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# PERFORMANCE EVALUATION AND CHARACTERIZATION OF FABRICATED SILVER NITRATE DOPED DSSC SENSITIZED WITH DYE EXTRACTED FROM *Corchorus olitorius* L

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## ABSTRACT

This study concentrates on the conventional dye sensitized solar cell (DSSC). This type of solar cell is generally made from components such as photo anode support, photo sensitizer (dye), electrolyte and counter electrode. This research investigates the properties of the photosensitizer which was locally sourced from our environment, was analyzed. The effect of the dopant on the absorbance spectrum of the chlorophyll based dye was also studied. The optical properties of the natural dyes showed that the dye-sensitized material exhibits an intense absorption broad band of 620-720 nm in the visible light region indicating the absorption of red light from the photons with a more prominent peak 659 nm. The structural characterization of the film was investigated using scanning electron microscopy (SEM), energy dispersive x-ray (EDX) and x-ray diffraction (XRD). The solar cells were finally prepared by sandwiching the $TiO_2$ photoanode with the counter electrode. The electrical properties of the fabricated solar call was analyzed by the use of a solar simulator which resulted to an efficiency of 0.05 %.This was calculated from the experimental values of short circuit current ($I_{sc}$), open circuit current voltage ($V_{oc}$), fill factor (ff) as 0.389 V, 0.242 mAcm$^{-2}$ and 0.48 respectively.

**Keywords:** DSSC, absorbance spectra, chlorophyll based dye, Scanning Electron Microscopy, Structural characterization

## INTRODUCTION

The sun has the greatest potential to supply humanity's energy demands with a substantial advantage over fossil fuels in terms of power output, making it the most accessible and widely available renewable energy source (Klaus *et al.*, 2016; Oji ., 2012). The effective conversion of solar energy is contingent upon its accessibility as well as the use of suitable technology, an undertaking that has proven to be highly challenging for scientists and engineers in general. The process of converting solar energy into electrical energy just takes one step (Osolobri *et al*., 2024).

One of the most, sustainable, and environmentally beneficial forms of renewable energy is quickly emerging to be solar energy (Singh, 2013). In the past twenty years, the output of solar cells has increased exponentially (Singh, 2013; Ikhioya *et al*., 2023; Chukwuemeka *et al*., 2024; Chen *et al*., 2015; Yoo *et al*., 2015). At present, solar energy generation is significantly more expensive compared to generators, gas and grid electricity. Dye-sensitized solar cells (DSSC), which were first created by Grätzel *et al*., in 1991 and have gained a lot of attention in the last few decades.The use of DSSC is one of the most promising method for converting solar energy into electrical energy (O'Regal and Gratzel, 1991; Shalini *et al*., 2015; Sugathan *et al*., 2015; Bahadur *et al*., 2012). In the last few decades, natural dye-sensitized solar cells are becoming popular because of their inexpensive manufacturing costs and environmentally benign characteristics (Hug *et al*., 2014; Ludin *et al*., 2014; Osolobri *et al*., 2024; Ojegu and Omamoke, 2020). At present, DSSC can convert photons from sunlight to electrical energy with an efficiency of 13% (Mathew *et al*., 2014).

Photo-sensitization of a semi-conductor wide band gap is the mechanism by which dye-sensitized solar cells (DSSCs), which are photoelectrochemical devices, convert solar radiation into electricity (Supriyanto *et al*., 2019; Ezeh *et al*., 2024; Odia *et al*., 2024). These photosensitizers are organic and naturally based from the dye extract of plants, such as the stem and leaves, which can be locally sourced. In order to create more stable and effective cells, a great deal of work has gone into optimizing the different DSSC components. To fabricate the DSSC, a photo-anode and a counter electrode are placed between two glass plates along with a redox couple electrolyte system, typically an iodide or triiodide complex(Fig. 1). The oxidized dye is regenerated by the electrolyte's redox pair.For the purpose of catalyzing the redox reaction with electrolyte, the counter electrode is also composed of a glass slide covered in Fluorine Thin Oxide (FTO) glass and typically coated with a thin layer of carbon or platinum.

The nature, optimization, and compatibility of each solar cell component, especially the photo-anode which is essential to the processes of charge generation and transfer, determine the overall efficiency of the DSSC.The photo-anode of a dye-sensitized solar cell (DSSC) is usually built using nanostructured porous titanium dioxide that has a large exciton binding energy and a wide band gap, which helps in improving the photo conversion efficiency of the constructed cell. The nanostructured $TiO_2$'s large surface area ensures that sufficient number of dye molecules will be absorbed for the effective harvesting of radiant energy. The dye usually has a broad and strong absorption spectrum when adsorbed on $TiO_2$ by anchoring groups like carboxylic, carbonyl, and hydroxyl on its molecules electron injection into the $TiO_2$ semiconductor's conduction band generates a strong dye adsorption onto the nanostructured material.

