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Performance Comparison between Dyes on Single Layered TiO_2 Dye Sensitized Solar Cell

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Abstract. Dye Sensitized Solar Cells (DSSC) is another kind of solar cell from the third generation that forms a photovoltaic. DSSC is designed to reduce cost from usage of expensive material in conventional solar panels. The purpose of this project is to fabricate and compare dye sensitized solar cells (DSSC) by using organic dye from blueberry and blue dye from chemical substances. The DSSC is fabricated using 'Doctor Blade' method. Results are based on investigating the electrical performance and characteristic of the fabricated TiO_2 solar cell based on these comparisons of dyes in order to investigate the potential of organic dyes as a light absorbing mechanism. The required data that is investigated are the open circuit voltage, Voc, short circuit current, Isc, fill factors, solar cells efficiency and UV absorption. Result shows good potential in the blueberry dyes as a sensitizer but further investigation is needed in order to fully understand the characteristic of these organic dyes.

Dye Sensitized Solar cell background

A solar cell is an electrical device which converts the energy of light directly into electricity by the photovoltaic effect. Solar cell is the core element in making solar panels. RE industries are seeking an alternative to conventional method in fabrication of a solar cell which is free from contamination and its high manufacturing cost. This Project introduces a much efficient and cost saving way to fabricate a solar cell which is non-hazardous to health and can generate the right amount of electricity.

Working principle

Dye-sensitized solar cells are solar cells that mimic photosynthesis in plant innovations. These cells have great potential because they can be made and are made using low cost materials. Unlike traditional solar cells, the cells are dye-sensitive function effectively in low light conditions and less prone to loss of energy to heat.

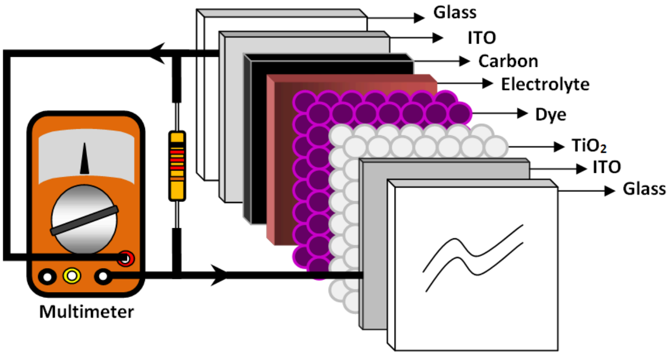

Fig 1. Dye Sensitized Solar Cell cross section

Figure 1 show the Dye Sensitized Solar Cell cross section. Titanium oxide is the preferred and suitable material because its surface contain high resistant to the continued charge electron transfer Molecule in sensitizers that have in dye molecules attached to the semiconductor surface, are used to harvest the light in the solar light. Dye Sensitized Solar Cell (DSSC) are consist of n-type semiconductor, (titanium oxide) , a dye- sensitizer to absorb visible light, an electrolyte, and a counter electrode that is p-type [1].

Ultraviolet and Visible Spectrometer

Spectrometer is the tool measurement to measure the properties of visible light and used for producing spectral lines and measuring their wavelength and intensities. Figure 3 show the visible spectrum that used as a spectrometer [2]. Table 1 shows the summary measurement of spectrometer that used to determine the colour that the dye absorbs in visible light.

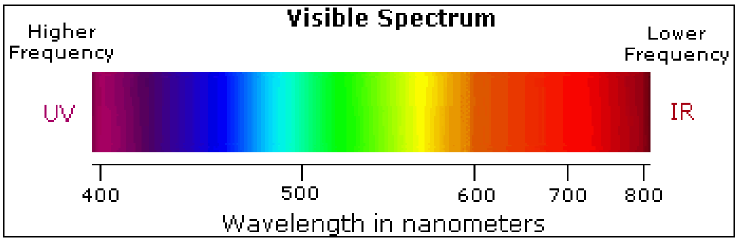

Fig 2. Visible Spectrum wavelength [2]

Table 1. Summary of Spectrometer [2]

Colour	Wavelength
Violet	400 - 420 nm
Indigo	420 - 440 nm
Blue	440 - 490 nm
Green	490 - 570 nm
Yellow	570 - 585 nm
Orange	585 - 620 nm
Red	620 - 780 nm

DSSC Setup and Measurements

The fabrications of DSSC have been explained in detail at [3] as well as the test involved. The absorption spectra were performed by Evolution 201 UV-Vis spectrophotometer. The light source is conducted by using halogen lamp produced about 512 W/m^2. The parameters of solar cell are measured using Data Logger (Graphtec) and Multi meter. The indoor testing is covered by using black box during measurement process to prevent the influence of room temperature that will affect the reading of DSSC in terms of charge generation. To identify the solar absorbance, both dyes were put into the test tube and insert into the centrifuge to obtain only the fluid of dyes without any impurities. After the pure dyes without any impurities were obtained, it will be filled in a small cubical flask and will be put into the Spectrometer machine so it can be radiated by using UV-Visible light as shown in Fig 3

