

EFFECT OF TiO_2 WEIGHT ON THE EFFICIENCY OF DYE SENSITIZED SOLAR CELL (DSSC) USING NAVICULA SP. TAD MICROALGAE AS NATURAL DYE.

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ABSTRACT

Electricity requirements increase every year and have become a necessity for every household in the world. Alternative electricity sources will be required to handle the need. New and renewable energy (NRE) offer divers source on this issue; however, the development of these sources demands more exploration. DSSC or Dye Sensitized Solar Cell as the third generation of Solar Cell is one of the sources that can be explored. Using Microalgae as its dye is known to be an excellent choice for alternative natural dye. Navicula TAD, the original type of Microalgae found in Ambon Bay has been proven to be able to be a catalyst in electricity flow on DSSC. This research is investigating the effect of TiO_2 paste weight on the efficiency of DSSC that uses Navicula TAD as the natural dye. Early studies showed that as the weight of TiO_2 paste increases, the efficiency also increases. Using TiO_2 weight of 0.1; 0.3 grams, the greatest efficiency is found in the DSSC with 0.3 grams of paste. The efficiency of DSSC with 0.3 grams of TiO_2 paste is 17.02%.

Keywords: Efficiency, DSSC, Microalgae, Natural

INTRODUCTION

Electrical energy is a very basic need in this modern era. However, due to the increasing use of these energy sources caused by the industrial sector, transportation, household electricity, and others, it is necessary to find alternative energy sources that can meet these needs.

One solution is to utilize new and renewable energy, such as solar, wind, biomass, and water energy. Between these technologies, solar cells as an alternative energy source have been thriving in the last decade (Kemenristek, 2006). Solar cells based on the development of manufacturing technology can be divided into three categories. First, solar cells are made of single silicon, and multi-crystalline silicon. Second, thin film type solar cells (thin film) and third, organic solar cells (Dye Sensitized Solar Cell / DSSC) (Chang et.al, 2013). Conventional solar cells in the form of p-n junctions made of semiconductor materials such as silicon, are still expensive to develop because they use sophisticated technology. Until it was discovered by Gratzel, namely organic solar cells, DSSC as a solar cell with a dye sensitizer from organic materials could be developed at a low cost and easy fabrication (Ainurraziqin dan Artsanti, 2018).

According to Ma and Kuang (2011), in recent years the developed TiO_2 DSSC has attracted a lot of attention because of its low cost and easy manufacture. DSSC TiO_2 consists of a wide band gap semiconductor electrode such as TiO_2 coated on a sensitized conducting glass substrate.

Semiconductor electrode preparation methods play a very important role in DSSC performance. The weight of the TiO_2 paste that is applied to the semiconductor glass also greatly affects the electric current generated by the solar cell. Based on research by Gonzalez-Verjan et al (2020), the thicker the TiO_2 paste is used as an electrode in DSSC with synthetic dyes. In a study by Telussa et.al (2022), the use of the Navicula TAD microalgae originating from the Ambon Bay area can generate electric current with a maximum efficiency of $4.117 \times 10^{-3}\%$. On the other hand, this study has not examined the effect of TiO_2 paste weight on use with Navicula TAD dye.

Our study aims to ensure the effect of TiO_2 paste weight on DSSC made using Navicula TAD as natural dye. This study uses two weight variables, 0.1 and 0.3 grams of TiO_2 paste.

METHODS

The research started by collecting microalgae sample from Ambon Bay, and group them into the species. After doing so, then the process continued with cultivating the microalgae especially Navicula sp. TAD in the lab and extracting the crude from the organism.

After finished extracting the microalgae, then the ITO glass is prepared to put on the TiO_2 paste. Subsequently, the process was heating the glass and applied the Navicula sp. TAD dye. Then, electrolyte was dripped on the glass and continue to the efficiency testing process.

The testing was using solar artificial lamp GUNT HL 313.01, and two multimeters to measure the voltage and the amps. After getting the result, then the numbers were used in the formula to obtain the efficiency.

RESULTS AND DISCUSSION

After the solar cell is ready, proceed with the process of measuring volts and amperes. This measurement process uses GUNT HL 313.01 in the Solar Lab. Measurements were made on 2 weight combinations of TiO_2 paste. The weight used is 0.1 gr, and 0.3 gram.

Measurements are carried out using 2 multimeters, each showing voltage and amperage. The setting for the multimeter that shows the voltage is the DC current voltage for millivolt (mV) readings, and for the multimeter then it is set for DC current amperage readings in units of microamperes (μA).