Doping elements into DSSC photoanodes have attracted a lot of attention in recent years. Ore dye molecules can be absorbed in the working electrode due to the larger surface area resulting from increased roughness and pores after doping. This increases the conversion efficiency of the $TiO_2$ electrode based DSSC and improves its performance (Arunachalam *et al*., 2016).Few studies have documented the application of two different types of metal ions co-doped $TiO_2$ in DSSC (Qiuping et al., 2013). Doping $TiO_2$ with silver nitrate ($AgNO_3$) can instinctively alter the material's band edge and Fermi level, changing the electron transfer characteristics and offering a viable means of increasing DSSC efficiently (Tran Van Nam *et al*., 2012). Group III metal aluminum ($Al^{3+}$) is also a promising candidate for doping because of its high conductance, low resistivity, and good optical quality. Improved $V_{OC}$ values have been reported, and $I_{SC}$ is largely unaffected (Bart *et al*., 2015).

In this study, dye extracted from the leaves of *Corchorus olitorius* L were investigated as potent sensitizer for DSSC.Jute leaf is a native plant of tropical Africa and Asia, and has since spread to Australia, South America andsome parts of Europe (Ahmed and Sarkar, 2022). It belongs to the family of *Malvaceae*. It is a popular vegetable in West Africa, commonly known as *ewedu* in Yoruba language, *ahonghara* in Igbo language, *rama* in Hausa. Plant leaves which are a rich source of chlorophyll have been used as sensitizer to assist DSSCs in absorbing photons and produce electricity. It has been shown that they exhibit a broad absorption/emission bands due to electron charge transfer transitions in the UV-visible region of the spectrum (William *et al*., 2017; Malumi *et al.*, 2023).

## MATERIALS AND METHOD

Materials used in this research are leaves of*corchorusolitorius* L *(jute leaf)*, basic laboratory equipment and the usual equipments used for characterization. Such as, UV-VIS-NIR (UV-1800 series) Schimadzu spectrophotometer, 350 W Xenon lamp Solar Simulator, Scanning Electron Microscopy (JSM 7100F, JEOL.COM), X-ray diffractometer (XRD) (Cu-$K_{\alpha 1}$ radiation source, λ = 1.5406Ǎ) were also used for characterization.

The Natural dye extraction of the fresh leaves of *Corchorus olitorius* L *(jute leaf)* was harvested, from local farm in Abraka, Delta State. The leaves were rinsed thoroughly with distilled water and air dried for two weeks at room temperature range of 24ºC - 32ºC until they became invariant in weigh. The leaves were ground using an electric blender to form a powder. Then 50g of the ground leaf was measured using a weighing scale, then soaked with 100ml of methanol and stirred on a magnetic stirrer for 3hours.The mixture was covered with an aluminum foil sheet and set aside for 24hours. The dyes from the leaves were then extracted into a beaker using filter paper. The filtered samples were poured into storage containers and kept out of reach of the sun rays. This is to prevent degradation of the dyes.

During the preparation of Fluorine doped Thin Oxide (FTO) glass substrate, the FTO glass was cleaned by immersing it in an ultrasonic bath for about 30 minutes in each of the acetone and distilled water solutions to dissolve any unwanted organic materials and remove any dust or contaminating material that may remain on the substrate after manufacture. Another 20 minutes of ultrasonic bath is done using methanol to remove the acetone initially deposited on the substrate and the materials that are not cleansed by the acetone. Finally the substrate was heated to 50ºC using a hot air oven in order to prepare it for deposition.

The photoanode deposition onto the FTO glass was done using the Doctor Blade method. The term "Doctor Blade" refers to a technique for smoothing films that uses any kind of blade steel, rubber, plastic, to apply or remove liquid material from another surface (Kontos *et al*. 2008, Tian *et al*. 2010). The $TiO_2$ paste was prepared by the addition of 5 ml of methanol to 3 g of $TiO_2$ powder drop wise in a mortar while grinding and stirring with a pestle to separate aggregated particles of $TiO_2$ mechanically. During the fabrication, 0.2mol silver nitrate ($AgNO_3$) was used to dope the $TiO_2$, the silver nitrate ($AgNO_3$) was dissolved with 2 ml of methanol before adding to the $TiO_2$ paste.

A transparent FTO conducting glass with average dimension 2.25 cm by 2.35cm was used as substrate for the deposition of $TiO_2$/silver nitrate ($AgNO_3$) paste. An ohmmeter was used to check for the conductive side on the glass. Two transparent FTO conducting glasses were used during the deposition. While one is the depositing surface, the other is used as a guide to ensure uniformity. Paper tape was

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applied on the conductive side to mask 0.15 cm – 0.2 cm at the three edges of the depositing glass surface and the opposite sides of the guiding slide. A glass rod is used to ensure that there is no opening into the masked edges. After evenly distributing drops of the $TiO_2$ colloidal solution onto the substrate, the material was smeared with a glass stirring rod. The grown films were annealed at 250°C for 30 minutes using a thermostatic blast resettable oven with a temperature range of 50°C to 1000°C. After which it was kept to cool and ready for sensitization.

