American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-7, Issue-2, pp-211-214
www.ajer.org
Research Paper Open Access

Electrical Characterization of Solar Cells Sensitized With Natural Dye Extracted From Local Plant as a Photosensitizer

[1]Sanusi Y.K, [1]Kazeem A.A, [2]Afolabi B.A And [3]Olabisi .O And [4]Faluyi O.O

[1]Department of Pure and Applied Physics Ladoke Akintola University of Technology Ogbomoso, Oyo State, Nigeria

[2]Department of Physics College of Education Ilorin Kwara State, Nigeria.

[3]Department of Science Laboratory Technology Ladoke Akintola University of Technology Ogbomoso, Oyo State, Nigeria.

Department of Physics Kwara State University, Ilorin Kwara State, Nigeria.

Corresponding author: Sanusi Y.K

ABSTRACT:*One of the most important considerations for those working towards the commercialization of dye-sensitized solar cells (DSSCs) is how to replace metal complex and novel man-made dyes that their processing and synthesization are complicated and costly with development of photosensitizes whose absorption extends to the near infra-red (IR). Therefore, it has been emphasized by many researchers to obtain useful dyes as photo sensitizers for DSSC's from natural products, because of the simple preparation techniques, widely available sources, and low cost. The present study aims to investigate the electrical performance of natural photosensitizers extracted from locally available plant for dye-sensitized solar cells. The natural photosensitizers was extracted from fresh leaf of henna plant.. Photo electrochemical solar cells were fabricated by sandwiching a Platinum spluttered conducting glass plate with dyed TiO2 film. The photocurrent-voltage characteristics under constant illumination of 28.28mv/cm^2 with a Xenon lamp for all the samples fabricated were carried out. The overall conversion efficiencies and fill factors were calculated. It revealed from results obtained that DSSCs were successfully fabricated under experimental conditions using fresh hennea leave as a natural dye for DSSC sensitizer. The dye extract from henna leaf gives the good performance as dyes using TiO_2 synthetic. The highest efficiency of 0.0548% was obtained for nanocrystalline film of µm thick. The corresponding filling factor was 0.9037 %. These results and efficiency value in particular obtained for the DSSCs affirm that fresh henna leave extract is good sensitizer for DSSC application.*

KEY WORDS: *Photosensitizer; Solar cells; Electrical performance; natural dyes*

Date of Submission: 09-02-2018 Date of acceptance: 26-02-2018

I. INTRODUCTION

Solar energy can be explored through generation of electricity from sunlight using solar cells semiconductor devices that is, photovoltaic technology or production of thermal energy from sunlight using solar collector (Thermal Technology).The basic functional solar cells are crystalline silicon on which several studies have been done since 20th century [1]. The solar cells made from the crystalline silicon were generally very efficient as its conversion efficiency from photon to electrical current have been obtained [2], but the major problem is high cost of production. Besides crystalline silicon, there are other two materials that have reached the situation of mass production; Cadium Telluride (CdTe) and Copper Indium –Gallium diselamide,(Cu(InGe)Se [3]. However, the cost for these materials still high and relatively lower conversion efficiencies [4]. As a result of this high cost of production, researchers have been working on developing a cheaper and efficient solar cells to make photovoltaic technology accessible to a common man. In achieving this, recently developed Dye- sensitized Solar cells (DSSCs) appear promising [5]. DSSCs can be used for a wide variety of applications. DSSCs don't lose effectiveness at high temperature like crystalline silicon solar cells do, making them ideal for hotter environment, however, their conversion efficiencies remain a challenge as efficiency comparable to silicon solar cell has not been recorded [6].

To enhance the conversion efficiency, sythentized inorganic material, Ruthenium (ii) complexs with carboxylated polypyridyl ligards are usually used as molecular sensitizers in DSSCs. Several types of organic synthetic dyes have been actively studies and tested as low-cost materials to replace the rare and expensive ruthenium compounds. Many researchers have recorded good solar – electrical conversion, testing natural dyes as the cheaper and environmentally friendly alternatives to these artificial sensitizers for DSSCs. Some flowers, plants and bacteria contain several pigments that can be extracted and be used as a sensitizer in DSSCs. Unlike artificial dyes, natural dyes are non-toxic, easy to prepare, low in cost and biodegradable. For this reason many researchers efforts have recently focused on the development of new efficient sensitizer that could help improve device performance and allow for practical and real use of this solar cell technology beyond laboratory. However, in this study, electrical evaluation performance of natural photosensitizers for dye-sensitized solar cells with nanocrytalline TiO2 will be investigated.

