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Fabrication of 5-Nitrosalicylaldehyde with Aniline as Sensitizer for Dye Sensitized Solar Cells

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Abstract

Objectives: To create a DSSC circuit, combine 5-Nitro Salicylaldehyde with Aniline (5NSA). **Methods:** Working and counter electrodes are made of TiO_2 and activated carbon film. Digital multimeters are used to test the conductive side of FTO glass prior to deposition. Graphite is used as the counter electrode. A functioning electrode was developed on conductive glass. FTO glass plate edges with Scotch tape (on the conductive side as determined by a multimeter). Distribute three drops of TiO_2 blade-coated electrodes equally using a glass stirring stick. 5-nitrosalicylaldehyde and aniline dye are applied to the working electrode. I-/KI are electrolytes. An electrolyte is KI solution. I-V and P-V properties were examined in direct sunshine and a solar simulator. **Findings :** Using a digital multimeter and a solar simulator with glass plates, analyzed the efficiency of DSSC in Mayiladuthurai (L1), Nagapattinam (L2), and Vedaranyam (L3). The DSSC constructed with 5-Nitro salicylaldehyde and an aniline circuit is obtained direct sunlight from a combination of 5NSA (L1-2.95 % ;L2-2.3 % ;L3-4.4 %) with an open circuit voltage (Voc) of (L1-26 mV;L2-38mV ;L3-39mV) and a short circuit current density (Isc) of (L1-80 mA;L2-60 (L1- 1.42 % ; L2-.1.01 % ; L3-1.9 %). Different glasses determine the lowest and maximum light locations of the solar simulator. 5NSA discovered 5.8mV from frosted glass in lamp position 5 and a fill factor of 8% from plain glass in lamp position 5(0.92%). **Novelty:** 5NSA pigments with optimized agents exhibited improved photovoltaic properties, absorbed more sunlight, and utilized photon energy more effectively.

Keywords: Aniline; Dye Sensitized Solar Cells (DSSC); Solar simulator; Titanium dioxide (TiO2); 5-Nitro Salicylaldehyde

1 Introduction

Dye Sensitized Solar Cells (DSSC) were formed and operated using TiO_2 layered with 5-Nitrosalicyladehyde with Aniline and 5-Methylsalicyladehyde with Aniline on FTO glass. The first TiO_2 covered with 5NSA dye module reached more than 39mv, 60mA, and 4.4 percent efficiency[1]. The goal of the research is to get data that indicate greater efficiency in the manufacture of difluorometallic compounds (DSCC) from organic molecules. The DSSC is created using a synthetic dye, 5-Nitro salicylaldehyde with aniline (5NSA)[2]. The development of important components such as semiconductor films, dye sensitizers, redox electrolytes, and conducting substrates in dye-sensitized solar cells has been discussed shown in Figure 1. Researchers have been drawn to a significant advancement in the use of biodegradable organic dyes for DSSC. A sensitizer, which is mounted to the outside of a broad crew semiconductor, absorbs light.[3] The performance of the DSSC was investigated using the Solar Simulator and the Direct Radiation technique. UV spectroscopic characterization has also been examined, as has scanning electron microscopy (SEM).[4]