During sensitization process, $TiO_2$/Silver nitrate ($AgNO_3$) coated glass films were separately immersed for about 24 hours in the various dye extracts. The counter electrode was made from another conductive glass. An ohmmeter was used to check for the conductive side on the glass. A pencil made of carbon was used to coat the conductive side of the glass substrate. No masking or tape was required for this electrode, and thus the whole surface was coated to increase its surface area in use. The Potassium Iodide-Iodine(KI/Iodine) electrolyte solution from Institute of Chemical Education (ICE) was used as redox electrolyte.

**Assembly of DSSC and its Electrical Output Measurement**

Each dye stained $TiO_2$/silver nitrate ($AgNO_3$) electrode was placed on a laboratory table such that the film side faced up, and the counter electrode was placed on top so that the conductive side of the counter electrode made direct contact with the $TiO_2$/silver nitrate ($AgNO_3$) film. The two opposing glass slides were offset such that the entire$TiO_2$/silver nitrate ($AgNO_3$) was covered by the counter electrode, and the 0.2 cm strip of glass not coated by $TiO_2$/silver nitrate ($AgNO_3$) was exposed. Two crocodile clips were used to hold the slides together at the other edges. Potassium Iodide-Iodine (KI/Iodine) electrolyte solution was injected through the edges of the slides (Plate 1). The fabricated solar cell was taken for measurements so as to determine the current-voltage characteristics.

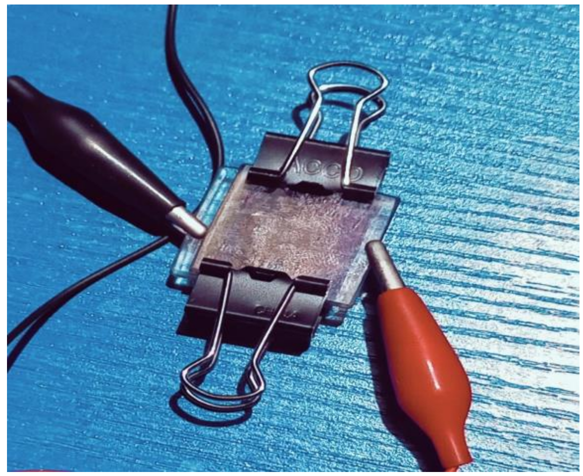

*Plate 1: Fabricated solar cellundergoing electrical testing*

**Results and Discussion**

**Optical Study of $TiO_2$ and $TiO_2$ /$Ag_{0.2}$/dyes**

The absorbance spectra of $TiO_2$ and $TiO_2$ /$Ag_{0.2}$/dye extracted from *Corchorus olitorius* L dye are is shown in Fig. 1. The figure reveals that as the wavelength increases, the absorbance decreases. The dye-sensitized material exhibits an intense absorption broad band of 620-720 nm with a more prominent peak of absorption observed at 659 nm in the visible light region indicating the absorption of red light from the photons. More energy is absorbed by the cell because of the presence of dye, enhancing its energy storage capacity. The Lagos spinach dye and lemon grass dye display more significant peaks showing their suitability for fabrication of infrared devices and devices that will function effectively using red light.

Fig. 2 shows the transmittance spectra of $TiO_2$ and $TiO_2/Ag_{0.2}$/dye material. With an increase in wavelength, there is a corresponding increase in transmittance. The dye-sensitized material displays a surge of up to 610 in the visible light region, which is evidence of the cell's acceptance of both the nickel and dye. The surge which is clearly visible, suggests that the cell has transmitted all light wavelength ranging from 300-1100 nm, exempting red light which shows the least transmittance with range 640 -700 nm. The dye-sensitized material *Corchorus olitorius* L peaked at a wavelength of 662 nm.

The reflectance spectra of $TiO_2$ and $TiO_2/Ag_{0.2}$/dye are shown in Fig. 3 Reflectance increases as the wavelength increases. Maximum reflectance occurs at about 480 – 590 nm, because all the dyes are green consequently reflect green light. By incorporating silver and dye and using the visible light region of the spectrum, the cell's energy storage capacity was increased. Analysis shows that Lagos spinach and lemon grass dye spectra display significant peaks. Hence fabricated cells are ideal for light emitting/absorbing application as in solar panels and lighting systems.

