Blueberries and Blackberries Amalgam in Dye-Sensitized Solar Cells

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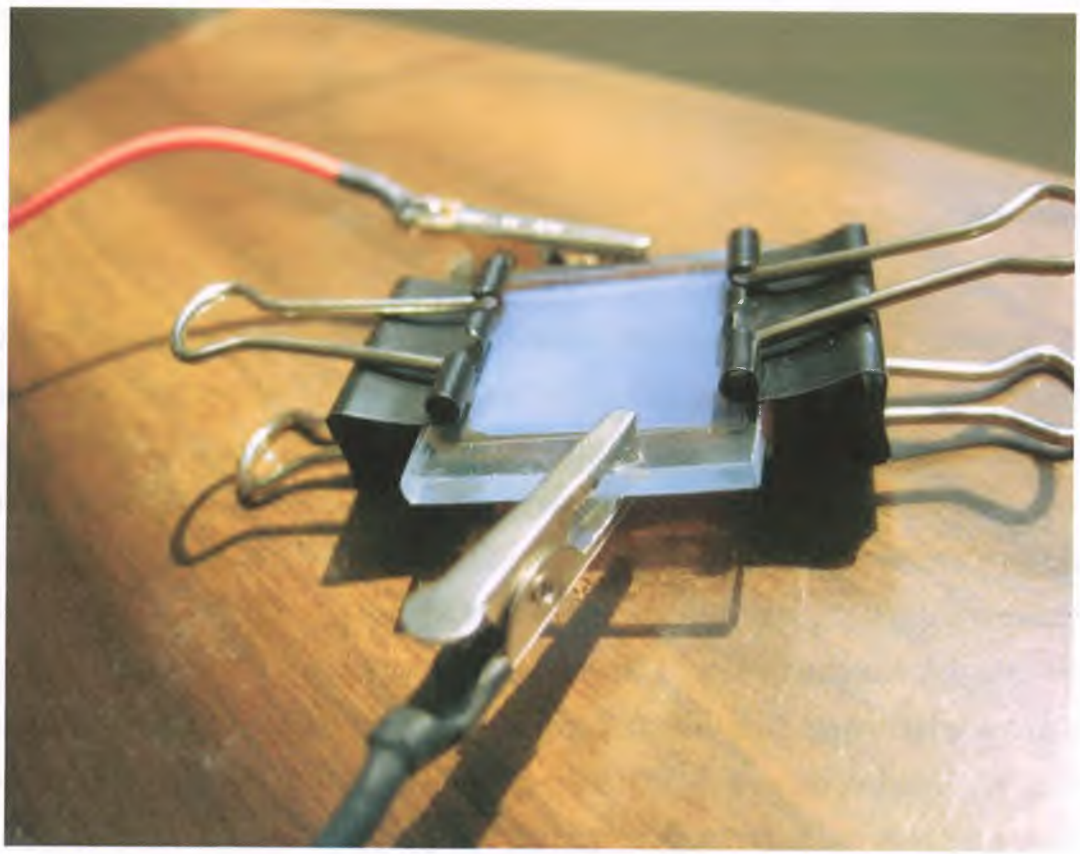
Submitted under the supervision of Tamara Beilke: October 19, 2015



Abstract

The purpose of the lab was to construct and learn about dye-sensitized solar cells using titanium dioxide and acetic acid paste as well as an inexpensive dye to be measured for light attraction. The experiment was conducted by researching facts about dye-sensitized solar cells, practicing casting slides with the TiO_2 pastes, then constructing those solar cells. The final solar cell that was built had a voltage of 0.217. Due to mistakes that occurred within the lab, the final dye used within the solar cell was unknown. The solar cell happened to obtain decent results, although the dye could not be identified. If this lab were to be conducted in the future, the titanium dioxide and acetic acid paste would be prepared in a better manner, and extra caution and precision would be taken when constructing the final solar cell. Another suggestion would be to document every step through pictures and notes. With this information and experience the knowledge of how solar cells function and what components make them up was noted.

