THE SMART MATERIAL ABILITY OF DYE SENSITIZED SOLAR CELL USING ANTHEOCELESISTA VOGELILI (APAORO) LEAF AS THE PHOTOSENSITIZERS

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Abstract: This work is to investigate the smart material ability of DSSC using natural plants using antheoceleista vogelili (Apaoro) leaves. The plant was air dried and subjected to methaonic extraction. Three mordants were used as fixative on the dye and the extracts were exposed to sun radiation to observe colour changes. The constituents of the dyes extracts were identified by phytochemicals analysis, optical properties of each of the fabricated DSSC were measured using the UV/VIS spectrophometer and evaluation was done to determine their electrical parameters. The fabricated DSSC were also characterized using Scanning Electron Microscopy (SEM) and the band gap was also measured. The results of the study showed that antheoceleista vogelili with Potash mordant has the highest Power Conversion Efficiency (PCE) of 0.156 %, the Optical results indicated the photon to electrons conversion is between 350–700 nm with an absorption band gap ranging between 1.25 – 4.25 eV, which confirms that the cells absorb light in the visible region of the electromagnetic spectrum. There were colour changes which allow for diurnal variability indicating DSSC as smart materials which can be integrated as photovoltaic and photochromic.

KEYWORDS: antheocelesista vogelili, DSSC, Mordant, smart material

INTRODUCTION

Solar power is the cleanest, safest and largest green renewable energy resource, which makes her demand increasing every year. Surface areas of windows of buildings could therefore be utilized for light absorption when covered with solar cells. These surface areas are completely transparent and colourless at night but function similar to photochromic materials. This therefore provide for a best view. With the continuing progress study of dye-sensitized solar cells (DSSC) and the appearance of different configurations and new components, [1] Establishing different properties of prepared DSSC using a range of characterization methods will definitely enhance its technological uses. There are a few classes of organic compounds that exhibit this photochromic property—diarylethenes [2–5], azas [6], spiropyrans[7,8,9] and its derivatives with the spirooxazines are among the most studied organic compounds in this group, with high stability and broad visible light absorption and spirooxazines [10]. This cell exhibits the ability to change color when exposed to ambient light conditions, and therefore has the potential to be used as a solar cell to be installed on windows.

In the work of Prihanton et al [11] he studied the problem of efficiency in DSSC, where he used clarion protein at different percentage concentration as a means of improving efficiency. Chijung Yun et al [4] Fabricated energy storage smart window integrated super capacitor in one device but as an independent modules. Gratzel et al 2007 [12] also studied the panchromatic film, linking dyes with halide semiconductor grains at short wavelengths. O'Regan et al [13] was the first to study the low cost, high efficiency DSSC using TiO_2 as the dye. When the first dye-sensitized solar cell (DSSC) with photovoltaic properties competitive to the conventional silicon-based technology was presented by [14] their success relied on the use of a mesoporous TiO_2 film with a very large internal surface area for sensitization. Photosensitization was demonstrated in 1873 by Hermann Wilhelm Vogel [2], who mixed dyes of different colors in photographic emulsions to render silver halide photographic plates sensitive to different parts of the light spectrum.

METHODOLOGY

Extraction-Samples of the plants of ***antheocelesista vogelili (apaoro)*** were collected, air dried at 40°C in a thermostatically controlled oven until it attained a constant weight. It was then soaked into a 250ml of methanol for twenty-four (24) hours. A filter paper was then used to decant the dyes into a bottle and labeled. Three different mordants which include; Potassium Carbonate (potash), Potassium Aluminum Sulfate (Alum) and Sodium Chloride were used on the dye as a fixative.

Phytochemical screening-Chemical tests was carried out on the aqueous extracts to identify its constituents such as ***Test for tannins, Test for saponins,Test for phlobatannins, Test for flavonoids, Tests for anthraquinones, Tests for steroids ,Test for alkaloids, Tests for carbohydrates and Tests for Glycosides*** using standard procedures which includes the one described by [12] and [13]

Rate of absorption-A spectrophometer machine (spectrumlab P22) in Laboratory was used to measure the absorbance, transmittance and concentration at different wavelength ranging from 350-1000nm.

Preparation and construction of cells-we used conductive FTO glass ordered from Hartford Glass Company USA with dimension of 2.5 X7.6cm (1"X3") and 2mm in thickness. The photo anode was prepared using two slides of the conductive FTO glass. A digital multimeter was then used to check the conductive side of the FTO glass. Adhesive –tape was applied to the face of the conductive glass plate in order to create on opening of dimension1.5 x 1.5cm2 at the centre of the glass, the cells were assembled and tested using the method reported by [15].

