VARYING DYE COLOR AND NANOPARTICLE COATING IN DYE-SENSITIZED SOLAR CELLS FOR THE HIGHEST EFFICIENCY

Introduction

Currently the burning of fossil fuels creates unhealthy living conditions for most species on Earth, so our grand challenge aims to create a more efficient renewable source of energy. Solar panels are expensive but if we can increase their efficiency and lower their cost it would give more incentive to make the shift away from fossil fuels. In doing so we can start eliminating the creators of greenhouse gases. Our proposed solution is Dye-Synthesized Solar Cells(DSSC); this is a type of solar energy that utilizes nanoparticle coatings in order to increases the surface area in which photovoltaic energy can be captured from the sun. The method is low-cost, easy to manufacture, and operates in normal light conditions, but this method does result in high toxicity levels due to utilizing rubidium dye and lower efficiency levels comparatively to other solar cells. This solution was then conducted in two parts to help eliminate those problems:

- Organic dye color Experiment
- Nanoparticle Experiment

Methodology

Organic Dye Color Experiment

Figure 1: The organic dyes are made by using cabbage juice, a type of anthocynin, which is a dye naturally found in nature. We change its pH levels to achieve the distinct colors using Hydrochloric Acid, Ammonium Hydroxide and deionized water to dilute the cabbage juice.

Nanoparticle Experiment

Figure 2: Two types of nanoparticles were synthesized: Gold and Titania. The gold NP were prepared and mixed with a sodium citrate solution and centrifuged to be collected. The Titania NP were prepared using a similar procedure.

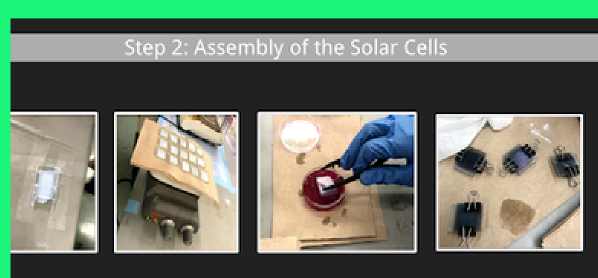

Figure 3: The conductive glass plates are coated with a layer of NPs to serve as the dye docking site and to increase absorption. The glass plates are then baked before being coated with the dye. The layer of electrolyte solution is added before binding the glass plates with an alligator clip. The electrolyte solution was made with ethylene glycol, Iodide, and potassium iodide. 32 Solar Cells were assembled for the dye-experiment.

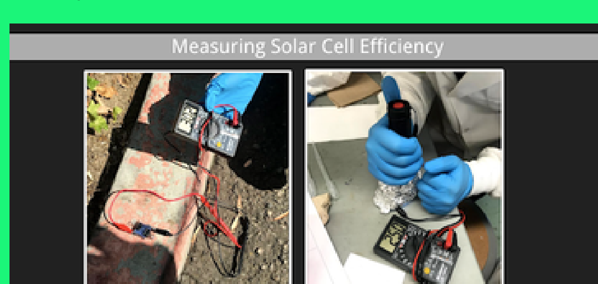

Figure 4: The voltage and the current produced by the solar cells were tested both outside and with LED flashlights using a multimeter. UV Index, temperature, and time of day were kept as consistent as possible.

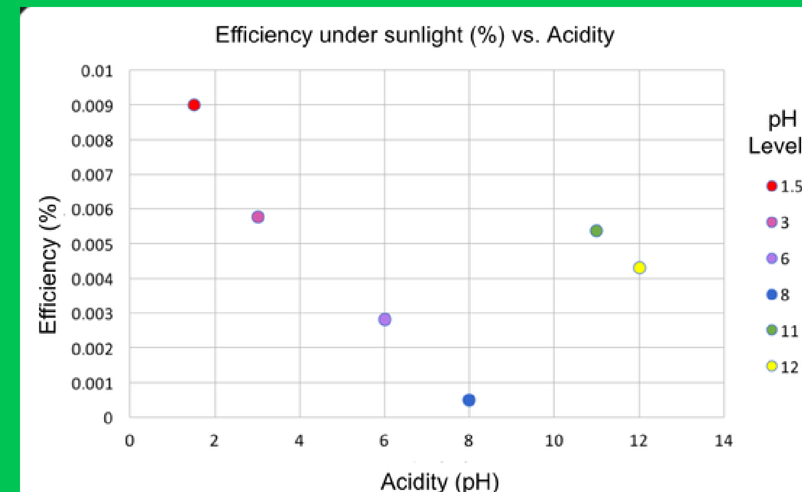

Figure 5: Graph demonstrating the calculated Efficiency under sunlight versus pH level .