1. Background

Solar energy is important since it is a source of renewable energy with an understandable cost. While non-renewable resources, such as fuel and coal, are gradually running out of supply, solar energy will be around for a long time, since it is obtained from the sun. There's a wide variety of solar cells, some more common than others. They range from crystalline silicon to thin film solar cells. Others include amorphous silicon, cadmium telluride, and copper indium solar cells. While several solar cells have demonstrated little efficiency, there are advantages to them, particularly the dye-sensitized solar cell. A dye-sensitized solar cell (DSSC) utilizes dyes in order to absorb solar energy. Such dyes include plants and fruits such as teak leaves, raspberries, blueberries, blackberries, and coffee. DSSCs can be made for a cheap cost since the dyes used within these solar cells can be accessed from local grocery stores. The solar cells also have a high price-to-performance ratio, although they do have little efficiency compared to some other types of solar cells. Unlike other solar cells, DSSCs are able to absorb diffused sunlight and fluorescent light, allowing them to be used inside. They can also be used within direct sunlight since they do not degrade like other cells, allowing them to withstand natural conditions and exposition, leading them to having a long life. While dye-sensitized solar cells may not be the best to use, they do have many benefits.

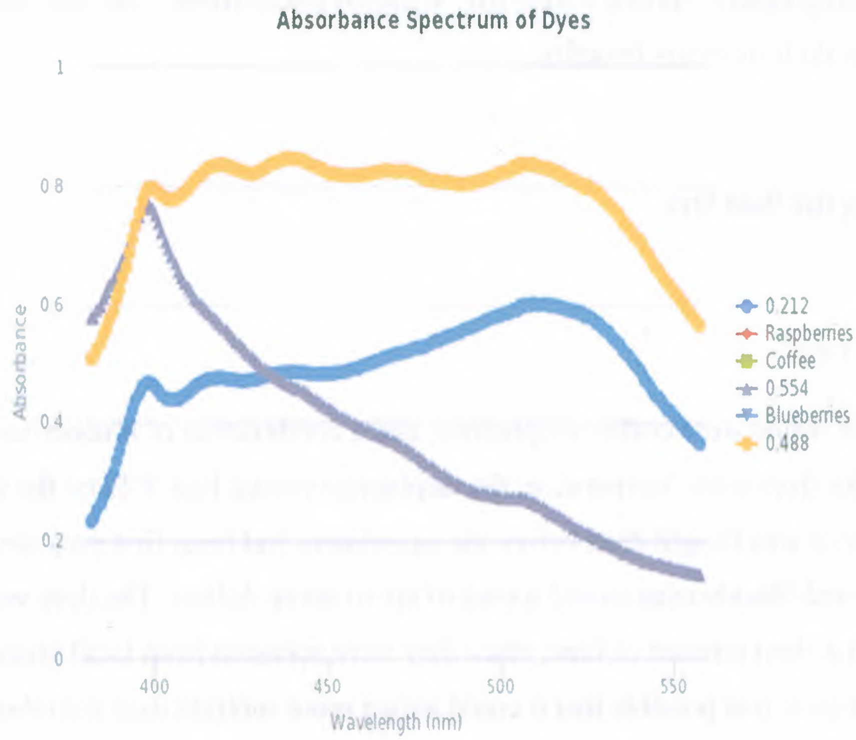
2. Determining the Best Dye

2.1 Vetting the Dyes

The dyes tested were coffee, raspberries, and a combination of blueberries and blackberries. The dyes were inexpensive; the raspberries costed four dollars; the coffee costed fourteen dollars (it was bought days before the experiment had been first proposed); and finally, the blueberries and blackberries costed a total of six to seven dollars. The dyes were easily obtained within a short amount of time, since they were accessed from local grocery stores. The coffee was dark so it was possible that it could attract more sunlight than the other three dyes, but the same could have been true for the mixture of blueberries and blackberries since they had a dark color as well. While there have been previous experiments which consist of detailed outlines about building a raspberry, blueberry, or blackberry dye-sensitized solar cell, there are very few websites which have such procedures for coffee. The reason behind this may be because coffee is a rare dye to use when it comes to building DSSCs, or the dye itself may be ineffective. The dye that was extracted from the raspberries may have been too light to collect enough sunlight for the solar cell.

2.2 Final Choice Dye

After thorough research and testing, the blueberry and blackberry amalgam was selected as the final choice of dye to be used within the solar cell. The graph below represents how much light each dye absorbed. Although coffee had a higher absorbance than the berry amalgam, it did not absorb much light compared to the other dyes. The opposite was true for the raspberry dye; it absorbed a wide range of light, but absorbed so little of it. The berry amalgam seemed to have the benefits of both the coffee and raspberry dyes, so it was decided that it would be the dye to be used for the rest of the experiment.



