CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Asmita Kumar

Project Number
S0710

Project Title
Alternate Electrolytes for Organic Dye Sensitized Photovoltaic Cells

Abstract

Objectives/Goals
To design a replacement electrolyte for the potassium iodide/iodine electrolyte in Grätzel type dye-sensitized photovoltaic cells using simpler materials. Research has shown that cell performance is directly related to electrolyte presence.

Methods/Materials
Grätzel type photovoltaic cells were made with ITO glass. All cells had one electrode composed of a mesoporous titanium dioxide layer with absorbed blackberry anthocyanin or citrus chlorophyllide dye and a second graphite catalyst electrode. Control cells had a commercial KI/I electrolyte in ethylene glycol placed between electrodes. Water, inorganic and organic salt mixtures, strong oxidizing agent based electrolytes, and electrolytic capacitor electrolytes were tested as alternate electrolytes. Performance of each electrolyte was evaluated by measuring voltage and current of photovoltaic cells under a calibrated halogen light.

Results
Most of the designed electrolytes carried some charge because cells showed an ability to convert photon energy into electrical energy. Water based electrolytes were not as useful as charge carriers though good open circuit voltage of up to 0.5V was observed. Strong oxidizing agents like potassium permanganate destroyed the photovoltaic cell. Electrolytic capacitor electrolytes made with ethylene glycol, boric acid and ammonium hydroxide show promise as replacements for the conventional KI/I electrolyte. Among alkali metals, the potassium ion in ethylene glycol provided best results. The best current carrying capacity of alternate electrolytes was nearly 50% of the conventional KI/I electrolyte.

Conclusions/Discussion
Organic dye-sensitized photovoltaic cells can use alternate electrolytes that do not contain the iodide/iodine redox pair to act as charge carriers. These alternate electrolytes provide less current than the KI/I electrolyte, but open circuit voltage remains the same. Superior performance of electrolytes based on ethylene glycol rather than water indicates that ethylene glycol is a necessary solvent. Different organic dyes sensitizers such as anthocyanin and chlorophyllide may require different electrolytes for optimum performance.

Summary Statement
Alternate electrolytes for anthocyanin and chlorophyllide dye-sensitized photovoltaic cells were developed to replace conventional KI/I electrolyte by substituting the redox pair with inorganic salts and electrolytic capacitor electrolytes.

Help Received
Dad provided supervision. Michael Reidy of Hartford Glass provided glass, commercial electrolyte, and titania. Ms. C Peauroi and Professor A. Niemz provided materials for alternate electrolytes.