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Project Number
38361

Project Title
Modeling a Bioluminescent LED that Converts the Light of Luminescent Bactera to Electricity via Dye-Sensitized Plate

Abstract

Objectives/Goals
The problem with current similar products, such as bioluminescent lamps is that it is made by simply putting luminescent bacteria inside a container with food. Thus, it is not very applicable because the light is dark and colored; one can only use it as night or party light. My goal is to model a bio-luminescent LED (bLED) that is more applicable than the currently existing bio-luminescent products by combining Photobacterium Phosphoreum with a dye-sensitized solar cell(DSSC). I also aim to enhance the light of the bLED by optimizing culture conditions of the luminescent bacteria and the DSSC.

Methods/Materials
First, I determined optimized culture conditions of Photobacterium Phosphoreum regarding Br concentration (Belousov-Zhabotinsky reaction) and the number of carbon nanotubes (Rayleigh scattering) by measuring the growth rate of bacteria after each reaction using a spectrophotometer. Second, I increased the efficiency of the DSSC by changing the dye and the amount of material used in the current DSSC (Gratzel Cell). Last, I quantified the efficiency by calculating how much power[V] the final bLED can save.

Results
At first, I decided to use the enzyme reaction as the light source, but could not do so due to instability, so I changed my light source to the bacteria. I determined that an optimal Br concentration and amount of carbon nanotubes exists for culturing conditions. I figured the light absorbance from the DSSC is highest when a small amount of sulfuric acid and starch is used, and the paste is not too thick or viscous. The results were put together to make a finalized bLED. The brightness was 89.5[lx], and the power saved for 30 LEDs was 58.2[W]. The error was 0.11[W].

Conclusions/Discussion
The bLED can emit continuous light because the DSSC can re-emit energy as brighter light when necessary. Theoretically, it also can be an indefinite cycle if the growth rate of bacteria is controlled properly. Thus, to maintain the growth rate I found optimal culturing conditions that is not previously determined. In the future I will attempt to minimize project constraints and do correlated research to increase the efficiency of DSSC. If I do succeed initiating the luciferin-luciferase reaction, I will pursue my goal to model a bioluminescent LED in vitro by determining optical conditions for firefly luciferase enzyme.

Summary Statement
I designed a Bioluminescent LED that converts the luminescent light of Photobacterium Phosphoreum to electricity via optimized dye-sensitized plates of optimum bacteria culture conditions (regarding B-Z reaction and Rayleigh Scattering).

Help Received
I designed the experiments methods myself after internet research. All experimentation was done under my mentor's supervision. My school biology teacher reviewed the results.