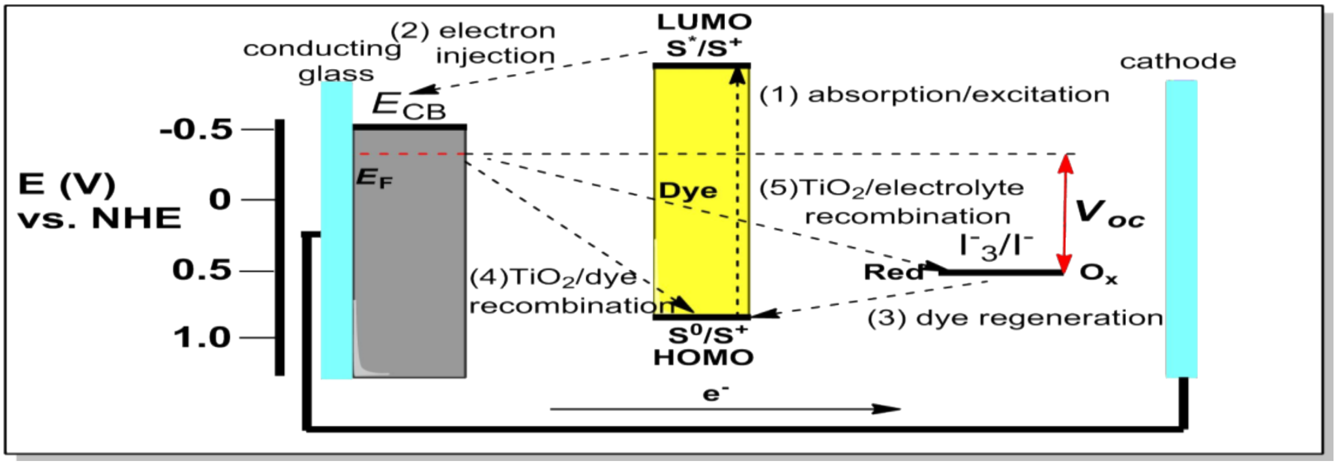

Fig 1. Schematic depicting of a device operation in Dye Sensitized Solar Cell (DSSC)

2 Methodology

2.1 Preparation of the dye 5NSA

Salicylaldehyde and aniline were immersed in a solution for 1 hour at 324K. Each dye is combined with ethanol and swirled at room temperature for 10 minutes[5,6]. The dye was then filtered via Whatman filter paper Figure 2.

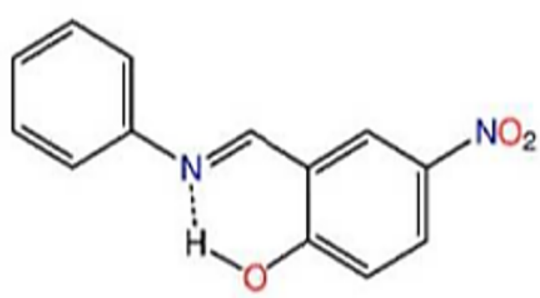

Fig 2. Chemical structure 5-Nitro Salicylaldehyde with Aniline Dye

2.2 Preparation of TiO_2 paste and electrolyte

TiO_2 powder and acetic acid are used to make this product. Iodine/potassium iodide (I+/KI) is available from Sigma-Aldrich. For 60 minutes, the powder is mixed at room temperature.[7]

2.3 Assembling of DSSC

A cell electrolyte solution coated with DSSC is injected. For cathodes, FTO glass is pencil-coated with graphite. The anode and cathode are sandwiched together. This is the 5NSA training. Tint was extracted using ethanol. The optical density was measured using a Perkin Elmer-Lamda 35, and productivity was measured using a solar spectrometer.

Experimental methods

Afterward the creation of the DSSC performance has been analyzed by the following methods:

- Solar Simulator-Method I
- Direct Radiation from the sun –Method II

The solar trainer device measures the DSSC of a Sun-derived chemical and dye. The instrument's direct radiation is used to measure the Sun's reflectance before and after peak sunlight.

2.4.1 Solar Simulator

This work used TiO_2+5NSA to construct a DSSC. The performance of the cell will be evaluated using a solar simulator. This simulator is equipped with two lights, a fan, and four-quadrant electricity.

2.4.2 ***Direct radiation***

A DSSC is formed from TiO_2+5NSA. This research evaluated I-V and P-V by exposing the produced DSSC to bright sunlight and collecting data at several points during the monsoon season.

2.4.3 Testing the performance of the DSSC (TiO_2+5NSA cell to Direct Sunlight and Solar Simulator)

Digital multimeter was used to measure open circuit voltage (V_{oc}) and short circuit current (I_{sc}).We're testing DSSC (TiO_2+5NSA) in Mayiladuthurai, Nagapattinam, and Vedaranyam. Solar cells turn light into electricity. Direct sunlight is used to test a solar cell's I_{sc} and V_{oc} (V_{oc}). Multiplying voltage and current yields maximum power (V_{max}, I_{max}). Comparing maximum power, V_{oc}, and I_{sc} determines solar cell performance.

Fill factor (FF) measures solar cell performance and the I_{sc}-V_{oc} curve's square area[8] gives FF.