Current -Voltage Characterization-The performance of the DSSC under AM1 atmosphere was measured using a multimeter (Voltcraft; M-3850 series). Results obtained were plotted to obtain an I-V curve, from which the open circuit voltage (V_{oc}), short-circuit current (I_{sc}), the fill factor (FF) and the conversion efficiency (η%) was determined using the formulae below.

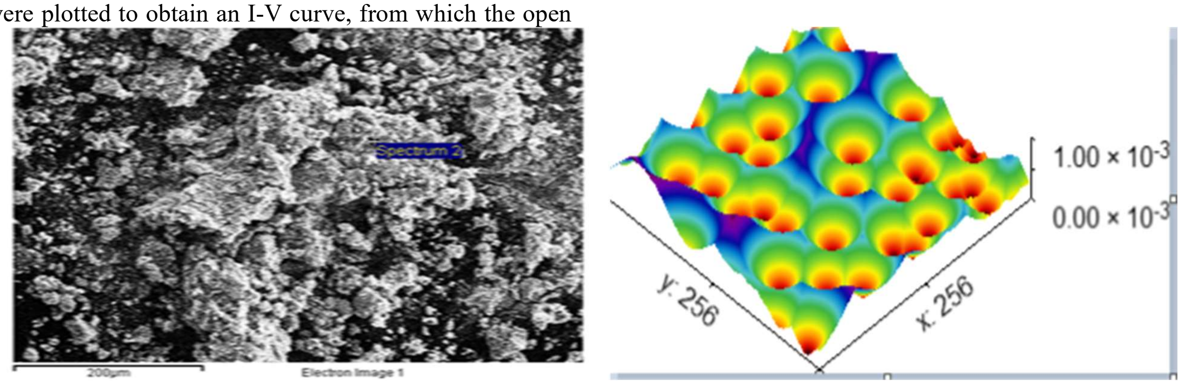
$$FF = \frac{I_m \times V_m}{I_{sc} \times V_{oc}} \quad \ldots\ldots 1$$

$$\eta = \frac{I_{sc} \times V_{oc} \times FF}{P_{in}} \quad \ldots\ldots 2$$

Confirmation of smart material

2ml of the aqueous extract will be dropped on the surface of the FTO and their colours will be noted and then place on a Platform, exposed into direct sunlight for about15 minutes. The colour changes were then noted to identify the extract which exhibits smart materials ability.

RESULTS AND DISCUSSION



A B

Fig.1. The scanning electron microscope and the 3D images of apaoro

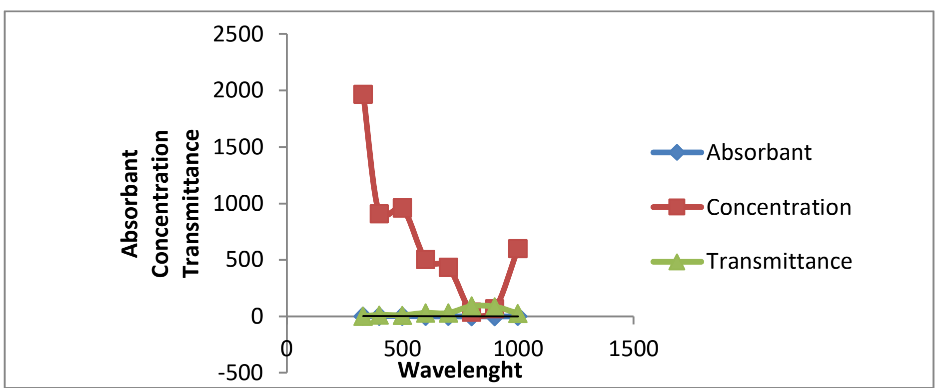


Fig.2. The graph of absorbant, concentration and transmittance against wavelength with *apaoro* dye and NaCl as mordant

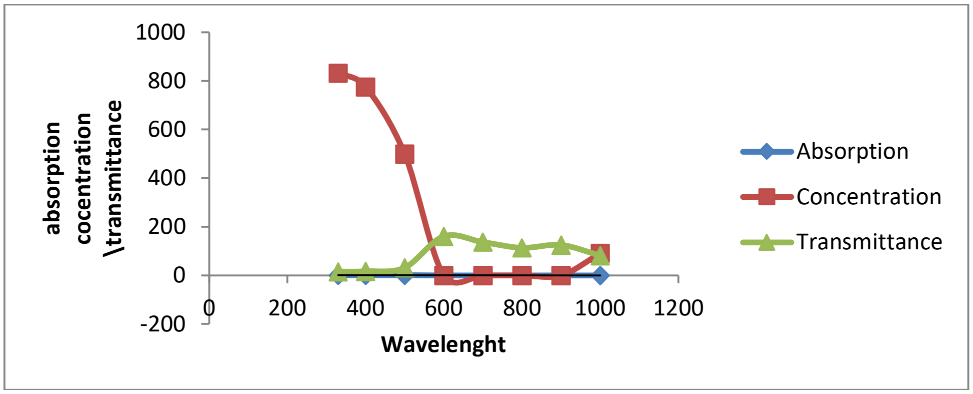


Fig.3. The graph of absorbant, concentration and transmittance against wavelength with *apaoro* dye and Potash as mordant

