2012 International Conference on Environment, Chemistry and Biology
IPCBEE vol.49 (2012) © (2012) IACSIT Press, Singapore
DOI: 10.7763/IPCBEE. 2012. V49. 1

Fabrication and Characterization of Titanium Dioxide-Based Sensitized Solar Cell Using Vinegar

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Abstract. A project is designed primarily to Fabricate Solar Cell using Titanium Dioxide and vinegar as an alternative to that of the Gratzel Cell which is cheaper, non-toxic and more energy efficient. The characteristics of this device is, when titanium dioxide were mixed into dishwashing liquid it creates nanoparticles which absorbs heat energy from the sun called photons. When light rays strikes the titanium dioxide nanoparticles it then collects electrons. The electrons where then sensitized by vinegar to behave like conductors. As the electrons in the solar panels were heated, they can break free and carry electric charges. The charged electrons will now be transferred through the aluminum foil which serves as the negative electrode and the copper wire as the positive electrode. Using vinegar, dishwashing liquid, aluminum foil, copper wire, titanium dioxide, regular glass plate makes a cheap solar cell device. The photoelectrochemical characteristics of TiO_2 based sensitized solar cell were tested under simulated sunlight. Two cells were fabricated. Each cell constructed on one square foot and has twelve blocks of cell with 2in. x 3in. in each side. Based on the results obtained from day 1 under shadowed area from 5pm to 6pm, the first cell obtained 6.24volts with 154 microamperes; the second had 7.81 volts with 169 microamperes. Under moderate light source from 7am-8am, the first panel obtained 6.42 volts with 191 microamperes; the second panel had 7.90 volts with 210 microamperes. Under strong light source from 11am-12nn, the first panel obtained 6.50volts with 190 microamperes, and the second has 8.7volts with 252 microamperes. Results of the study shows strong exposure to sunlight exhibit the highest voltage mean generated by the solar panel compared to moderate and shadowed exposure. This implies that in terms of energy efficiency, this technology is much efficient than of the Gratzel Cell.

Keywords: Titanium dioxide, Nanoparticles, Vinegar, Dishwashing liquid, Voltage, Microamperes.

1. Introduction

The Dye-Sensitized Solar Cell (DSSC's) are relatively new class of low-cost solar cells that belong to the group of thin film solar cells. They are very promising because they are made of low-cost materials and do not need elaborate apparatus for their manufacture. They are currently the most efficient third-generation solar technologies available [1].

Through Plausible, one major disadvantage in the DSSC design is the use of the liquid electrolyte, which has temperature stability problems. At low temperatures the electrolyte can freeze, ending power production and potentially leading to physical damage.

Higher temperature causes the liquid to expand, making sealing of the panels a serious problem [2]. Replacing the liquid electrolyte with a solid has been a major ongoing interest for research. Recent experiments using solidified melted salts have shown some promise but currently suffer from higher degradation during continued operation and are not flexible [3]. Despite these, their price-performance ratio is high enough to allow them to compete with fossil fuels in electricity generation.

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Dye-Sensitized solar cells (DSC) show great promise as an inexpensive alternative to conventional p-n junction solar cells. Investigations into the various factors influencing the photovoltaic efficiency in this novel approach have recently been intensified [4-8].

Fabrication of Solar Cell using Titanium Dioxide and vinegar was an alternative to that of the Gratzel Cell which is cheaper, non-toxic and more energy efficient. The characteristics of this device is, when titanium dioxide were mixed into dishwashing liquid it creates nanoparticles which absorbs heat energy from the sun called photons. When light rays strikes the titanium dioxide nanoparticles it then collects electrons. The electrons where then sensitized by vinegar to behave like conductors. As the electrons in the solar panels were heated, they can break free and carry electric charges. The charged electrons will now be transferred through the aluminum foil which serves as the negative electrode and the copper wire as the positive electrode. Using vinegar, dishwashing liquid, aluminum foil, copper wire, titanium dioxide, regular glass plate makes a cheap solar cell device.

