Absorbance/Transmittance Property Of Natural And Synthetic Dyes In The Fabrication Of Dye Sensitized Solar Cell

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ABSTRACT

There are two sources of sensitizers: natural, from plants and synthetic from organic dyes, for the fabrication of dye sensitized solar cell. This study intends to investigate the absorbance/transmittance properties of both sources in order to ascertain the best. Two natural dyes Tomato fruit and Zobo leaves- plants and synthetic dye- Methyl red have been chosen because of their unique red colour which performs at the Uv-visible region for light harvesting. The Absorbance and Transmittance properties were carried out and Zobo emerged the best absorber and tomato the best transmittance material.

Keywords: Natural, synthetic, absorbance, transmittance, adhesion.

1. INTRODUCTION

Dye sensitized solar cell has emerged one of the best technology for the enhancement of electricity generation since its materials can be sourced locally. The sensitizers are natural dyes extracted from Tomato seed found every market in the country and Zobo leaves used for drinks. The synthetic dye (Methyl red) was used in comparison in order to establish the advantage of natural over synthetic. The metallic oxide ZnO which serves as a good window for absorbtivity and TiO_2 which makes the image of the dyes to be visible are composite systems. When these fabricated dye sensitized solar cells are connected in series a panel is built and the terminals connected to LED diode bulb electricity are generated. These panels can be used to build solar latten or clock depending on the voltage produced.

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In this study emphasizes will be on the transmittance and absorbance properties of these dyes in the enhancement of light harvesting.

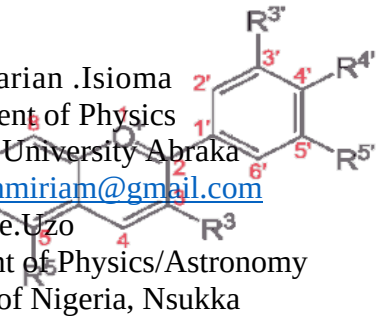
Natural dyes: Two types of natural dyes considered in this work are:

Zobo: Zobo is the leaf of a plant commonly known as Roselle's which has a botanical name hibiscus sabdariffa also known as red sorrel. Zobo belongs to the malvaceae family, which is a branched, erect annual shrub, with stems are reddish in colour and are up to 3.5m tall. Zobo dye contains the physiochemical group known as anthocyanin whose surface area is 1.54cm^2 (fig. 1). Anthocyanin has an optical absorbance with the wavelength of 283nm-516nm, and also has a Peak absorbance of 216AU [1].

Tomato: Tomato is the fruit on a plant and the botanical name is known as Lycopene, with structural formula as shown in fig. 2. It is also a fat soluble carotenoid with 11 conjugated double bonds in the molecule, and it is a precursor of the b-carotene with a well known antioxidant activity, reported as at least twice that of the b-carotene (Sies and Stahl, 1998)[2]. Lycopene content is in the range between 5.40-1500 mg/kg in tomato paste (wet weight)[3]. The structure and fruit are as shown in fig. 2 (a and b).

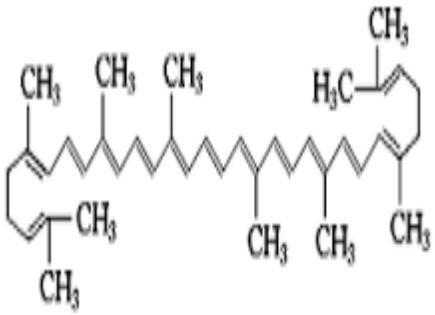
Synthetic dye: Methyl red dye is complex and resists microbial degradation posing serious threat to the environment. These are man-made organic dyes which mean that it can be prepared using conventional means. Methyl red is investigated as promising enhancers of sonochemical destruction of chlorinated hydrocarbon pollutants. It is a pH indicator; it is red in pH under 4.4, yellow in pH 6.2 and orange in between. The chemical structure and the picture of Methyl red are shown in fig. 4a and b respectively.