II. METHODOLOGY

The preparation of TiO_2 paste has been discussed in details elsewhere [5].The TiO_2 layer nanoparticle films were deposited on to conductive FTO glass substrate by Doctor Method techniques. The deposited TiO_2 were sintered for 40minutes at 45^0C at slow heating rate. The thickness of the films was controlled using different blading guides thickness to obtain five (5) different samples labelled A,B,C,D and E . The six specimens were annealed with electric oven set at different temperatures and for specific duration and allowed to cool. They were then kept in well covered glassware to prevent contamination. The thickness t, of the TiO_2 thin films was determined by equation 1.

$$t = \frac{m_2 - m_1}{AD} \quad (1)$$

Where; M_1 = mass of substrate before deposition
M_2 = mass of substrate after deposition
A = Area covered by the film
D = Density of the thin film (6.44 g/cm^3)

After this, the films were sensitizes by soaking in the fresh hernn leaf extract dye solution and left for hours. After the specified time, the specimens were carefully removed, air dried and kept in a sealed petridishes. The outer surface of the petridishes were covered with black tape to prevent the specimen from direct sunlight.

A low cost counter electrode was applied in this study. Carbon soot is used as a counter electrode. This was obtained by depositing a layer of carbon sooth on the conductive side of the FTO as a substrate. FTO glass was deposited by burning with candle for 20seconds without a direct hit by a candle flame, this resulted to an opaque carbon layer on the substrate.

A prepared counter electrode was then placed on a bench with the carbon layer pointing upward. Then the FTO/ TiO_2 slides were placed laterally into an offset on top of the counter electrode so that the TiO_2 film faced downward against the carbon layer. Binder clips were used to held the DSSC together (Plate 1 A and B).

The photocurrent-voltage (I-V) characteristics under constant illumination of 28.28mv/cm^2 with a Xenon lamp for all the samples were carried out using solar simulator.

The overall conversion efficiencies and fill factors were calculated using equation 2 and 3 respectively:

$$Fill\ Factor\ FF = \frac{I_m \times V_m}{I_{sc} \times V_{oc}} \frac{I_m \times V_m}{I_{sc} \times V_{oc}} \quad (2)$$

$$Efficiency = \frac{I_m \times V_m}{Input\ \ Photon\ \ Power} \times 100\% = \frac{I_{sc} \times V_{oc} \times FF}{Input\ \ Photon\ \ Power} \times 100\% \quad (3)$$

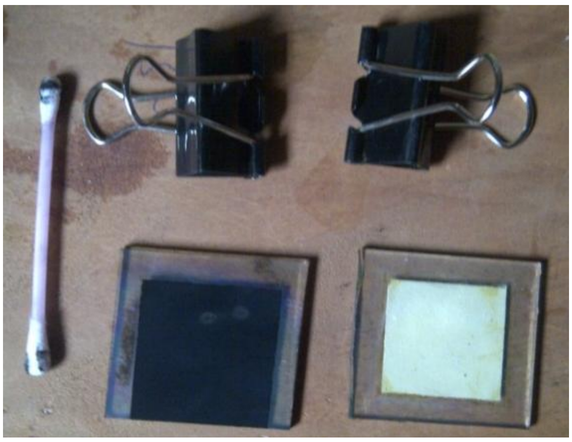

Plate 1A: Cell Components

Plate 1B: Fabricated DSSCs

III. RESULTS AND DISCUSSION

Table 1 and figure 1 present the results of electrical evaluation performance of all the solar cells sample fabricated.

Characteristic Curves of DSSC

The photocurrent-voltage (I-V) characteristics under constant illumination of 28.28mv/cm^2 with a Xenon lamp for all the samples are displayed in figures. The highest efficiency of 0.0548% was obtained for nanocrystalline film of µm thick. The corresponding filling factors was 0.9037 %. These results and efficiency value in particular obtained for the DSSCs affirm that fresh henna leave extract is good sensitizer for DSSC application.