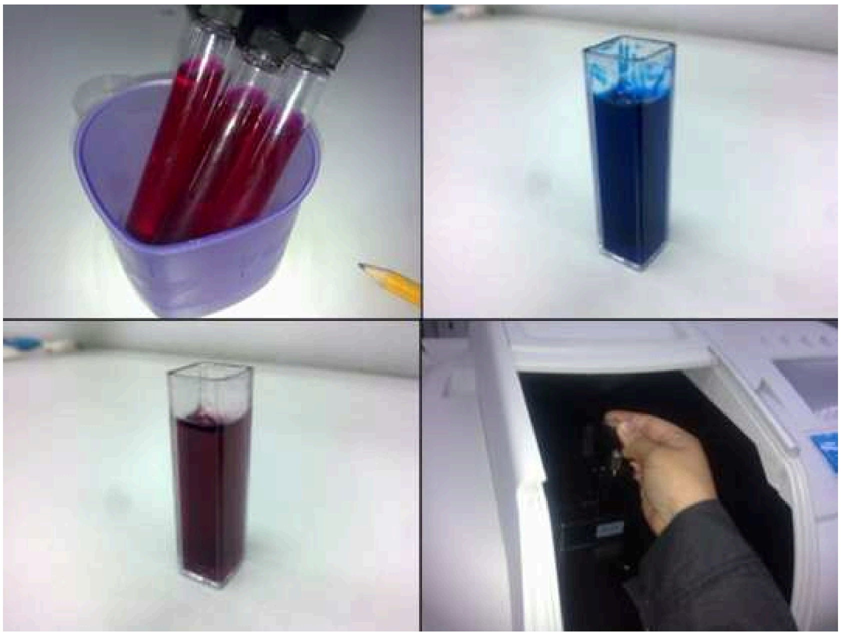

Fig 3. Blue and Blueberry dye tested in the Spectrometer Machine to obtain the Solar Absorbance reading

Table 2 shows the result of indoor and outdoor test by using Doctor Blading method for the TiO_2 of 30µm. Based on the result in Table 2, organic dye shows slight potential in DSSC compare to chemical dye.

Table 2. Summary DSSC indoor performance by using Doctor Blading method.

Dye	TiO_2 Thickness	Experiment	FF	η
Blueberry	30µm	Halogen simulation	0.87	0.122%
Blue Dye			0.77	0.007%
Blueberry		Solar irradiance	0.76	0.067%
Blue Dye			0.69	0.005%

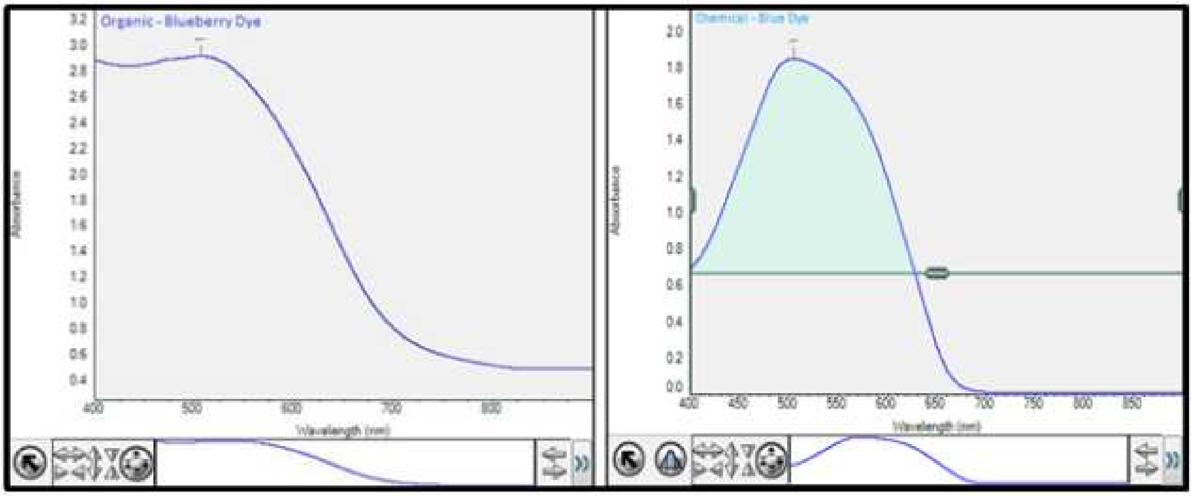

Fig 4. UV-Visible absorption wavelength graph for blueberry dye and blue dye

Figure 4 shows graph of absorbance rate for the blueberry extracted dye and blue chemical dye. Both graph had achieve 520nm to 530nm for the maximum absorbance peak of the wavelength. Both dye will reacted on the green colour in the visible light because the scale of the wavelength is from 520nm to 550nm. The surface of TiO_2 film contain a chemical bond of hydroxyl which affect the chemical absorption result which is good because it will enhanced the absorption molecules and increased the performance of dye sensitized solar cell (DSSC). For the visible spectrum light it has be the cyan tone with wavelength in nanometres.

Conclusion

Successful conversion of visible light into electricity was achieved by using blueberry dye as dye sensitizer in DSSC. The use of natural dye as dye sensitizer is good because of easily purification, simple extraction and low cost but only selected dyes promotes energy conversion. Result shows potential from the use of blueberry as a sensitizer.

Acknowledgements

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