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Preparation and Optical Properties of DracanaFragransDye Extract

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Abstract- The dye was extracted with acidified solvent, ethanol to study the effect of solvent type on the extraction. UV-vis spectrometer can analyze the optical properties of these natural extracted dyes. The sharp absorbance values in this study were 1.4532, 2.0278, 3.1925 at 435 nm and 0.8719, 1.2111, 2.7909 at 665 nm for ZawGyiTaungWhae (DracanaFragrans)dye. The electrochemical property of this dye was observed by cyclic voltammetry (CV). These facts indicated the extract can be used as sensitizer in DSSC. Fourier Transmission Infrared Spectroscopy (FTIR) indicated the structural properties of this dye.
Keywords – Natural dyes, optical absorption, electrochemical properties, FTIR

I. INTRODUCTION

DSSC has been increasingly used because it provides high energy conversion efficiency. [1] This type of cells exhibits potential for future photovoltaic applications because of its simple fabrication process, low manufacturing cost, low environmental impact, and flexibility.[17] Natural dye solar cells are a sub category of organic solar cells. Natural dyes are relatively easy to obtain and extract from plants, fruits, flowers, and leaves, reducing the cost manufacturing of DSSC, as opposed to the production of synthetic dyes.[2, 3, 4]

The natural dye used in this study was obtained from dark red colored ZawGyiTaungWhae (DracanaFragrans)s (coded as "ZGTW"), species- D. fragrans, family- Asparagaceae by using ethanol solvent. These plants were found in various places of Myanmar. In this investigation, the samples were collected from Yangon University of Distance Education. The effect on temperature and band gap and molecular energy levels of extracting dyewas investigated systematically by UV-vis spectroscopy and cyclic voltammetry method. FTIR spectral analysis was used to determine the functional group in the natural dye.

II. MATERIALS AND METHODS

2.1 Preparation of Dyes

25g of ZawGyiTaungWhae (DracanaFragrans)leaveswas ground and mixed with 50 mL of 70% ethanol and then stored overnight in the refrigerator at 4°C. On the following day, the extracted samplewas stirred using magnetic stirrer at 25°C, 45°C and 65°C for 2 h. The procedure continued with the filtration of the sample to remove large residue. Subsequently, the extractwas centrifuged at 4000 rpm using a Denley BS400 (UK) centrifuge machine for five minutes to separate any remaining residues. After that the extractwas placed in a 45–50°C water bath to dissolve more pigments into the extracting solvent.

2.2 Characterization

The presence of chlorophyll and anthocyanin pigments in this natural dye was determined by measuring its absorbance spectra using UV-Vis spectrophotometer (Shimadzu UV-1800, Japan).UV-vis spectroscopy can be used to measure the absorbance of ultra violet or visible light by organic dyes in the range of 400 nm to 700 nm. The functional group of the sensitizerwas determined via Fourier transform infrared spectroscopy (FTIR) (Perkin Elmer Spectrum 400 FT-IR).

2.3 Cyclic Voltammetry Measurment

Cyclic voltammetry is a very suitable method for a wide range of applications and it is one of the standard techniques used for characterization.[5] It is accomplished with a three electrode arrangement such as a glassy carbon working electrode, platinum counter electrode, and Ag/AgCl reference electrode at a scan rate of 50 mV/s.[7]