Table 1: Table of Response Values for DSSCs

CELL	Thickness (µm)	Annealing Temp (°C)	Annealing Time (hrs)	Dye Laoding Time (hrs)	Max Voltage (mV)	Max Curren t (mA)	Fill Factor (FF)	Efficiency Ŋ(%)
SS1	2.3167	300	2	2	89.5	0.28	0.9034	0.0119
SS2	2.1858	400	4	4	92	0.29	0.8296	0.0127
SS3	2.2167	500	6	8	148	0.47	0.7627	0.0364
SS4	5.4758	400	6	2	177.5	0.57	0.9017	0.0457
SS5	6.1076	500	2	4	180	0.605	0.8594	0.0548

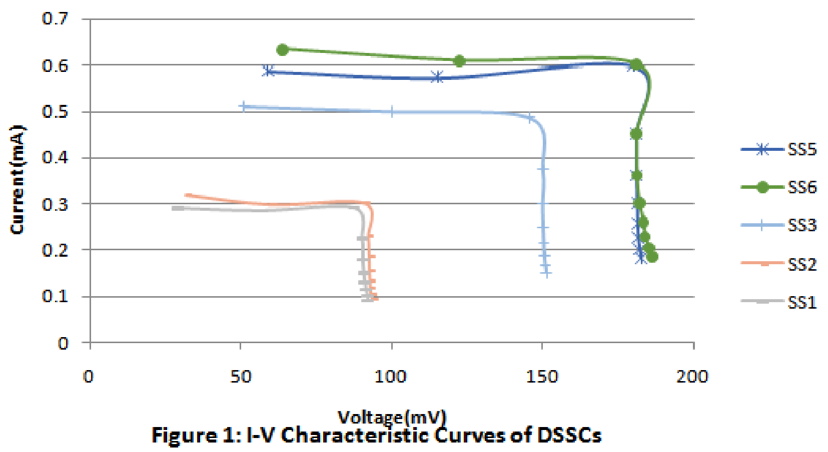

Figure 1: I-V Characteristic Curves of DSSCs

IV. CONCLUSION

DSSC has been attracting considerable attention all over the world because of their reasonable electrical conversion efficiency and low cost of production. In order to replace the expensive synthetic inorganic compounds usually employed as molecular sensitizers in DSSC, many organic synthetic dyes have been actively studied and tested as low-cost materials. In this study, six DSSCs specimen were successfully fabricated under experimental conditions using fresh hennea leave as a natural dye for DSSC sensitizer. The dye extract from henna leaf gives the good performance as dyes using TiO_2 synthetic and carbon soot as counter-electrode. Therefore, the use of fresh henna leave is recommended for DSSC application and further research on natural dye is recommended with the hope that someday a natural dye that will outperform ruthernium based dye complexes can be discovered.

REFERENCES

[1]. [1]. Dai, Q. and Rabani, J., 2002. Photosensitization of nanocrystalline TiO2 films by anthocyanin dyes. *Journal of Photochemistry and Photobiology A: Chemistry*, 148, 17–24.

[2]. [2]. Grätzel, M., 2003. Dye-sensitized solar cells. *Journal of Photochemistry and Photobiology C: Photochemistry Reviews*, 4, 145–153.

[3]. [3]. I Jinchu, C. O. Sreekala, and K. S. Sreelath (2014), "Dye Sensitized Solar Cell using Natural Dyes as Chromophores – Review", *Materials Science Forum*, vol. 771, pp 39-51,

[4]. [4]. K. Ebrahim Jasim, "Natural Dye-Sensitized Solar Cell Based on Nanocrystalline TiO", *Sains Malaysiana*, vol. 41, pp. 1011–1016,

[5]. [5]. Sanusi Y.K, Asafa T.B and Kazeem A.A (2016): Optimization of TiO_2 Based Henna Dye Sensitized Solar Cell using Grey-Taguchi Technique. International Journal of Renewable Energy Research, Vol. 6 (3) pp 1119-1128

[6]. [6]. T. El-Agez, S. Taya, K. ElRefi, and M. Abdel-Latif (2014), "Dye sensitized solar cells using some organic dyes as photosensitizers", Optica applicata, vol. 44, pp. 345–351,

Sanusi Y.K "Electrical Characterization of Solar Cells Sensitized With Natural Dye Extracted From Local Plant as a Photosensitizer" American Journal of Engineering Research (AJER), vol. 7, no. 2, 2018, pp. 211-214.