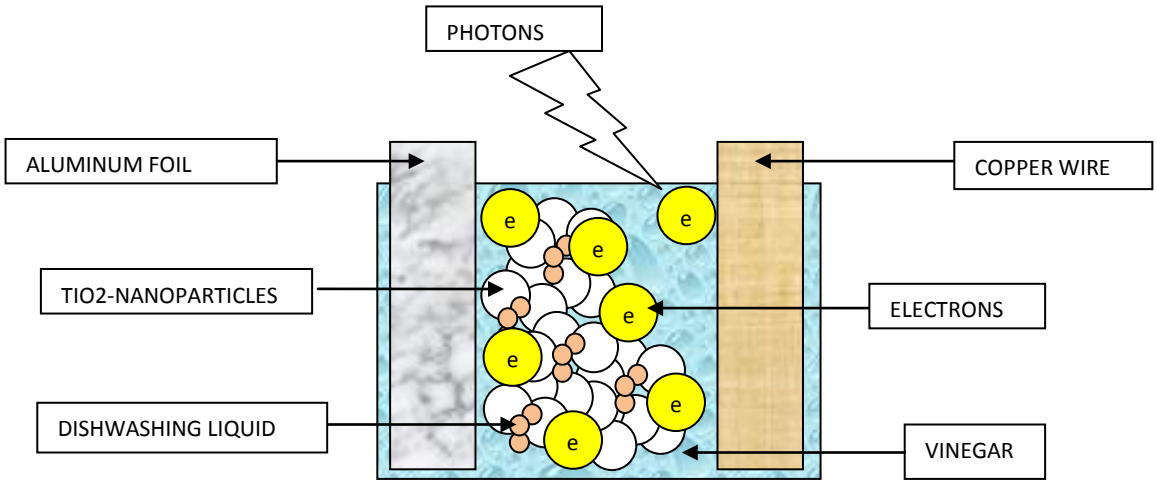

Fig. 1: Simulated Characteristics of TiO2-Based Sensitized Solar Cell Using Vinegar

2. Materials and Methodology

For a TiO2-SSC to be useful for practical applications, the device should be able to efficiently convert solar energy into electricity, the materials used needed to be nontoxic and the device production method environmentally friendly. The following components were purchased locally and used as major components.

i. Vinegar
ii. Titanium Dioxide
iii. Aluminum Foil
iv. 1 sq. ft. of Ordinary Glass
v. Copper wire
vi. Masking Tape 0.5 inch.
vii. Dishwashing Liquid
viii. Plastic Container (Serves as Mixing Bowl)
ix. Paper Clips
x. Digital Voltmeter/Ammeter

In order to fabricate a solar cell for a typical solar panel, five tablespoon (5 tbsp) of titanium dioxide were mixed with a few drops of pure vinegar and dishwashing liquid in a plastic container until colloidal suspension was obtained. (Fig.2.)

Fig. 2:

The two ordinary glasses were rinsed into running water to remove unnecessary greases and apply ethyl alcohol to clean the glass thoroughly. (Fig. 3)

Fig. 3:

The two glasses were taped to make 12 blocks of the same size (the blocks depends on how you design the cell). (Fig. 4.)

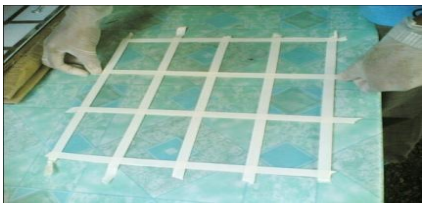

Fig. 4:

The titanium dioxide mixtures were then spread into the surface of each block. Same procedure will be applied on the other glass. (Fig. 5.)

Fig. 5:

The tapes will then remove carefully and let it dry for about 10-15 minutes. (fig. 6.)

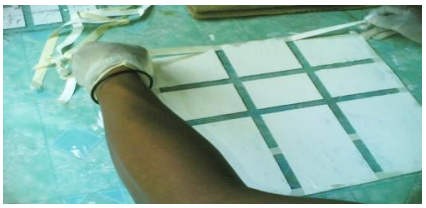

Fig. 6:

In preparing the working electrodes, prepare an aluminum foil and copper wire and cut about half of the size of the block. (Fig. 7.)

Fig. 7:

Mount the aluminum foil and copper wire on each block layered with titanium dioxide mixture which will serve as the terminal point-aluminum foil as the negative terminal and copper wire as the positive terminal. (Fig. 8.)