(a)



(b)

Fig. 1: Chemical structure of anthocyanin dye. Source: [4]



(a) (b)

Fig.2: Chemical structure of lycopene dye source: [5]

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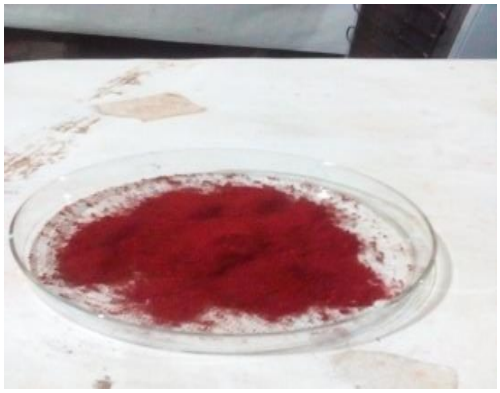

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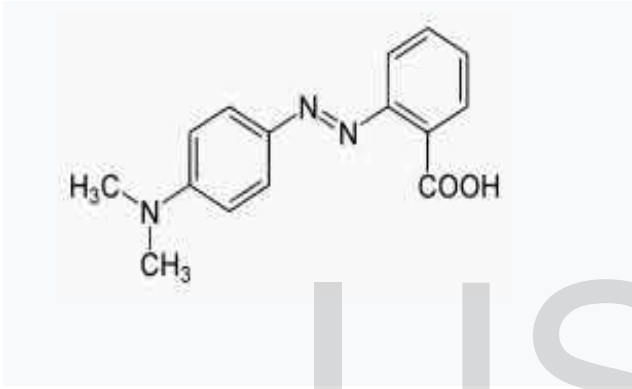

(b)

Fig.4: Chemical structure of Methyl red dye Source: https://en.m.wikipedia.org/wiki/Methyl_red [6]

2. MATERIALS AND METHOD

The following materials were used for this study: tomatoes fruit, Zobo leaves, synthetic methyl red dye, morter, filter, slides, beaker, and distilled water. Chemicals used were ethanol and acetone, equipments were weighing balance, ultrasonic and magnetic stirrer.

2.1 Method

The two natural and one synthetic dye were extracted using simple extraction methods.

100ml equal volume of ethanol and H_2O with 20g of Zobo leaves and filtered into a beaker. It had a dark wine colour as shown in fig.5.

23.80g of Tomatoes seed was crushed and soaked in 20ml of ethanol over night. A reddish solution was filtered into a beaker shown in fig. 6.

20g of powdered methyl red synthetic dye was weighed and soaked in 100ml of distilled water ready for use fig.7.

Sterilized and treated glass slides were placed inside the prepared solution for three days to deposit thin film using chemical bath deposition method.

The films were prepared for optical characterization. This was carried out at the energy research centre University of Nigeria Nsukka using SHIMADZU UV-1800 SPECTROPHOTOMETER as shown in fig. 8. These films were placed in (a) and light is allowed to pass through it and there is a display on the screen (c) (graph) as will be discuss later.

(a)

(b)

Fig. 5: Zobo dye solution and slide deposited inside

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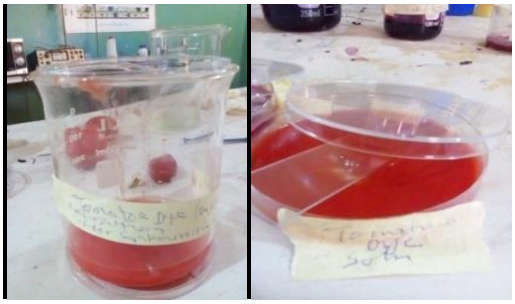
(a)



(c) (d)

Fig. 6: Tomato dye and slide deposition

(a)

Fig.7: Methyl red dye solution and slide deposition

2.2 Deposition procedure

The dyes having been carefully extracted and placed in a dish, glass slides were deposited into the solutions for three days to enable proper adhesion of the dye films unto the slides. This was further prepared for the optical characterization.

3. Optical characterization

The optical characterization was carried out using SHIMADZU UV-1800 Spectrophotometer machine situated at the ENERGY research Development Centre University of Nigeria Nsukka. There are three sections of the machine; the inner chamber Figure 8(a), the outer chamber fig. 8(b) and the screen fig. 8(c). The slides are placed inside an opening in the inner chamber then light shines through it and the transmittance/absorbance result is observed on the screen. The transmittance was done before the absorbance. These results are discussed in details.

