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Dye Solar Cell using Syzigium Oleina Organic Dye

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Abstract

Dye sensitized solar cell (DSSC) is another type of solar cell that utilise the use of a Dye as to absorp more sun rays on solar cells and to direct solar irradiance in it as to circulate electron process like in a conventional diode. The components used to build a DSSC can be divided into 4 parts from making the substrate in this case the TiO_2 as the anode and Carbon as the cathode, soaking it in Dye which act as absorption mechanism, adding of electrolyte and finally assembling them as a unit of solar cell. The process of solar absorption works as the photons from the sun molecular works similarly as in photosynthesis of green leaves. This paper proposed the use of Syzigium Oleina fruit as dye. Syzigium Oleina is a genus of flowering plants that belongs to the myrtle family, Myrtaceae. The genus comprises about 1100 species, and has a native range that extends from Africa and Madagascar through southern Asia east through the Pacific. The usage of Syzigium Oleina as Dye compared to blueberries shows higher solar irradiance absorption and can be used as alternative of other types of organic berries.

Keywords : Syzigium Oleina, Dye, Solar Cells, DSSC

1. Introduciton

A dye-sensitized solar cell (DSSC, DSC or DYSC) [1] is a low-cost solar cell belonging to the group of thin film solar cells [2]. It is based on a semiconductor formed between a photo-sensitized anode and an electrolyte, a *photoelectrochemical* system. A later version of a dye solar cell, also known as the **Grätzel** cell, was invented by Michael Grätzel and Brian O'Reganat the École Polytechnique Fédérale de Lausanne in 1991 [3]. Michael Grätzel won the 2010Millennium Technology Prize for its invention [4].

The DSSC has a number of attractive features; it is simple to make using conventional roll-printing techniques, is semi-flexible and semi-transparent which offers a variety of uses not applicable to glass-based systems, and most of the materials used are low-cost. In practice it has proven difficult to eliminate a number of expensive materials, notably platinum andruthenium, and the liquid electrolyte presents a serious challenge to making a cell suitable for use in all weather. Although its conversion efficiency is less than the best thin-film cells, in theory its price/performance ratio should be good enough to allow them to compete with fossil fuel electrical generation by achieving grid parity. Commercial applications, which were held up due to chemical stability problems [5], are now forecast in the European Union Photovoltaic Roadmap to significantly contribute to renewable electricity generation by 2020.

Dye-sensitized solar cells separate the two functions provided by silicon in a traditional cell design. Normally the silicon acts as both the source of photoelectrons, as well as providing the electric field to separate the charges and create a current. In the dye-sensitized solar cell, the bulk of the semiconductor is used solely for charge transport, the photoelectrons are provided from a separate photosensitive dye. Charge separation occurs at the surfaces between the dye, semiconductor and electrolyte.

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The dye molecules are quite small (nanometer sized), so in order to capture a reasonable amount of the incoming light the layer of dye molecules needs to be made fairly thick, much thicker than the molecules themselves. To address this problem, a nanomaterial is used as a scaffold to hold large numbers of the dye molecules in a 3-D matrix, increasing the number of molecules for any given surface area of cell. In existing designs, this scaffolding is provided by the semiconductor material, which serves double-duty.

2. Methodology

2.1. Titanium Dioxide (TiO_2)

Titanium dioxide is a white semiconductor that is not sensitive to visible light. The titanium particles have to be sensitized with a layer of dye molecules absorbing light in the visible spectrum. Simply DSC composed by order of conductive glass- emiconductor (TiO_2) dye (dye) counter-electrolyte-electrode (pt) [5]. How it works, Photon derived from sunlight absorbed by Dye (coloring) and then generated electron. Electron will move quickly to the semiconductor, and then passed to the counter electrode, after which the electrons move through the electrolyte solution (redox processes), and back again to this Dye. Proses spin cycle continue to form, so that electrical current can be generated, show in Show Fig 1.

