CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
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Project Number
J0231

Project Title
Novel Techniques and Materials for Dye Sensitized Solar Cells

Abstract

Objectives/Goals
This project explores new materials and techniques for the production of dye sensitized solar cells (DSSC). The objective is to find the combination of materials and preparation techniques that will provide the best performing photovoltaic cell.

Methods/Materials
Most of the research done in this field over the last twenty years has been based on cells made using thin films of nanocrystalline TiO2. For this work, I chose to study both ZnO and TiO2 because this would allow me to compare the performance something new (ZnO) to a material that has been well studied (TiO2). Another avenue to explore is the possibility of forming a working cell starting with ordinary, industrial grade chemicals rather than specially prepared nanocrystals. Industrial grade chemicals may offer an advantage since they are cheaper and easier to handle than nanocrystals. While researching this project, I came across the use of ultrasonic liquid processing or sonication. A sonicator is a machine that has a small tip which vibrates at 20,000 times per second. Sonicators are commonly used in biology to disrupt cell membranes for the extraction of genetic material. I remembered how tedious it was to grind the TiO2 powder for the recommended thirty minutes with a mortar and pestle for my project last year. I wondered if sonication could be used to prepare the semiconducting material for a DSSC and if it would prove better than hand grinding.

Results
It was found that that working cells can be made using the semiconductor ZnO. Furthermore, working cells can be made using industrial grade samples of both TiO2 and ZnO. Sonication proved to work as well as or better than hand grinding in all cases. Surprisingly, films that were prepared from material that had been hand ground for thirty minutes and then sonicated performed poorly.

Conclusions/Discussion
The cell made using nanocrystals of TiO2, sonicated for thirty minutes, and sintered at 500 oC outperformed all others. It was found that the best TiO2 cell outperformed the best ZnO cell by a factor of 15 times. In the cells made from TiO2, the best nanocrystalline cell outperformed the best industrial grade cell by 28 times. In the case of ZnO, the industrial grade cells outperformed the cells made with nanocrystals by 16 times.

Summary Statement
This work seeks to find the materials and techniques that will produce the best performing dye sensitized solar cell.

Help Received
My Grandmother let me set up a laboratory in her garage. My Dad helped me find a sonicator and lab furnace on ebay. He also helped me hook up my meters.