Fig.4shows the estimation of the energy band gap of dye-sensitized material and silver-doped $TiO_2$since the absorption coefficient (α) and the photon energy are related by; $\alpha hv = A(hv - E_g)^2$(Yousaf and Abass, 2013). The optical energy band gap $E_g$, is estimated from the intercept on the horizontal axis, where hv, α, and A are the photon energy, absorption coefficient, and constant, respectively. The result showed that the optical energy band gap was 2.23 eV for $TiO_2$ and 2.30 Ev *Corchorus olitorius* L dyes. The energy band gap of the LUMO of dye is higher that the band gap energy of semiconductor metal oxide layer responsible for the charge transfer of excited electrons. Generally, the energy band gap is due to quantum size effect, and carrier concentration (Sanusi, *et al*., 2014; Al-ofin *et al.*, 2012)

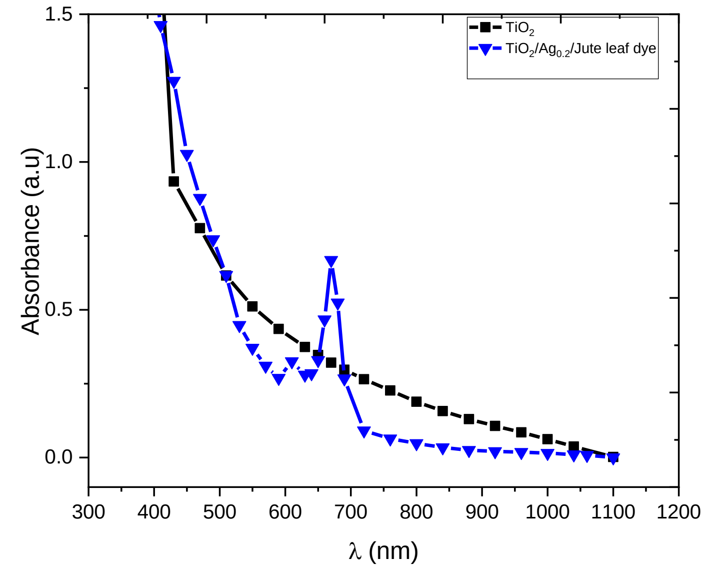


Figure 1: Absorbance spectra of dyes extracted from *Corchorus olitorius* L as sensitizer. The Transmittance spectrum for $TiO_2$ films is also shown for comparison.

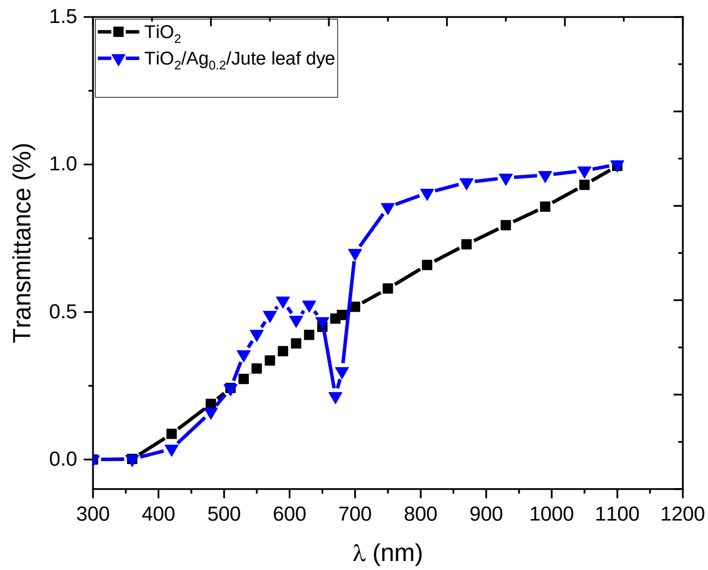


Figure 2: Transmittance spectra of dyes extracted from *Corchorus olitorius* L as sensitizers. The Transmittance spectrum for $TiO_2$ films is also shown for comparison.

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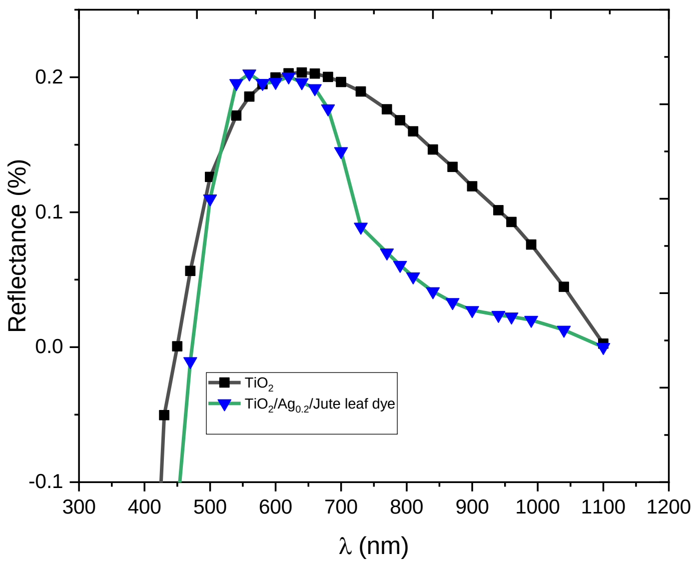


Figure 3: Reflectance spectra of dyes extracted from *Corchorus olitorius* L as sensitizers. The reflectance spectrum for $TiO_2$ films is also shown for comparison.