III. RESULTS AND DISCUSSION

3.1 Optical properties

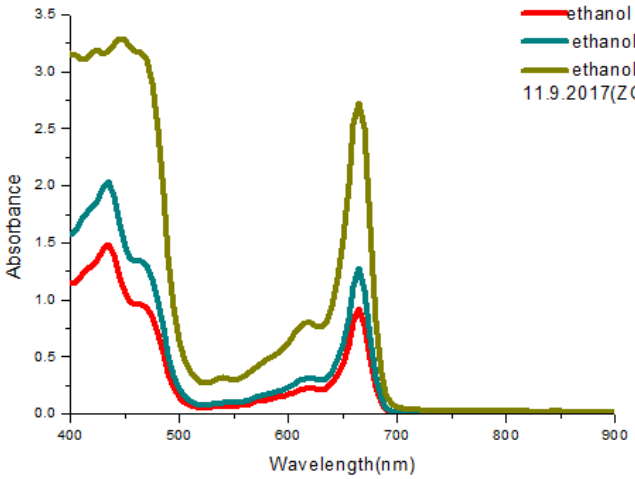


Figure 1 described the optical absorption spectra of ZawGyiTaungWhae(DracanaFragrans)dye at 25 °C, 45 °C and 65 °C for the same concentration. The sharp absorbance values were 1.4532, 2.0278, 3.1925 at 435 nm and 0.8719, 1.2111, 2.7909 at 665 nm for ZawGyiTaungWhae dye.

Figure 1 Optical absorption spectra of ZawGyiTaungWhae (DracanaFragrans) dye extract in solvent ethanol (25oC, 45oC, 65oC)

The energy band gaps (Eg) of these samples at different temperatures were calculated by the following equation.[10]

$$E_g = \frac{hc}{\lambda}$$

where $h =$ Planck's constant $= 6.626 \times 10^{-34}$ Js, $c =$ velocity of light $= 3 \times 10^{8} ms^{-1}$ and $\lambda =$ wavelength

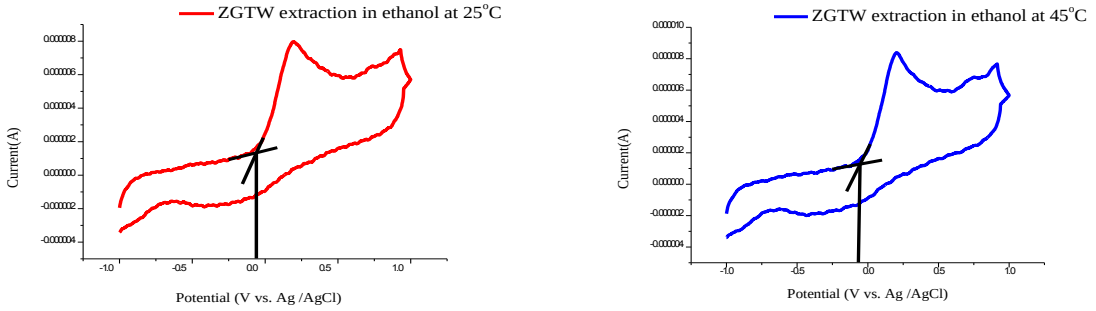
3.2 Electrochemical properties

Electrochemical cyclic voltammetry (CV) was performed to determine the HOMO and the LUMO energy levels of the natural dye. [6] Figure 2 (a-c) showed the cyclic voltammograms of ZawGyiTaungWhae (DracanaFragrans)dye. The electrons from the lowest unoccupied molecular orbital (LUMO) and the highest occupied molecular orbital (HOMO) levels were determined from the following equations. [8,9]

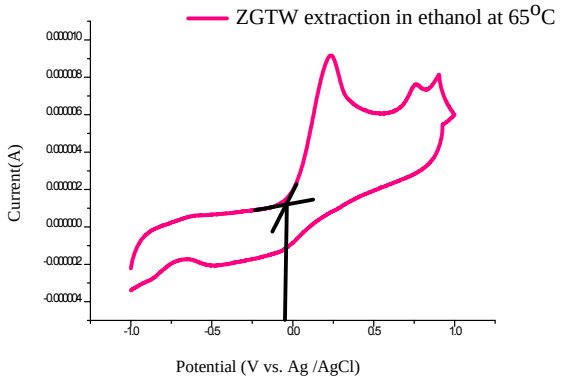
$$E_{Lumo} = -\left[E^{onset} + 4.4\right] eV$$

$$E_{Homo} = E_{Lumo} + E_g$$

The reduction onset potential E^{onset} is determined from the intersection of the two tangents drawn at the rising current and baseline of the CV traves. The optical band gap energy was determined from the UV-Vis absorption spectra. The electrochemical energy levels and optical band gap energies of the dye are listed in table 1.