Fill Factor, $\mathbf{FF} = \mathbf{V}_m\,\mathbf{I_m} / \mathbf{V}_{oc}\,\mathbf{I}_{sc}$

The maximum power (P_{max}) produced by the solar cell can be obtained through the equation

$\mathbf{P}_{max} = \mathbf{V}_{oc} \times \mathbf{I}_{sc} \times \mathbf{FF}$

Efficiency (η) produced by solar cells can be obtained through the equation

Efficiency, $\eta = \mathbf{V}_{oc}\,\mathbf{I}_{sc}\,\mathbf{FF}/\mathbf{P}_{in}$

3 Results and Discussion

3.1 Absorbance of 5NSA dye

5-Nitro salicylaldehyde light aniline absorption 5NSA absorbs light at 200-500 nm (Perkin Elmer-Lamda 35). 5NSA absorption peaks at 458 nm. While the absorption intensity is 2.6 a.u., the energy band gap is 2.71 eV Figure 3, which is semiconducting[9].

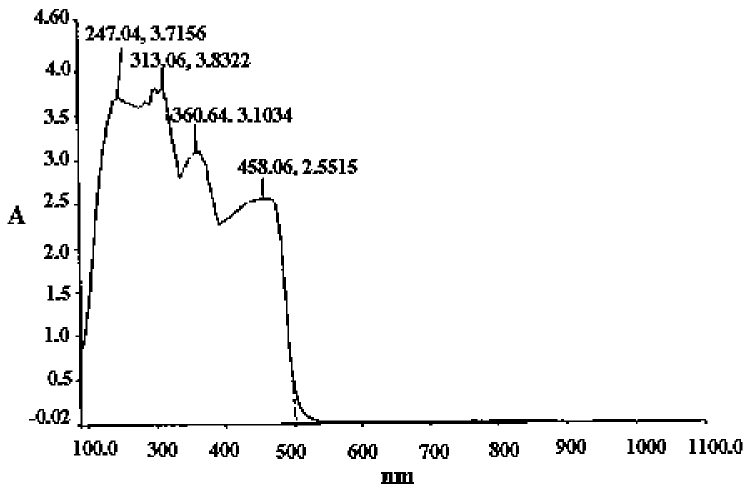

Fig 3. Absorbance spectrum of 5NSA UV-Vis spectrum

3.2 UV spectrum of TiO_2 Thin film

Figure 4 and Table 1 illustrate TiO_2's light absorption. TiO_2 absorbs light at 200-500 nm (Perkin Elmer-Lambda35). TiO_2 absorbance peaks at 383 nm [10]. 4au absorption. It's 3.2eV.

Table 1. UV Spectrum Analysis of TiO_2 thin film:

Compound	Wavelength(nm)	Absorption(A)	Band gap(eV)
TiO_2	383	4	3.2

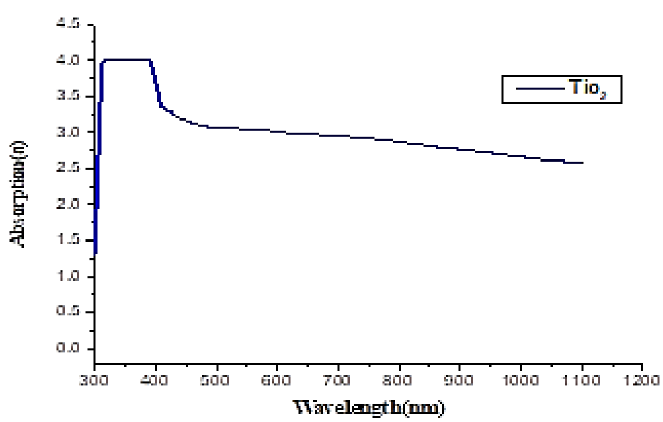

Fig 4. UV spectrum of TiO_2Thin film

3.3 SEM images of TiO_2 +5NSA Dye

Thin-film TiO_2+5NSA is examined by SEM. The particles' size and average diameter resemble small aggregates. Figure 5 shows that the predominant elements of the thin film TiO_2+5NSA produced are 200nm nanoparticles.[11]