The measurement showed the I-V Curve for each weight as follows:

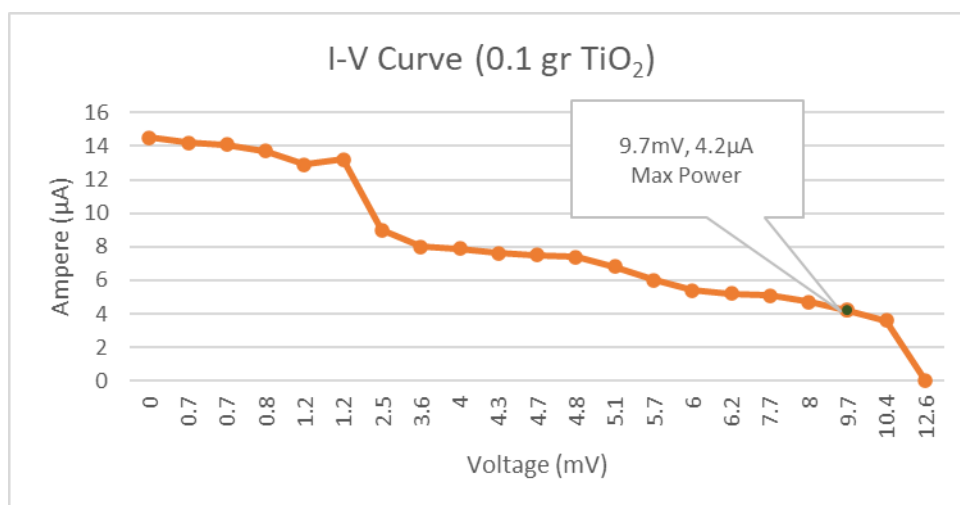


Image 5. I-V Curve of 0.1 grams of TiO_2 paste

The graph shows the V_{oc} and I_{sc} respectfully are 12.6 mV and 14.5 μA , maximum power produce by the DSSC is 40.7 mW. The fill factor (FF) is:

$$FF = \frac{V_{mpp} \times I_{mpp}}{V_{oc} \times I_{sc}} = \frac{9.7mV \times 4.2 \mu A}{12.6 mV \times 14.5 \mu A} = 0.18$$

The efficiency for 0.1 grams of TiO_2 paste is:

$$Efficiency (\eta) = \frac{V_{oc} \times I_{sc} \times FF}{P_{in}} \times 100 \% = \frac{12.6 mV \times 14.5 \mu A \times 0.18}{625000 \mu W} \times 100 \% = 5.47 \%$$

The result for 0.3 gram of TiO_2 paste is as follows:

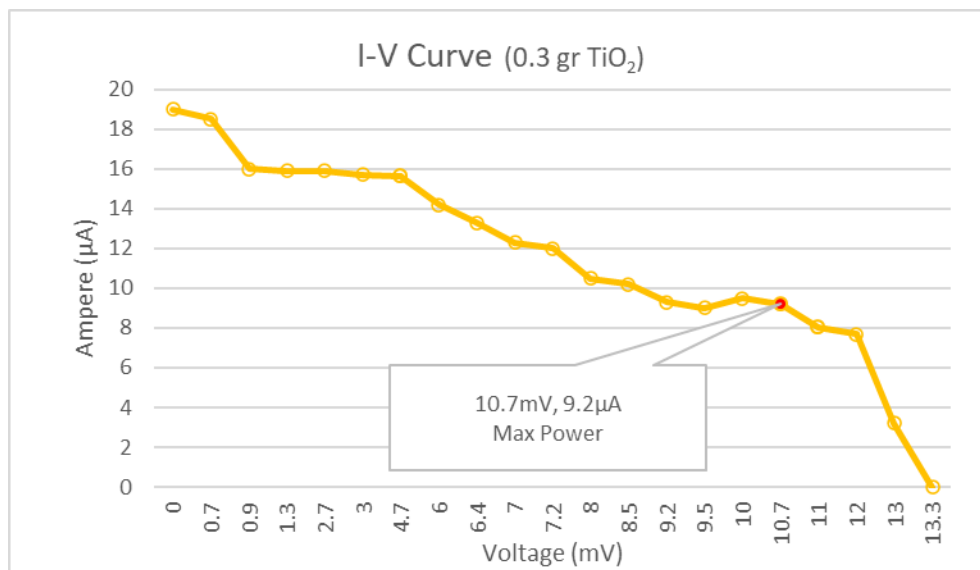


Image 6. I-V Curve for 0.3 grams of TiO_2 paste.

From the graph it is obvious that this variant produces more electricity than the previous one. The V_{oc} and I_{sc} respectfully are 13.3 mV and 19 μA , maximum power produce by the DSSC is 98.4 mW. The Fill Factor is:

$$FF = \frac{V_{mpp} \times I_{mpp}}{V_{oc} \times I_{sc}} = \frac{10.7mV \times 9.2 \mu A}{13.3 mV \times 19 \mu A} = 0.38$$

The efficiency is:

$$Efficiency (\eta) = \frac{V_{oc} \times I_{sc} \times FF}{P_{in}} \times 100 \% = \frac{10.7mV \times 9.2 \mu A \times 0.38}{625000 \mu W} \times 100 \% = 15.8 \%$$

From both results showed that, as the weight increases, the power produce is higher, and the efficiency is higher. The result is corresponded with the theory that the TiO_2 paste function is the semiconductor part of a DSSC, so increase weight of the TiO_2 paste will produce more power in a DSSC.

CONCLUSIONS

From the study, it can be concluded that:

1. *Navicula* sp. TAD microalgae can be use as natural dye in a DSSC.
2. The weight of the TiO₂ paste has influence on the power and the efficiency produced by the cell.
3. The DSSC with heavier TiO₂ paste (0.3 gram) give better power and efficiency compared to the lighter one (0.1 gram).

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