(A) (B)



(C)

Figure 2. (a) The Cyclic voltammogramfor ZawGyiTaungWhae (ZGTW) at 25 °C, 2h (b) The Cyclic voltammogram for ZawGyiTaungWhaeat 45 °C, 2h (c) The Cyclic voltammogram for ZawGyiTaungWhaeat 65 °C, 2h

Table 1. Energy levels & Band gap energies for ZawGyiTaungWhae (DracanaFragrans)at 25°C, 45°C and 65°C, 2h

Temperature (	Band Gap Energies (eV)	LUMO (eV)	HOMO (eV)
25	2.536	-4.345	-1.809
45	2.531	-4.333	-1.802
65	2.478	-4.351	-1.873

3.3 Ftiranalysis

ZawGyiTaungWhae (DracanaFragrans) spectrum with ethanol - Figure 3 indicated various peaks at different wavelengths of 3281.25, 2917.22, 2849.37, 1734.26, 1618.24, 1419.89, 1369.13, 1315.41, 1240.42 and 1021.11 cm-1 stretching frequency when it was compared with standard. These FTIR spectrums confirmed the presence of Alkane, Aldehyde, Carboxylic Acids, Oxygen compounds, Nitrogen compounds, Sulphur compounds, Phosphorous compounds and silicon compounds in the extractions of ZawGyiTaungWhae (DracanaFragrans).[11-14]

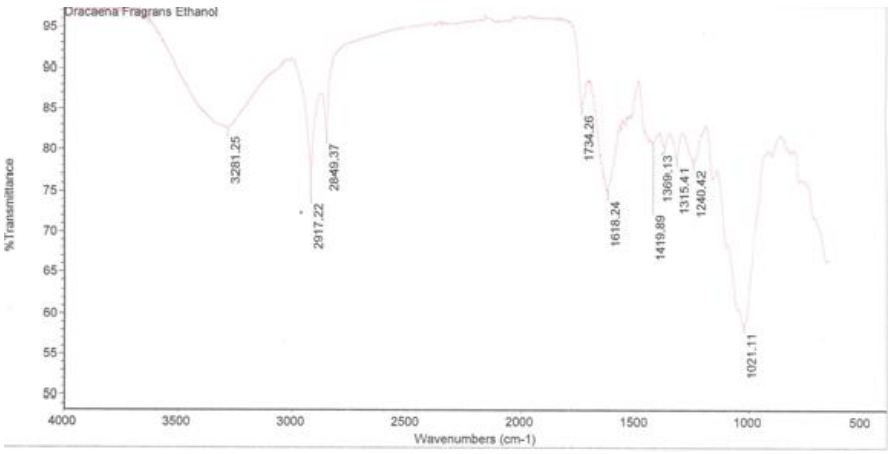


Figure 3. FTIR spectrum of ZawGyiTaungWhae (DracanaFragrans)s extracted from ethanol solvent

IV. CONCLUSION

The natural dye extracted fromleaf of ZawGyiTaungWhae (DracanaFragrans)was used to build dye-sensitized solar cells. It was characterized by UV-vis spectrophotometer. The absorption spectrum from UV-vis can give to calculate the maximum energy band gap. The results from this work forZawGyiTaungWhae (DracanaFragrans) dyeare2.536 eV at 25°C, 2.531 eV at 45°C and 2.478 eV at 65°C. The energy band gap of this dyeis nearly to 2.5 eV for organic dyes. According to the results of Cyclic Voltammetry measurements, the largest value of LUMO was found-4.351at 65oC.The results of FTIR showed ZawGyiTaungWhae (DracanaFragrans)dye solution were AMANO LIPASE Compound which contained Carboxylic acidic group.So the dye extracted in this research work may be applied in use for a part of dye sensitized solar cells.

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