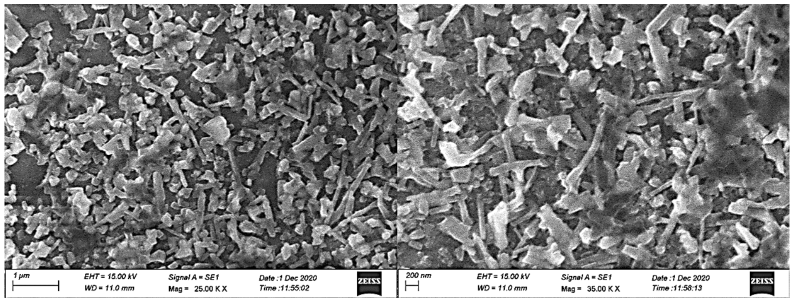

Fig 5. SEM images of TiO_2+5NSA Dye

3.4 I-V Performance of TiO_2+5NSA in solar simulator with different glasses

3.4.1 Solar simulator reading for DSSC, Different lamp position and lamp illuminated in Frosted glass

DSSC, frosted glass light, 33°C, lamp position 1. Isc = 0.01 mA, Voc = 1.3 mV. The maximum voltage (V_{max}) is 0.23 mV, the maximum current (I_{max}) is 0.15 mA, the maximum power voltage (P_{max}) is 0.0345 mW, the Fill Factor (FF) is 2.7%, the short-circuit current (I_{sc}) is 0.01 mA, and the open-circuit voltage (V_{oc}) is 1.5 mV. Short circuit current (I_{sc}) is 0.01 mA, and open circuit voltage (V_{oc}) is 2.7 mV in lamp position 3.The maximum voltage (V_{max}) is 0.6 mV, the maximum current (I_{max}) is 0.24 mA, the maximum power voltage (P_{max}) is 0.144 mW, the fill factor (FF) is 5.3%, the short-circuit current (I_{sc}) is 0.01 mA, and the open circuit voltage (Voc) is 4 mV in lamp position 4.The maximum voltage (V_{max}) is 0.5 mV, the maximum current (I_{max}) is 0.30 mA, the maximum power voltage (P_{max}) is 0.15 mW, the fill factor (FF) is 3.7%, and lamp position 5 has an open circuit voltage (V_{oc}) of 5.8 mV and a short-circuit current (Isc) of 0.01 mA. Maximum voltage (V_{max}) was 1.01 mV, maximum current (I_{max}) was 0.46 mA, and fill factor (FF) was 8% [12]. Figure 6 (a) & (b) and Table 2 show all lamp readings.

3.4.2 Solar simulator reading for TiO_2+5NSA, Different lamp position and lamp illuminated in Plain glass

Voc and Isc for DSSC, plain glass, lamp position 1, 33°C. Isc = 0.01mA, Voc = 2.6 mV. maximum voltage (V_{max}) and current (I_{max}) of 0.29 mV, maximum power voltage (P_{max}) of 0.08 mW, fill factor (FF) of 3.2%, lamp position 2, short circuit current (I_{sc}) of 0.01 mA, and open circuit voltage (V_{oc}) of 4 mV Maximum voltage (V_{max}) of 0.1 mV and current (I_{max}) of 0.34 mA, maximum power voltage P_{max} of 0.034 mW, fill factor FF of 0.85%, lamp position 3, short circuit current (I_{sc}) of 0.01 mA, and open circuit voltage (V_{oc}) of 4.6 mV. The maximum voltage (V_{max}) is 1.4 mV, the maximum current (I_{max}) is 0.38 mA, the maximum power voltage (P_{max}) is 0.532 mW, the fill factor (FF) is 11.5%, and the lamp position is number four. Short circuit current (Isc) is 0.01 mA, and open circuit voltage (V_{oc}) is 5.5 mV. The maximum voltage (V_{max}) is 0.4 mV, the maximum current (I_{max}) is 0.3 mA, the maximum power voltage (P_{max}) is 0.645 mW, the fill factor (FF) is 11.7%, and lamp position 5 has an open circuit voltage (V_{oc}) of 6.5 mV and a short-circuit current (I_{sc}) of 0.01 mA. The maximum voltage (V_{max}) was 0.2mV, the maximum current (I_{max}) was 0.6 mA, and the fill factor (FF) was 1.84 percent [13]. Figure 6 (c) & (d) and Table 2 show all light position readings.