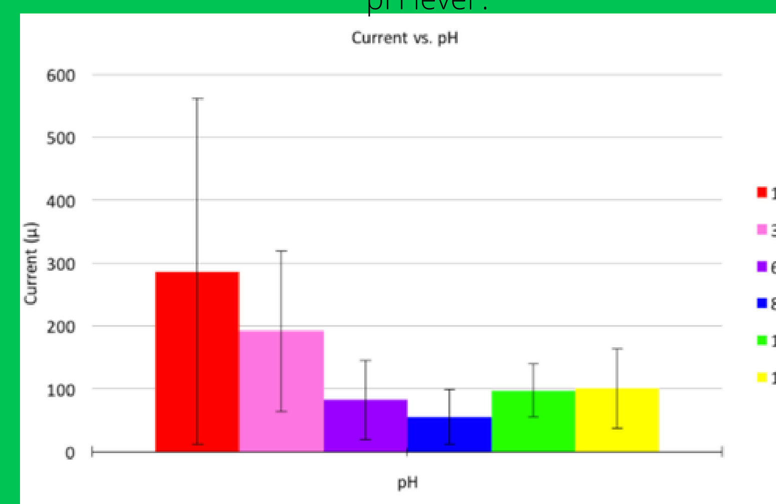

Figure 6: Graph demonstrating the current produced versus the pH level:

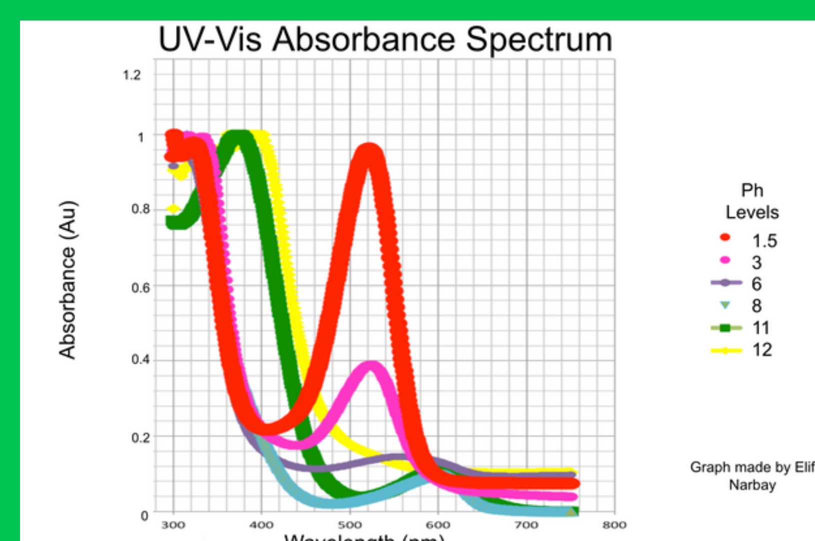

Figure 7: UV-Vis Absorbance Spectrum of the Organic Dye Colors:

Discussion

The results that we have obtained thus far demonstrate that the lower the pH of the organic dye (which corresponds to the colors red and pink) the higher the current produced by the dye-synthesized solar cell as demonstrated in figure 6. To calculate the % Efficiency of the Dye-synthesized solar cells we utilized the following equation:

Efficiency (%) = Electricity Produced (watts)/Solar Energy Absorbed (1300 Wm^2x(4 cm^2/100 m^2)= 0.5 W)

This also further demonstrated that the lower pH (i.e. the colors red and pink) of the organic dye produced the more efficient dye-synthesized solar cell as demonstrated in figure 5.

Conclusion

Through utilizing lower pH levels for the color of the dye in dye-synthesized solar cells (i.e. the colors red and pink) we were able to increase the the efficiency of dye-synthesized solar cells. This was demonstrated by both the high levels of current produced by the solar cells with those dye colors (figure 6) as well as using the Efficiency equation described in the discussion section to calculate for the efficiency for each dye color (figure 5). The red and pink organic dyes resulted in greater efficiency as they obtain the greatest absorbance when measured under the UV-Vis Absorbance Spectrum (figure 7) and therefore increase the amount of UV light that the synthesized cell can uptake to produce a current. Unfortunately, we ran out of time to retrieve data with the nanoparticle experiment, however, we hypothesized that the the smaller sized nanoparticles would increase efficiency as it would increase the amount of surface area and therefore the amount of absorption that would occur would also increase. In the future we hope to test this theory by both testing the different nanoparticles synthesized on the solar cell as well as using imaging such as SEM to characterize them and determine their size. If we can figure out the most efficient nanoparticle coating and use them in conjunction with the most efficient organic dye colors (pink and red) then dye-synthesized solar cells will become a more attractive option for renewable energy as it will be cheaper, more environmentally friendly and efficient source of energy.

Literature Cited & Acknowledgements

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