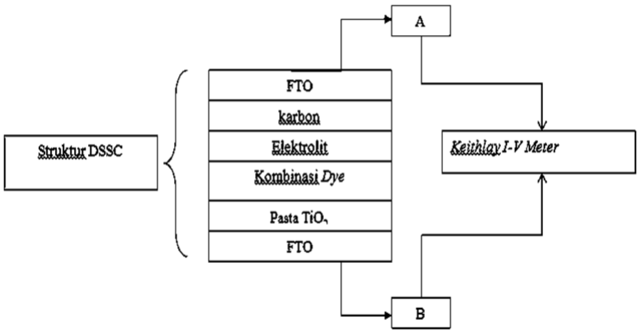
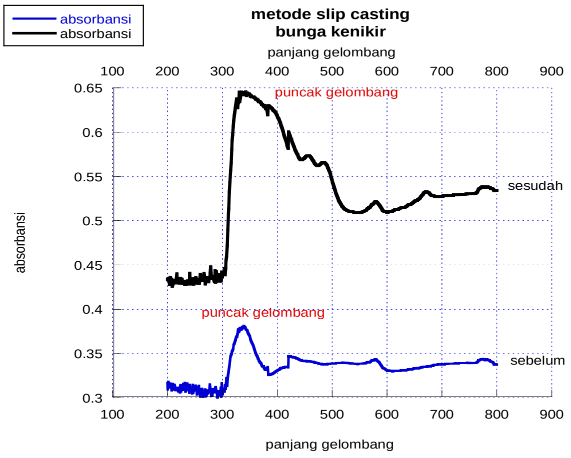


Figure 3. DSSC Voltage and Current Test Scheme

Result and Discussion

The dye solution is made from kenikir leaf extract (Sulpur cosmos) which can absorb and transmit the visible light spectrum. This dye functions as Dye Sensitized Solar Cells using kenikir leaf extraction as a dye sensitizer. Testing of kenikir leaf extraction was carried out using a UV Visible 1601 PC spectrophotometer using the Slip casting and Spin coting methods to determine the absorbance of kenikir leaf extract at visible wavelengths.

The absorbance spectrum was measured in the range of 200-800 nm. The results of the absorbance spectrum characterization in Figure 2 show that the absorption spectrum of kenikir leaf extract using the Slip casting and Spin coting methods is in the range of 320-380 nm.



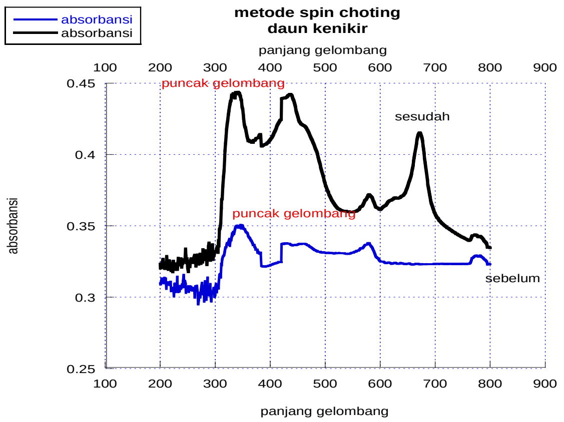
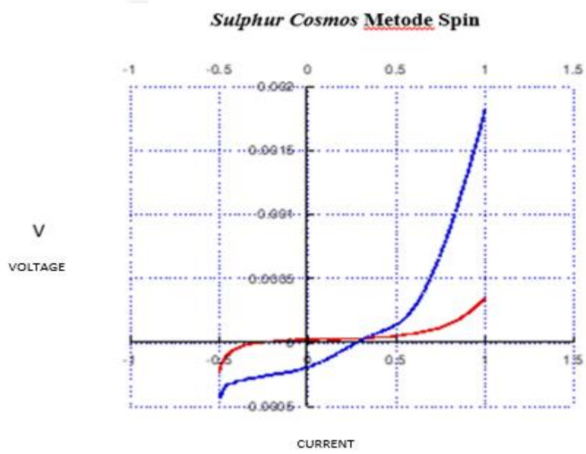


Figure 4. Graph of Cosmos Sulpur Absorbance Slip casting and Spin coting methods

Current-voltage (I-V) characterization is a method to determine the performance of Dye Sensitized Solar Cells, namely how much DSSC's ability to convert light into electrical energy I-V measurements are carried out in dark and bright conditions, namely under irradiation of a halogen lamp with an intensity of 1991 W/m2. The conductivity value of DSSC can be seen in the image below.



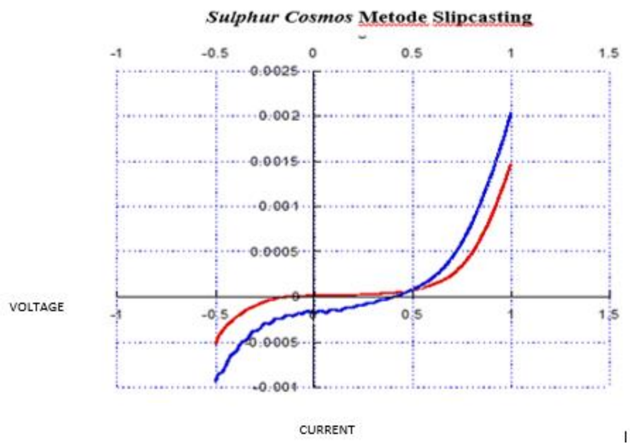


Figure 5. Graph of the conductivity of the Slip casting and Spin coting methods.

From Figure 5 shows the I-V curve of the conductivity value of the electrolyte in the bright current is greater than in the dark current. The efficiency produced by DSSC using Sulpur cosmos (Kenikir Leaf) extract with different treatments on TiO2 is presented in table 1. DSSC using the Slip casting method produces better efficiency compared to DSSC using the spin coting method.

Table 1. efficiency produced by DSSC

	Daun Kenikir	Voc (mV)	Isc (μA)	η (%)
1	Metode Slip casting	1.95×10^{-5}	1.88×10^{-4}	8.6×10^{-3}
2	Metode Spin coting	1.05×10^{-6}	1.17×10^{-5}	8.2×10^{-4}

The optimization results showed that the best efficiency was obtained in this study, namely 8.6 x 10-3%, namely in DSSC with the Sulpur cosmos (Kenikir Leaf) dye slip casting method.

Conclusion

Dye Sensitized Solar Cells (DSSC) solar cells use Sulpur cosmos extract (Kenikir leaves) with different treatments that have been fabricated. With the resulting current and voltage. The area of the curve shows that DSSC using the immersion method produces better I-V curves compared to DSSC using the drip method. The counter electrode is one of the important components that cannot be removed in the DSSC structure. Application of activated carbon to the counter electrode provides a fairly good performance on DSSC. Carbon serves as a catalyst in accelerating redox reactions with electrolytes. The efficiency produced by each Slip casting method is 8.6 x 10-3% while Spin coting is 8.2 x 10-4%.

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