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(a) (b) (c)

Fig. 8: Picture of SHIMADZU UV-1800 Spectrophotometer

4. RESULTS

The transmittance and absorbance properties of the two natural and one synthetic dye were carried out and results displayed: The transmittance and absorbance of zobo tomato and Methyl red is shown in figs. 9-14. Fig. 9, 10 and 11 shows the transmittance of Zobo dye (Anthocyanin) , Tomato dye (Lycopene) and Methyl red dye while figs. 12 and 13 the Absorbance of Zobo dye and Methyl red dye

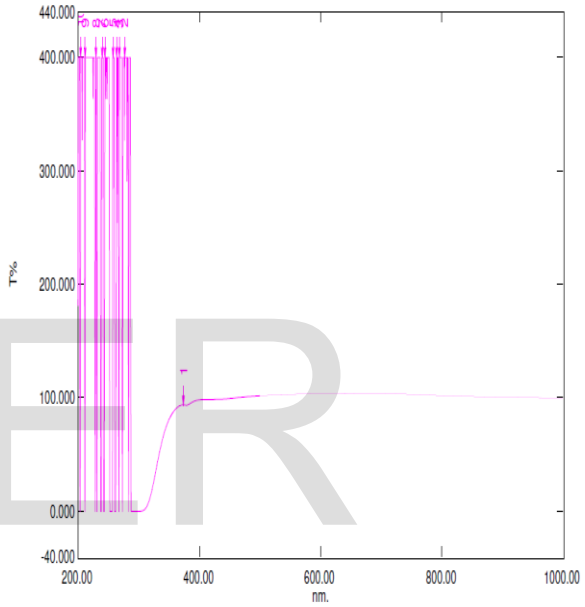

Fig.9: Transmittance of Zobo dye

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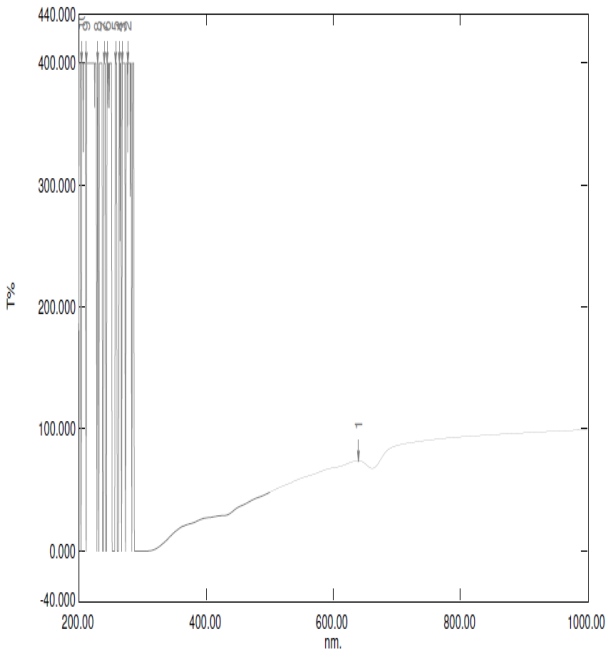