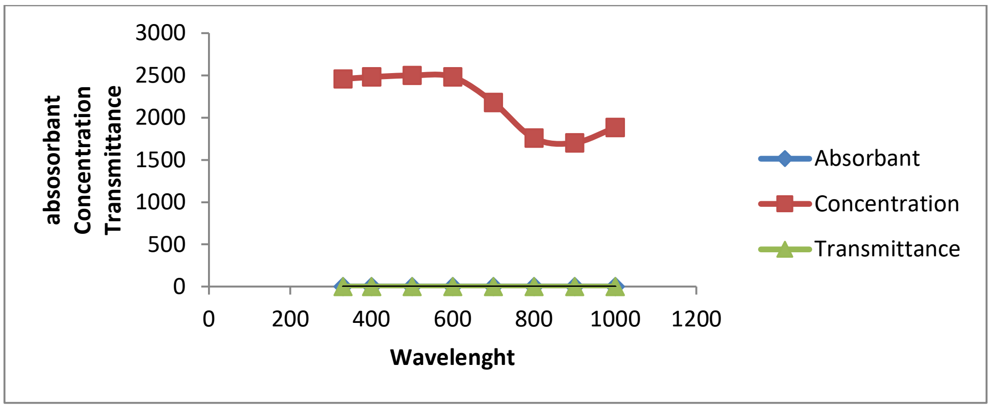


Fig.4. The graph of absorbant, concentration and transmittance against wavelength with *apaoro* dye and Alum as mordant

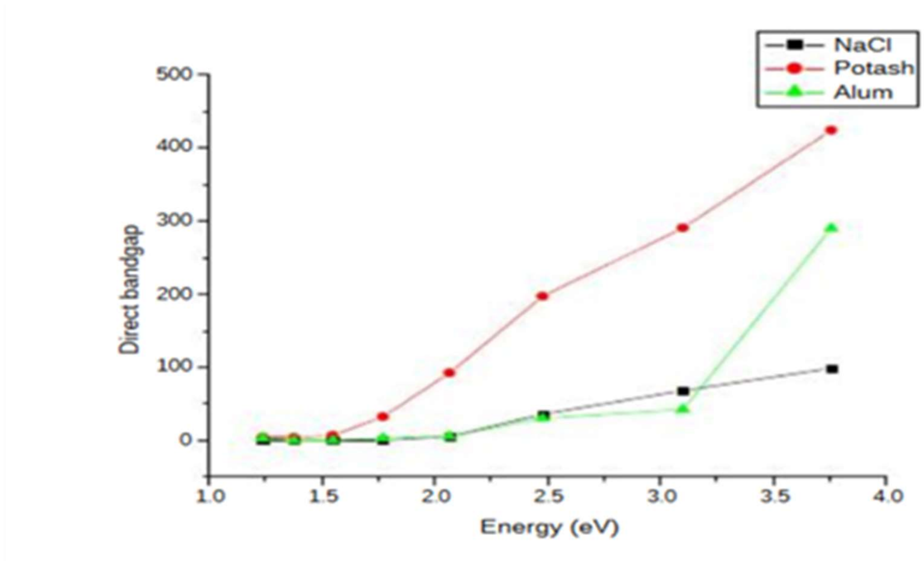


Fig. 5. The graph of direct ban gap against energy for Apaoro leaves for NaCl, Potash and Alum