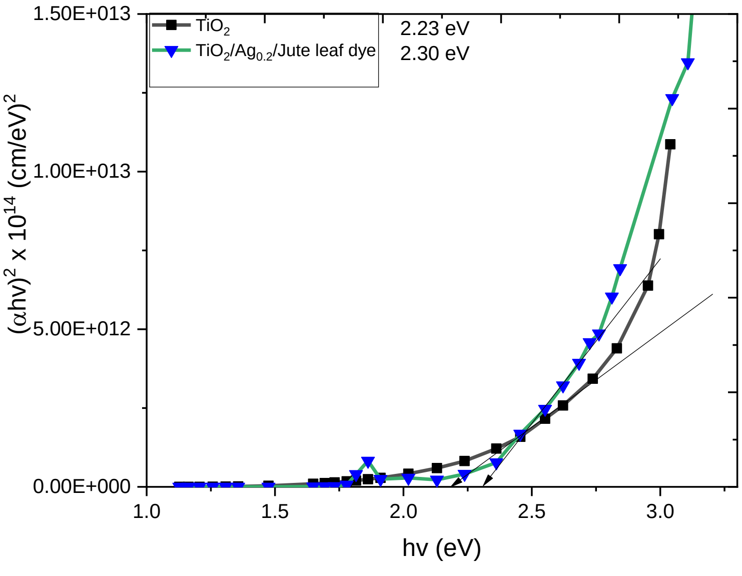


Figure 4: The determination of energy band gap of dyes extracted from *Corchorus olitorius* L as sensitizers. The reflectance spectrum for $TiO_2$ films is also shown for comparison.

**Morphological Characterization of DSSC**

Using a scanning electron microscope (SEM), the surface morphological properties of the synthesized $TiO_2$ and $TiO_2/Ag_{0.2}$/dye were analyzed. The surface morphologies of the synthesized $TiO_2$ and $TiO_2/Ag_{0.2}$/d *Corchorus olitorius* L are displayed in Plate

2 showcasing their surface morphology. The micrograph of $TiO_2$ surface shows a nano growth of a few clouded nanoparticles. $TiO_2$ synthesis is deposited well on the surface of the FTO substrate. The deposition of silver (Ag) and dye onto $TiO_2$ resulted in a complete alteration of its surface energy. The surface of the synthesized material shifted from clouded nanoparticles tonano flake particles which adhere to the surface substrate, in the surface micrograph of *Corchorus olitorius* L dye. The surface energy of the synthesized materials for solar and photovoltaic purposes is boosted by $TiO_2$, silver, and dye.

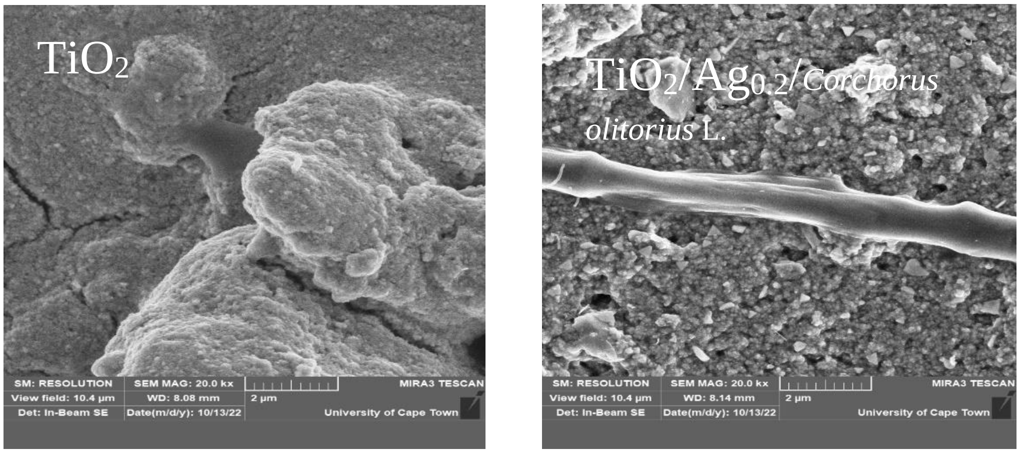


Plate 2: SEM micrograph of $TiO_2$ and $TiO_2$ /$Ag_{0.2}$/ *Corchorus olitorius* L