Fig. 8:

The connection of each block/cell will be in series circuit which means the total voltage output is the sum of all the voltage on each blocks/cells. The positive terminals were connected to the negative terminals of every blocks/cells. (Fig. 9)

Fig. 9:

Small amount of titanium dioxide were added in between the terminals to avoid contact. (Fig. 10)

Fig. 10:

Mount the other glass on the finished device for final sealing. (Fig. 11)

Fig. 11:

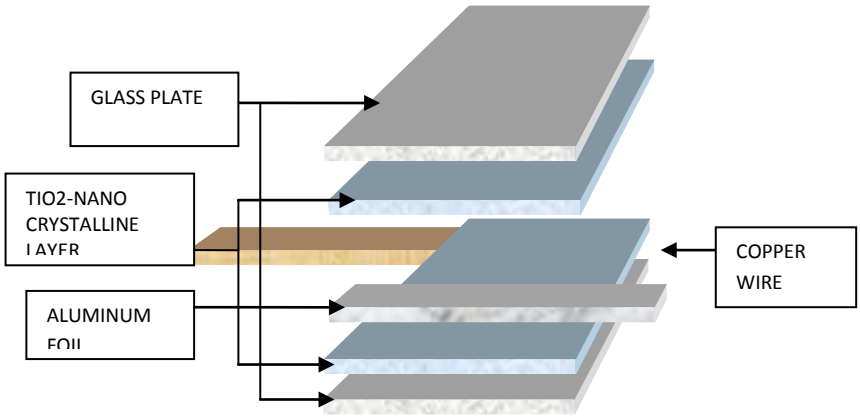

Fig. 12: Configuration of TiO2-Based Sensitized Solar Cell Using Vinegar

3. Results and Discussion

The photo electrochemical characteristics of TiO based TiO2-SSC were tested under simulated sunlight. Two Cells were fabricated. Each cell constructed on one square foot and has twelve blocks of cell 2x3 in each. Based on the results obtained from day 1 under shadowed area from 5pm to 6pm the first cell obtained

6.24 volts with 154 microamperes, the second had 7.81 volts with 169 microamperes. Under moderate light source from 7am -8 am, the first panel obtained 6.42 volts with 191 microamperes, the second panel had 7.90 volts with 210 microamperes. Under strong light source from 11am -12nn, the fist panel obtained 6.50 volts with 190 microamperes, and the second 8.7 volts with 252 microamperes.

Results of the study show that strong exposure to sunlight exhibit the highest voltage mean generated by the solar panel compared to moderate and shadowed exposure. This implies that in terms of current generation, the stronger light available, the higher the current produced by the solar and the voltage produced does not affect any of three conditions exhibited.

4. Conclusion

Using vinegar, dishwashing liquid, ordinary glass, aluminum foil, copper wire and titanium dioxide can also generate electricity and could be a valid competitor to solid-state junction devices for the conversion of solar energy into electricity. It has been observed that during testing of the device it produces an output of 6.24 volts with 154 microamperes which means 0.52 volts and 154 microamperes each block/cell. Other device was constructed with different mixture; it obtained 7.81 volts with 169 microamperes. It was found out that the performance of the cell is affected by different mixtures and also depends on the intensity of the light source. However, proper formula for mixing can generate large amount of voltage and current.

5. Recommendations

Even though the efficiency of the solar cell is good, there are still more to be done in order to improve it. Like, (a) prolonging the life expectancy of the device (b) use more systematic approach in preparation of mixtures.

The new DSSC materials should be considered as interesting future alternatives for the conventional photovoltaic materials as incorporation of these materials with existing large scale manufacturing process could open new directions for the development of low-cost solar cells in the future.

6. Acknowledgement

This work is supported by Sultan Kudarat State University(SKSU)-Kalamansig Campus, SKSU-System, SKSU-Research Division, SKSU-Finance Division, LGU-Kalamansig. Aid in manuscript preparation by Dr. Julie E. Albano, Dr. Rande B. Dechavez, Prof. Victorino M. Laviste, Dr. Ruby S. Hechanova, Dr. Teresita L. Cambel and experimental assistance by Al-Rhasid Panasang, Eduardo Aquino and Razel Baring most especially to my Family and very supportive sister Aline Remegio, my loving and understanding wife, Florlyn Cabang.

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