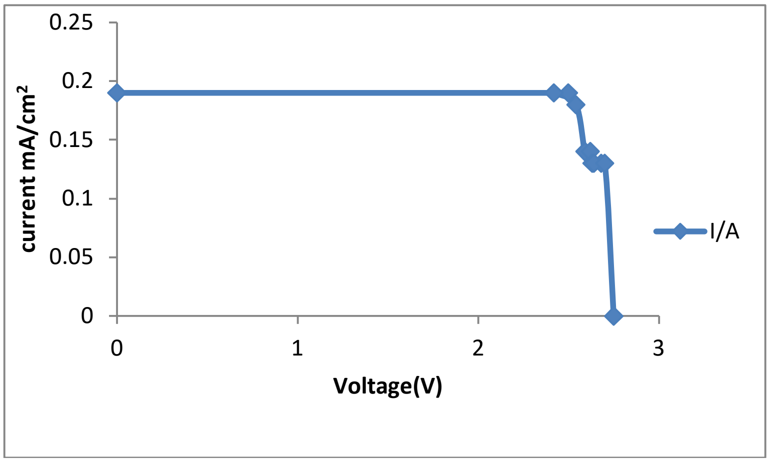


Fig 6 The I-V curve of *antheocelesista vogelili (Apa oro*) with Nacl as mordant

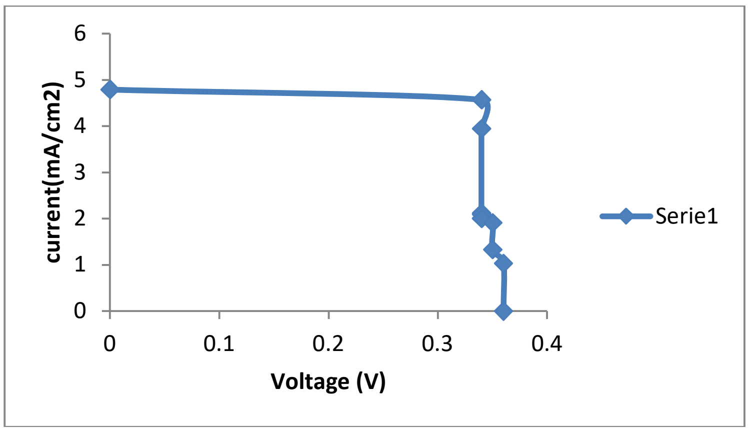


Fig.7 The I-V curve of antheocelesista vogelili (Apa oro) with potash as mordant

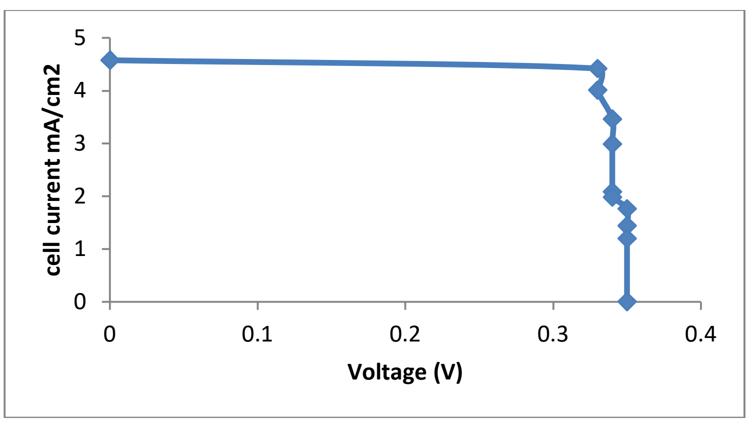


Fig.8 I-V curve of antheocelesista vogelili (Apa oro) with alum as mordant

Table 1. The phytochemical analysis of antheocelesista vogelili (Apa oro)

Test	antheocelesista vogelili + NaCl	antheocelesista vogelili + Potash	antheocelesista vogelili +Alum
Carbohydrate	Nil	Nil	Nil
Tannins	++	+++	++
Phenols	+++	Nil	+++
Cardiac glycocide	+++	+++	+++
Volatile oil	+	+	+
Flavonoid	+	+++	++

Table 2. Summary of the current, voltage, fill factor and efficiency of *antheocelesista vogelili (Apa oro)*

S/N	DYE	$I_{sc}(mA/cm^2)$	$V_{oc}(V)$	$I_m(mA/cm^2)$	$V_m(V)$	FF	η %
1	*Apa oro+alum*	0.19	2.75	0.18	2.54	0.875	0.45
2	*Apa oro+Potash*	4.79	0.36	4.57	0.34	0.901	1.56
3	*Apa oro+Nacl*	4.58	0.35	4.42	0.33	0.909	1.46

Table 3 Smart material test for antheocelesista vogelili (Apa oro)

EXTRACT	COLOUR BEFORE EXPOSURE TO SUNLIGHT	OBSERVED COLOUR AFTER EXPOSURE TO SUNLIGHT
APAORO +Potash	BLACK	NO CHANGES
APA ORO + Nacl	BLACK	SIENNA
APAORO + Alum	BLACK	MINT CREAM

CONCLUSION

Desired dye-sensitized solar cell system based on TiO_2 antheocelesista vogelili (Apa oro) was fabricated and characterized, the phytochemical analysis and its colour changes due to exposure to sunlight were noticed. The Surface Morphology of DSSC SEM (Scanning Electron Microscopy) analysis is aimed at determining the characteristics of the surface morphology of the DSSC layer of the dye, the presence of molecules deposited from this dye functions as a bridge for the electron transport is explained by the 3D picture in fig 1. Antheocelesista vogelili has an efficiency of between (0.45-- 1.56%). The natural dyes showed a wide band-gap semiconductor that fall the within spectrum of white light and so does the absorbance of each of the extract with mordant. This therefore makes the change in colour a possibility and noticeable. Since most of the cells manufactured show light absorption and photosensitivity when exposed to sunlight, it can be concluded that dye from apaoro as established that DSSC has smart material ability,

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