**X-ray diffractometry (XRD) analysis**

The XRD analysis of the synthesized $TiO_2$ and $TiO_2/Ag_{0.2}$/dye was shown in Fig. 5.The cell structure is polycrystalline and has a remarkable peak at 2 theta angles of 30.375$^o$ and 29.397$^o$ that correspond to plane (200) for the synthesized $TiO_2$. Remarkable peak at 2 theta angles of 39.634$^o$ that correspond to plane (204) for the synthesized $TiO_2/Ag_{0.2}$/ *Corchorus olitorius* L. Other peaks were noticed at 2 theta angles of 24.891°, 27.509$^o$, 32.915$^o$, 27.509$^o$, 35.296$^o$, 38.814$^o$, 43.152$^o$, 47.579$^o$, 53.231 $^o$ and 59.130$^o$ for $TiO_2$and 24.229°, 26.768$^o$, 29.397$^o$, 34.229$^o$, 36.195$^o$, 42.094$^o$, 45.454$^o$, 50.197$^o$ and 61.343$^o$ for $TiO_2/Ag_{0.2}$/ *Corchorus olitorius* L which corresponds to plane (101), (004), (105), (211), (116), (220), (215) and (303) respectively. The peak intensity is higher due to the improved crystal structure and energy absorption on $TiO_2$ lattice parameters. The peak locations remained unchanged even with the crystals' energy absorption. The dye causes a distortion in the lattice structure and individual cells, resulting in shifts in crystal orientation. Eqn. (1) was used to compute the crystallite or grain size (D). Table 1 shows the grain size for $TiO_2$, $TiO_2/Ag_{0.2}$/ *Corchorus olitorius* L enhanced films' crystallinity.

$$D = \frac{0.9\lambda}{\beta\cos\theta} \quad (1)$$

Where D is the crystallite size, λ is the X-ray wavelength used, β is the full width half maximum (FWHM) of the XRD peak appearing at the diffraction angle θ. is the angle of diffraction (Maurya *et al*., 2018).

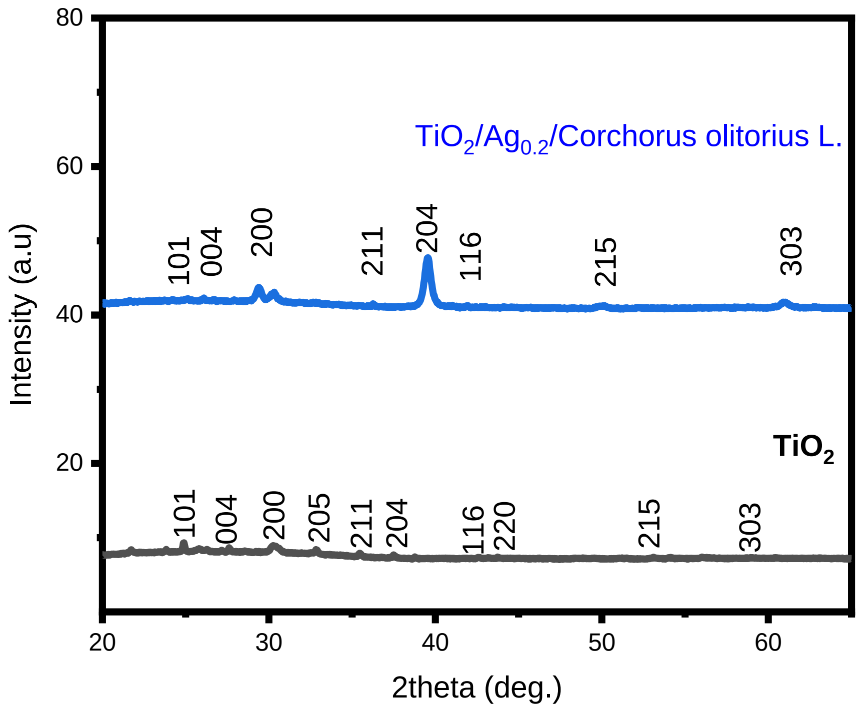


Figure 5: XRD pattern of $TiO_2$ and$TiO_2/Ag_{0.2}$/ *Corchorus olitorius* L.

Table 1: Structural variables for the $TiO_2$ and$TiO_2/Ag_{0.1}$/ *Corchorus olitorius* L.