Table 2. Solar simulator reading of DSSC (TiO_2+5NSA) with difference glass plates

Glasses	Compounds of DSSC	Lamp position	Open Circuit Voltage ,V_{OC} (mV)	Short Circuit Current, I_{SC} (mA)	Fill Factor, FF%
Frosted Glass	TiO_2+5NSA	1	1.3	0.01	2.7
		2	1.5	0.01	6.4
		3	2.7	0.01	5.3
		4	4	0.01	3.75
		5	5.8	0.01	8
Plain Glass	TiO_2+5NSA	1	2.6	0.01	3.2
		2	4	0.01	0.85
		3	4.6	0.01	11.5
		4	5.5	0.01	11.7
		5	6.5	0.01	0.92

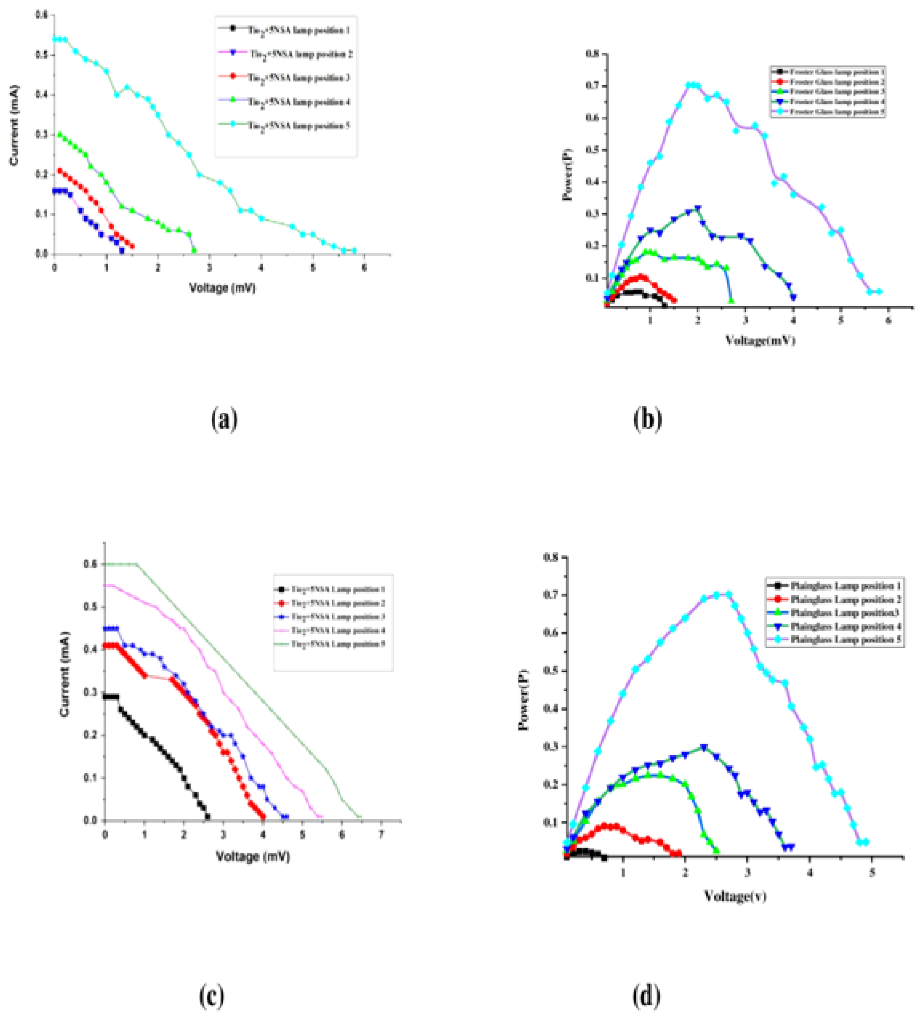

Fig 6. (a)I-V and (b) P-V characteristics of DSSC, Compounds of TiO_2+5NSA, Light illuminated with Frosted glass (c) I-V and (d) Voltage (mV) characteristics of DSSC, Compounds of TiO_2+5NSA, Light illuminated with Plainglass