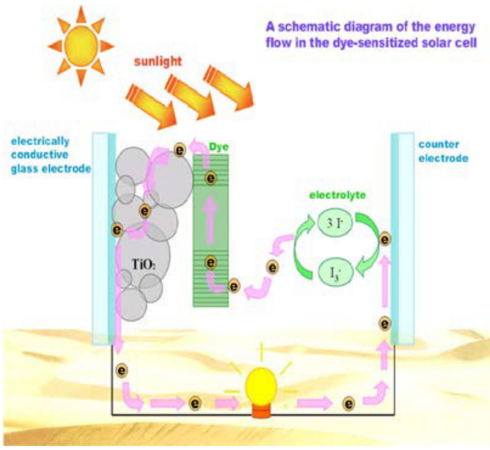

Fig. 1. A schematic diagram of the energy flow in the dye – sensitized solar cell

2.2. Syzigium Oliena Organic Dye

Some natural dyes can be employed, but have managed to find a dye that is renewable and the most efficient pigments, the dye is given in Fig 2.

Fig. 2. Syzigium Oleina organic dye

The plant family myrtaceae is a medium-sized tree that can grow up to a height of 20 m. Canopy is dense, compact and cylindrical. The leaves are elliptical face smooth and shiny, green, 3-8 cm long. Bright red young leaves and will be a lighter color if exposed to direct sunlight. The flowers are small, white or cream and inconspicuous. Shaped fruit is a small berry fruits that are red to reddish brown. While the brown stalks, show in Fig 3 and 4, Although Oleina / red shoots are from tropical rain forests, the plant is often used as a hedge or barrier because the canopy is very dense and not easy to fall out of twigs and leaves even the oldest ones. Oleina will grow rapidly in the state receiving enough water and direct sunlight. This plant can reach a height of 3 meters in less than 4 years. Oleina / red shoots are also tolerant of shade and can be grown under the shade though tend to be slow. Besides this plant is also resistant to pests and diseases.

Syzigium oleina can and usually planted on the main streets of big cities to the needs of "screening", which is to reduce the noise, air and visual pollution due to canopy density and skinfold easily dried twigs and leaves them. Besides the interesting leaf color makes Oleina / red tops as popular plants for landscaping.

Fig. 3. Syzigium Oleina

Fig. 4. Syzigium Oleina Fruit

Description of dye used :

Latin name	: Syzygium oleina
Local Name	: red bud
Family	: Myrtaceae
Treatment	: * 2minggu once * 2-3w-trimming once * Fertilization with NPK 2-3w once
Functions	: * Border * Potted plants * Focal point * Plant director
Average height	: 50 cm - 3 m
The attraction	: The young shoots orange and red
Other information	: - Require full sunlight - Moderate water needs - Including the kinds of evergreen plants

2.3. Staining the TiO_2 with syzigium Oliena Organic Dye

The sensitization of titanium dioxide by natural dyes consists of soaking the titania electrode in mashed fruits. Complete staining can take from several minutes to several hours, while the dye molecules from the fruit juice naturally adsorb onto the titania particles. The longer the electrode soaks in the dye, the better dyed the titania will be.

Start crushing fresh fruits in a petri dish or similar container. The fruits must be juicy enough to get the titania electrode completely soaked, fruits were weighed as much as needed of sensitized and then mashed with a mortar show in Fig 5.

Fig. 5. Syzygium oleina fruits were mashed with a mortar

Place the electrode onto the mashed fruits with the titania surface facing down. If necessary, apply slight pressure on the glass plate so that the whole titania area is soaked by the mixture, show in Fig 6.

Fig. 6. Slowly immerse the sintered titania electrode in the staining

The sensitization process takes an hour or more. Wait as long as possible, so that more dye molecules can attach to the titania. Show in Fig. 7.

Fig. 7. Condition of electrode when soak in dye of fruit

Remove the stained electrode and clean it carefully with tissue. Wait a few minutes for the ethanol to evaporate or use a hair-dryer to gently dry the electrode faster. Show in Fig. 8.

Fig. 8. Remove the stained electrode and clean it carefully with tissue

The resulting stained titania should now look red almost all over its surface. If not, put it back in the fruit juice for further dyeing. Note that the mashed fruits don't offer a homogenous medium, and may cause a pattern on the stained titania electrode. This is not a problem with the operation of the solar cell.