| **Films** | **2θ (º)** | **d-spacing (Å)** | **FWHM** | **(hkl)** | **Lattice constant a (A)** | **Dislocation density (δ)** | **Grain Size (D) nm** |
|---|---|---|---|---|---|---|---|
| **$TiO_2$** | 24.891 | 3.573 | 0.109 | 101 | 6.190 | 1.795 | 1.302 |
| | 27.509 | 3.239 | 0.112 | 004 | 6.478 | 1.875 | 1.274 |
| | 30.375 | 2.939 | 0.113 | 200 | 5.879 | 1.884 | 1.271 |
| | 32.915 | 2.718 | 0.114 | 105 | 6.079 | 1.893 | 1.268 |
| | 35.296 | 2.540 | 0.117 | 211 | 6.222 | 1.969 | 1.243 |
| | 38.814 | 2.317 | 0.119 | 204 | 6.556 | 1.996 | 1.235 |
| | 43.152 | 2.094 | 0.120 | 116 | 5.924 | 1.973 | 1.242 |
| | 47.579 | 1.909 | 0.123 | 220 | 6.332 | 2.007 | 1.231 |
| | 53.231 | 1.719 | 0.127 | 215 | 5.955 | 2.042 | 1.221 |
| | 59.130 | 1.560 | 0.129 | 303 | 5.840 | 1.994 | 1.235 |
| **$TiO_2/Ag_{0.2}$/ *Corchorus olitorius* L** | 24.229 | 3.669 | 0.115 | 101 | 6.356 | 2.003 | 1.233 |
| | 26.768 | 3.327 | 0.123 | 004 | 6.654 | 2.268 | 1.158 |
| | 29.397 | 3.035 | 0.124 | 200 | 6.070 | 2.279 | 1.156 |
| | 34.229 | 2.617 | 0.125 | 105 | 5.852 | 2.261 | 1.160 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 36.195 | 2.479 | 0.126 | 211 | 6.073 | 2.272 | 1.157 |
| 39.634 | 2.271 | 0.127 | 204 | 6.425 | 2.261 | 1.160 |
| 42.094 | 2.144 | 0.121 | 116 | 6.065 | 2.020 | 1.227 |
| 45.454 | 1.993 | 0.122 | 220 | 6.611 | 2.006 | 1.232 |
| 50.197 | 1.815 | 0.123 | 215 | 6.290 | 1.965 | 1.244 |
| 61.343 | 1.509 | 0.125 | 303 | 5.649 | 1.831 | 1.289 |

**Energy dispersive X-ray (EDX)**

The EDX spectrum of the synthesized $TiO_2$ and $TiO_2/Ag_{0.2}$/ *Corchorus olitorius* L (Figure 6) was used to determine the elements present in the material. The synthesized FTO showed distinct peaks of titanium, oxygen, silicon and calcium in the bare $TiO_2$ and $TiO_2/Ag_{0.2}$/ *Corchorus olitorius* L mesoporous film. Titanium (Ti) having the greatest peak followed by oxygen (O) in the bare $TiO_2$. The peaks shown inFigure 6 represents the level of concentration of the various elements present which is as a result of the thorough absorption of the dye and dopant. The potassium, calcium, carbon, Aluminum, sodium and silver content, at lower concentration in the $TiO_2/Ag_{0.2}$/*Corchorus olitorius* L indicate the presence of dopant and impurities. It is therefore, evident from the spectrum that all the elements composing $TiO_2$mesoporous film are present.

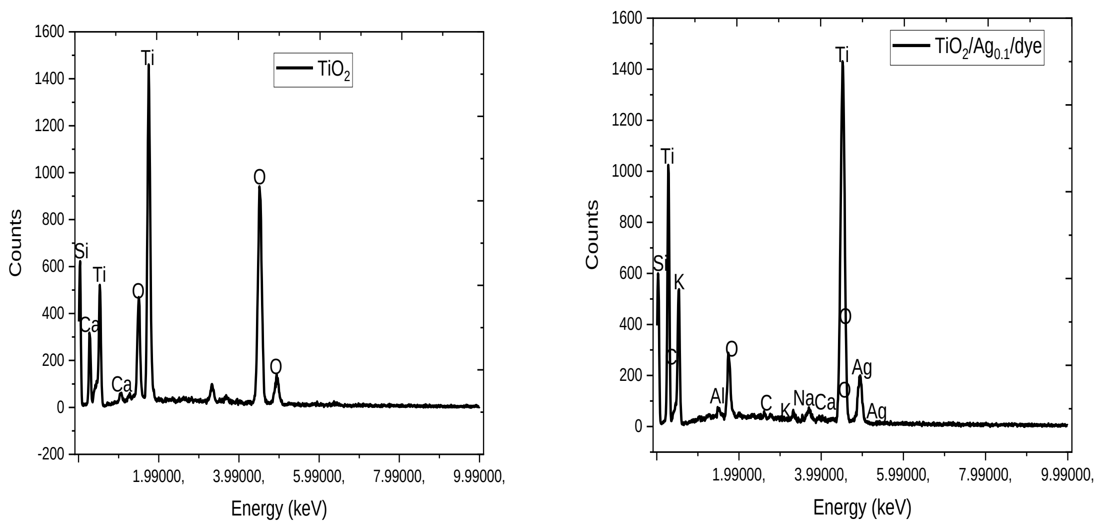


Figure 6: EDX spectrum of $TiO_2$ and $TiO_2$ /$Ag_{0.2}$/ *Corchorus olitorius* L.