3. Procedures

3.1 Titanium Dioxide Extractions

The experiment began by scraping several white-powdered donuts, since the powder consisted of titanium dioxide (TiO_2), a component needed to construct a dye-sensitized solar cell. Using the powder that had been collected, it was stirred into a beaker of 150 millimeters of water, and then continued to be stirred for fifteen to twenty minutes while it was boiling on a Bunsen burner. Afterwards, the TiO_2 was partially filtered since the process took a long time. Both the residue and the remaining titanium dioxide was deposited since there was not enough time to wait for the filtering to finish. Instead of using titanium dioxide from the donuts, titanium dioxide ordered from Flinn Scientific Inc. was utilized in the practice slides. Along with acetic acid, three separate pastes were made. One of them consisted of approximately two scoops of TiO_2 and forty-seven drops of acetic acid; the second contained four scoops of TiO_2 and around five streams of acetic acid; the third one contained three scoops of TiO_2 and three streams of acetic acid. The most suitable combination of titanium dioxide and acetic acid was the first one listed, so it was decided that it would be used for the final DSSC. When making the pastes, acetic acid had to be added whenever the pastes became too dry to use on the slides.

3.2 Dye Extractions and Preparation

Even though the blackberry and blueberry mixture was declared as the dye to be used in the construction of the DSSC, the actual dye needed to be extracted along with the other two dyes. The extractions were fairly simple. The coffee was boiled in order for it to be more concentrated. The coffee was originally 360 millimeters, but over a long period of time, decreased to 270 millimeters. The berries were all extracted similarly: they were mashed against a cheesecloth; the juice from the berries were deposited into a beaker; then, the juice was filtered so that any clumps of fruit would not be included with the actual juice. Both the raspberry and blueberry/blackberry dyes were also boiled for about fifteen minutes so that they would both be more concentrated. After the extractions were completed, they were set aside in a refrigerator to be used later within the experiment.

3.3 Constructing the Solar Cell

Using what was gained from the practice slides of the titanium dioxide, a combination of two scoops of TiO_2 and about fifty-four drops of acetic acid was used to make the final paste to be used on the solar cell. After several minutes of combining the titanium dioxide with the acetic acid, the paste was applied to a conducting slide (1 centimeter x 1 centimeter). Unfortunately, the process had to be repeated since the paste was applied to the wrong side of the slide. After repeating this process a couple of times, the TiO_2 was finally applied on the conducting side of another slide. Both slides were then baked in an oven at 450 □.

After the dyes finished baking in the oven, they were pulled out to be cooled. In the dying of the solar cell slide numerous struggles and mishaps occurred. Since the blueberry/blackberry dye had been discarded, an unknown dye had to be used. In the process of dying the slide, the wrong side had been dyed and the procedure had to be redone for the slide in which the titanium dioxide was on the conducting side of the slide. On the notion of dying the correct side of the slide, the slide was taped on one edge. Another slide was then retrieved in order to cover its conducting slide with graphite from a pencil. Afterwards, the two slides were clamped together, thus completing the construction of the DSSC.

4. Results and Future Considerations

The overall voltage of the final solar cell is 0.217. With that score, the solar cell came in second place within the class period and performed better than most of the solar cells. Although the final results of the solar cell are considered to be well compared to other solar cells, the final solar cell contained an unknown dye. The reason for this was because of an accident that occurred within the lab, so it was necessary for the solar cell to be used with another unknown dye since the blueberry and blackberry amalgam was already disposed of. Some factors within the solar cell construction that may have contributed to the overall results of the experiment is that the titanium dioxide was not applied in the best manner — it was chipped and cracked once it was baked in the oven — and the unknown dye may have performed worse or better than how the blueberry and blackberry combination would have if it were to be actually used within the solar cell. The dye, however, did actually dye the titanium dioxide coating. If this experiment were to be conducted again, three things to consider is double-checking that the experiment is being followed accurately (so as not to make any mistakes within the construction of the solar cell), document every single step taken in the lab more thoroughly, and more specifically, preparing the titanium dioxide in a better manner (making sure that it is not too thick to apply to the conducting side of the slide). Although there have been several faults within the experiment, a better understanding of dye-sensitized solar cells has been acquired.

Citations

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