Fig. 10: Transmittance of Tomato dye

Fig. 11: Transmittance of Methyl red dye

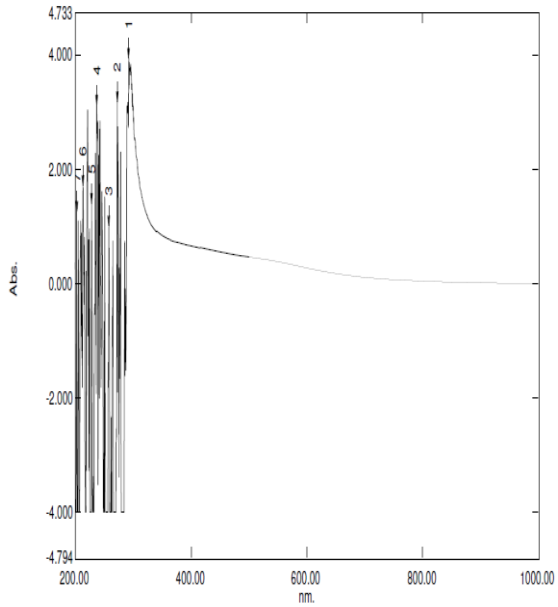
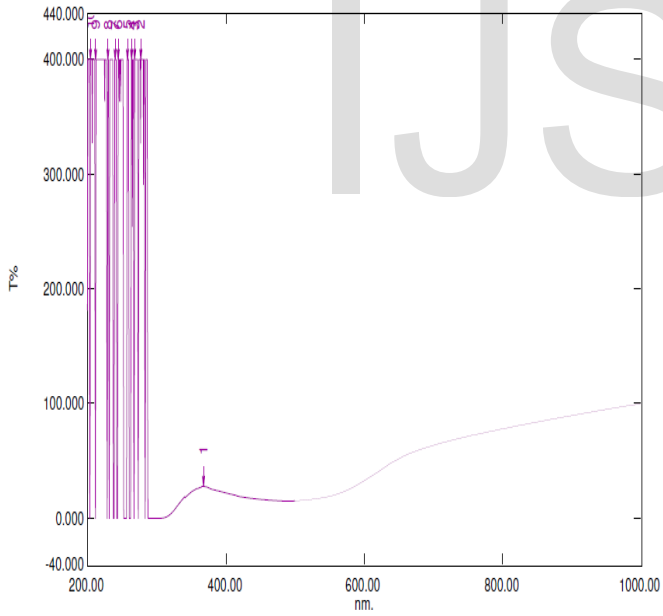


Fig.12: Absorbance of Methyl red dye



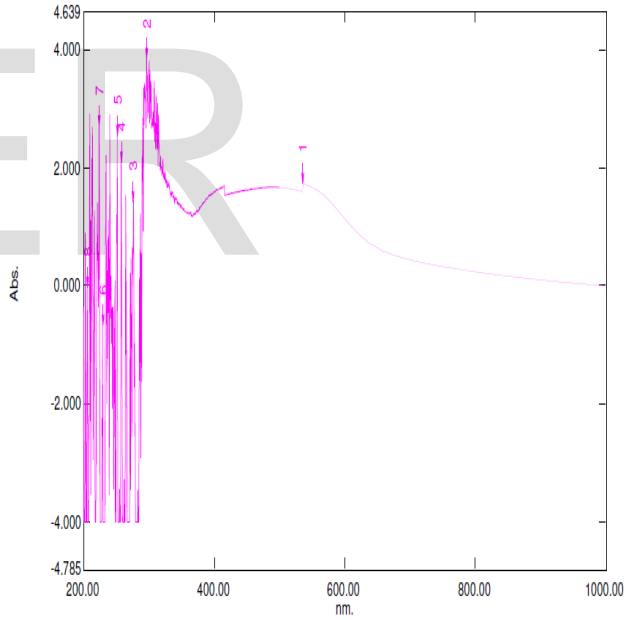


Figure 13: Absorbance of Zobo dye

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DISCUSSION

From the result it was observed that there was no absorbance for tomato dye which actually depicts it as a good transmittance material. It is earlier known from the theory of light in optics that a good transmitter would not show absorbance property. Same goes for a good absorber vice versa. Zobo dye showed constant transmittance figure 9, transmittance edges at 350nm, with maximum at 390nm and remain constant while from fig. 10, for tomato dye there was zero transmittance up to 340 nm and a gradual increase to 100% transmittance with no evidence of absorbance. For fig. 11, the synthetic dye Methyl red dye there was zero transmittance up to 340nm then from 340 nm to 390 nm there was sharp increase to 100% transmittance while there was 3.9 absorbance from 300 nm to 380 nm then an increase between 380 nm and 580 nm and a asymptotic decrease to zero fig. 12 . For fig. 13, Zobo dye there was 3.8 absorbance, from 280 nm to 390 nm with peak at 280 nm and then decreased to zero.

5. CONCLUSION

From the results presented in figs 9-13 Transmittance and absorbance of Zobo, Tomato and Methyl red, Zobo emerges the best absorber material while Tomato the best transmittance material for the fabrication of dye sensitized solar cell.

Acknowledgment

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[6] https://en.m.wikipedia.org/wiki/Methyl_red

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