3.5 I-V performance of TiO_2+5NSA in direct sunlight

V_{max} and I_{max} for DSSC in a (TiO_2+5NSA) cell at 33°C in Mayiladuthurai (L1). 7.15 mV V_{max}, 415 mA I_{max}, and 2967 mW P_{max} in Nagapattinam. 30°C. TiO_2+5NSA attained maximum voltage (V_{max}) of 4.17mV and maximum current (I_{max}) of 550mA at Vedaranyam, 31°C. Figure 7 (a) & (b).Table 3 given the efficiency 4.4% of TiO_2 with 5Nitro salicylaldehyde aniline (DSSC), from Vedaranyam.

Table 3. Direct sunlight reading for TiO_2+5NSA Solar Cell Performance

Places	Compounds	Open circuit voltage,V_{OC} (mV)	Short circuit current,I_{Sc} (mA)	FillFactor,FF%	Efficiency,η%
Mayiladuthurai	TiO_2+5NSA	26	80	1.42	2.9
Nagapattinam		38	60	1.01	2.3
Vedaranyam		39	60	1.9	4.4

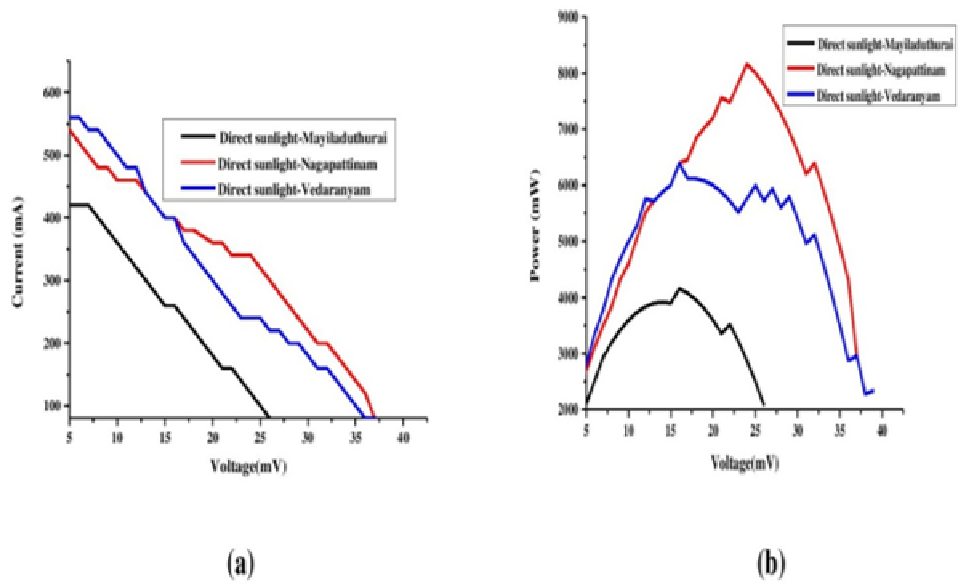

Fig 7. (a) I-V and (b) P-VCharacteristics of TiO_2+5 Nitro salicylaldehyde aniline-Mayiladuthurai, Nagapattinam, Vedaranyam

4 Conclusion

Tables 2 and 3 give device performance data. Table 2 shows the I-V and P-V characterization of frosted and clear glass. Plain glass has the highest open circuit voltage of 6.5 mV and the highest fill factor of 0.92%. In table 3, TiO_2+5NSA (DSSC) I-V characterization for direct sunlight from various places, this dye provided high efficiency from Vedaranyam (L3) for efficiency of 4.4% from the DSSC based on the dye 5-Nitro salicylaldehyde with aniline[14]. We devised and produced a Schiff-based organic dye. This dye is DSSC-friendly. DSSC based on 5NSA can convert direct sunlight to 4.4% efficiency. This offers a solar-harvesting p-conjugation strategy for organic dyes. In and similar materials have been shown to be interesting candidates for photochemical and phototherapeutic applications.[15]

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