**Electrical characterization of the sensitized film**

The performance of the photovoltaic cell in terms of efficiency, voltage and current was tested with a standard illumination of air-mass 1.5 global (AM 1.5G) having an irradiance of 100mW/cm$^2$ and analyzed using a 350 W solar simulator Xenon lamp. The photovoltaic performance of DSSCs fabricated using *Corchorus olitorius* L dyes as a potent sensitizer for $TiO_2/Ag_{0.2}$ was assessed. The result obtained via the current, voltage, fill factor and conversion efficiency measurement is displayed in Table 2. The result revealed that the after cell fabrication, a photoelectric conversion efficiency (η) of 0.05%; an open-circuit voltage (Voc) of 0.389V and a short-circuit current density (Isc) of 0.242mA/cm$^2$ respectively were obtained (Fig. 7). It has been shown that coated FTO glass with a $TiO_2$ metal oxide surface and 0.2 molar concentration of silver doped with dye provides more sites for dye adsorption, resulting in high dye concentrations that ensure the absorption of more sunlight.

| **Sensitized $TiO_2$ mesoporous films** | **$V_{oc}$ (V)** | **$I_{sc}$ (mA/cm$^2$)** | **$V_{max}$ (V)** | **$I_{max}$ (mA/cm$^2$)** | **Fill Factor, FF** | **Efficiency, η (%)** |
|---|---|---|---|---|---|---|
| **$TiO_2/Ag_{0.2}$/ *Corchorus olitorius* L** | 0.389 | 0.242 | 0.237 | 0.191 | 0.48 | 0.05 |

**Table 2:** The Photovoltaic performance of the $TiO_2$mesoporous film sensitized by natural dye extract.

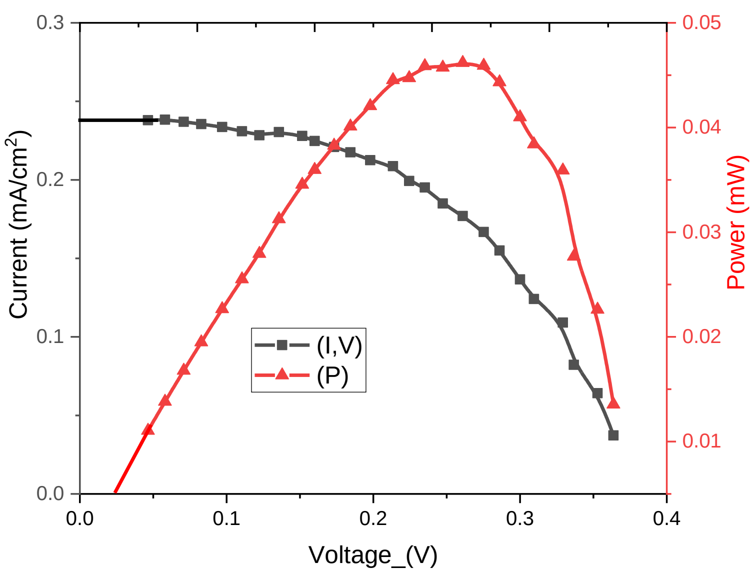


Figure 7: I-V curve of DSSC sensitized with the dye extract from *Corchorus olitorius* L (Jute leaf)

**CONCLUSION**

An affordable, sustainable sensitized dye solar cell has successfully been fabricated using dye extract of *Corchorus olitorius* L leaves. The optical, morphology, structural and electrical properties of the Silver doped dyes/$TiO_2$ coated FTO glass were investigated via UV-VIS spectroscopy, scanning electron microscopy and energy-dispersive x-ray spectroscopy. The plant leaf dyes absorbs visible light in the range of 620 nm to 720 nm, thereby allowing red visible light to pass through in significant amount. Visible light spectrum is transmitted through the dye except for the green light which is reflected back as shown in the reflectance spectra with a prominent peak of 670 nm. The photovoltaic energy conversion efficiency of the fabricated DSSC is 0.05 %, short circuit current ($I_{sc}$) of 0.242 $mAcm^{-2}$, open circuit current voltage ($V_{oc}$) of 0.389 V and fill factor (ff) 0.48. Remarkable peak at 2 theta angles of 39.634$^o$ that correspond to plane (204) for the synthesized $TiO_2/Ag_{0.2}$/ *Corchorus olitorius* L. Other peaks were noticed at 2 theta angles of 24.891°, 27.509$^o$, 32.915$^o$, 27.509$^o$, 35.296$^o$, 38.814$^o$, 43.152$^o$, 47.579$^o$, 53.231 $^o$ and 59.130$^o$ for $TiO_2$and 24.229°, 26.768$^o$, 29.397$^o$, 34.229$^o$, 36.195$^o$, 42.094$^o$, 45.454$^o$, 50.197$^o$ and 61.343$^o$ for $TiO_2/Ag_{0.2}$/ *Corchorus olitorius* L which correspond to plane (101), (004), (105), (211), (116), (220), (215) and (303) respectively.

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