CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
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Project Number
S1910

Project Title
A Photoelectrochemical Cell to Obtain Hydrogen from Water with Visible Light

Abstract

Objectives/Goals
The present demand for energy is growing and fossil fuels are not a sustainable energy source. Emissions from fossil fuels significantly degrade air quality and the greenhouse gasses they release are a leading factor in global warming. Direct solar energy has not proven reliable enough to replace fossil fuels because the sun is not always out. Solar produced hydrogen is a sustainable, storable, green energy solution. Light from the sun can provide the energy needed to separate water into hydrogen and oxygen. The purpose of this project was to build a photoelectrochemical (PEC) cell that uses visible light, dye sensitized TiO(2) and Fe(2)O(3) to convert water into hydrogen and oxygen and to demonstrate how PEC cells could be utilized as an alternative energy resource. This design was a modified Gratzel cell made with readily accessible materials.

Methods/Materials
A two chambered PEC cell was built with acrylic plastic. Nanocrystalline TiO(2) was dye sensitized with anthocyanin obtained from blackberries. Dye sensitized TiO(2) and Fe(2)O(3) were bonded to conductive glass plates and placed in chambers filled with distilled water and electrolyte solution respectively. A platinum wire was inserted into the distilled water and connected to the other chamber. The PEC cell was exposed to light; voltage, electric current and water displacement were recorded at set time intervals. The process was modified and repeated seven times.

Results
Trial 1 and 2 showed no current or hydrogen bubbles. With a stronger electrolyte solution, trial 3 gave a measurement of 0.01mA and several bubbles after 2 hours. In trial 7, with added oxide surface areas and a boost of 12 volts for 2 hours, the reading of the PEC cell was 2mA. The bubbles produced by the cell displaced 1ml of water. It was demonstrated that this gas contained hydrogen by igniting it with a flame.

Conclusions/Discussion
Voltage generated by this particular PEC cell was not great enough to separate useful amounts of hydrogen but larger oxide plates would increase hydrogen production. PEC cells could be used in combination with standard solar cells to provide additional voltage to the process. When placed on rooftops or grouped in solar farms, PEC cells could help replace carbon fuels with economical hydrogen.

Summary Statement
This project demonstrated that anthocyanin dye sensitized titanium dioxide could be employed in a photoelectrochemical cell with hematite and platinum wire to separate water into hydrogen and oxygen using visible light.

Help Received
I did all my research and experiments at home with my parent's supervision.