2.4. Cathode of a Dye Solar Cell

The cathode of a Dye Solar Cell is frequently made with platinum, but carbon also demonstrates interesting catalytic activity. The carbon alternative, although being less efficient than its platinum counter part, is easier and cheaper to realize. This makes carbon electrodes of great interest for educational purposes. Two practical ways of making such a carbon counter-electrode are described here. Pencils can be a convenient source of carbon that’s very easy to apply. Start with a TCO glass plate matching the size of the titania electrode being used for the assembly. Cover the entire conductive surface with the pencil [6]. A discrete layer of carbon is now attached to the glass. It is not necessary to have more material on the cathode. Your electrode is ready to go, no need for firing.

2.5. Putting Electrodes Together

Have seen how to prepare a titania anode and a counter-electrode made from either platinum or carbon. Now let's see how to assemble the two electrodes into a solar cell. When the electrodes are put together, the active sides of the anode and the cathode will be facing each other. In other words, the stained titania will face the platinum or carbon of the counter-electrode. The gap left between the two glass plates will be filled with electrolyte during the next step. This step can be accomplished using two different approaches. First, electrodes can be pressed together, and the electrolyte soaked in the resulting stack by capillary effect [7]. Second, the two electrodes can be sealed together and the electrolyte injected via holes drilled through the cathode. The first approach is called an “open cell” because the inner part of the solar cell is exposed to air. This is a very easy setup, but the electrolyte won't be confined in the cell and will eventually dry out. Such an assembly is practical for training courses, where results must be obtained quickly. However, the resulting solar cells won't last as long as in a sealed configuration. The second approach is meant to give longer lasting solar cells. The electrodes are sealed together with a gasket so that the electrolyte is confined in the cavity. It certainly takes more effort to manufacture, but it allows the Dye Solar Cells to operate for an undetermined period of time. Depending on your goals, speed or durability, follow the instructions for the open cell or sealed cell configurations. Putting Electrodes Together [8].

3. Results

Result of dye sensitized solar cells using Organic Dye syzigium Oliena and Blueberries has been done measurement and data collected in the forecourt parking Centre of excellent sources of renewable energy for University Malaysia Perlis, show in Fig. 9. and Table. 1.

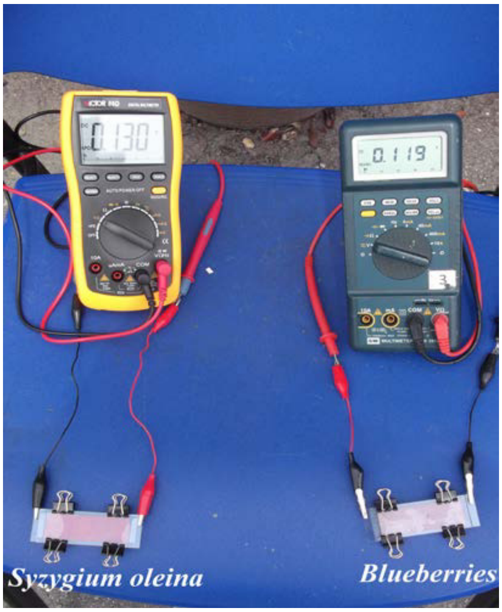

Fig. 9. DSSC with different organic dye between syzigium oliena and blueberries

Table. 1. Data Collected DSSC with different organic dye Syzygium oleina and Blueberries

Organic Dye	Voc (Volt)	Isc (µA)	Solar Irradiance (W/m^2)	Temperature (^0C)
Syzygium oleina	0.130	68.2	493	36.4
Blueberries	0.119	66		

4. Conclusion

From result the following conclusions can be deduced :

1. Base on data collected dye sensitized solar cell using Syzygium oliena organic dye produce Voc = 0.130 Volt, Isc = 68.2, with Solar Irradiance = 493 (W/m^2) and temperature 36.4 ^{0}C.
2. Base on data collected dye sensitized solar cell using Blueberries organic dye produce Voc = 0.119 Volt, Isc = 66, with Solar Irradiance = 493 (W/m^2) and temperature 36.4 ^{0}C.
3. The usage of Syzigium Oleina as Dye compared to blueberries shows higher solar irradiance absorption and can be used as alternative of other types of organic berries.

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