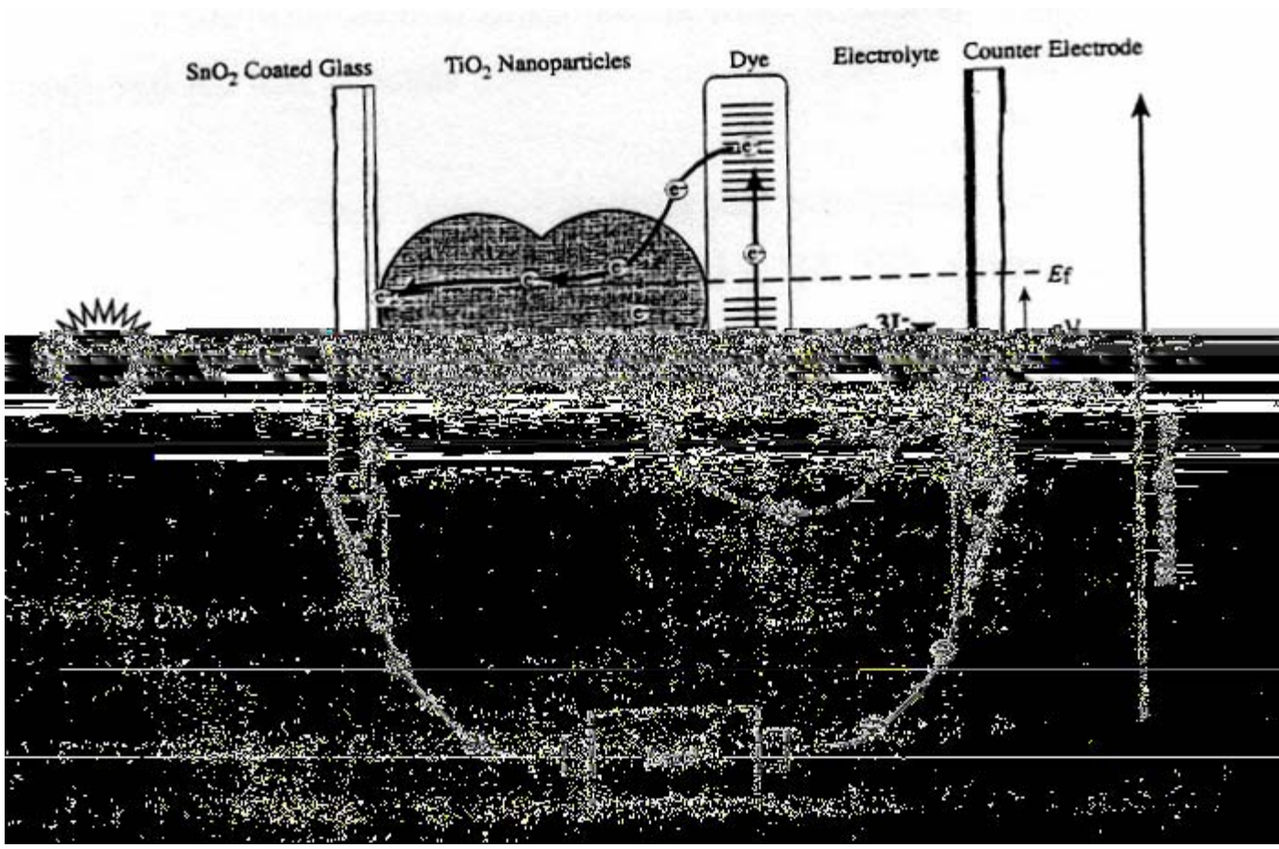
ABSTRACT OF HOMEMADE SOLAR CELL

INTRODUCTION

Solar energy is one of the solutions to the energy crisis as it is renewable and has no environmental hazards. Thus, we investigated the dye sensitized solar cell aiming at introducing a clean and cheap energy resource.

PRINCIPLE OF DYE SENSITIZED SOLAR CELL

The principle is that light excites electrons of the dye that is coordinated to titanium dioxide, and the electrons are then injected into the titanium dioxide nanocrystals. The electrons flow from the titanium dioxide coated electrode through the load and back to the counter electrode. Then the electrolyte in the cell, such as iodine, is reduced to iodide by absorbing the incoming electrons, and iodide in the electrolyte is oxidized to iodine by donating the electrons to the dye. Hence, the circuit is completed. Ideally, nothing is consumed, and the cell is regenerating. The diagram below shows the principle of the solar cell:



In fact, the principle of the cell is very complicated, as there are several processes couple together. The factors we have investigated in order to optimize the system were the effects of dye, semi-conductors, solvent, electrolyte, concentration of electrolyte, acidity, and alkalinity.

INVESTIGATION

We started our investigation using the conditions recommended in the literature, i.e. using raspberries or blueberries as the sensitizer, titanium dioxide as the semi-conductor, iodine and potassium iodide in ethylene glycol as the electrolyte

DYE EFFECT

**Using Titanium Dioxide as the Semi-conductor, and*
Iodine and Potassium Iodide in Ethylene Glycol as the Electrolyte.

Table 1

Dyes	Maximun Current (μ A)	Maximun Voltage (mV)
Red from Poinsettia	370	300
Yellow from Chrysanthemum	163	240
Chlorophyll	100	384
Thymol Blue	108	206
Bromophenol Blue	64	247
Red from Raspberries	286	460
Red from Blueberries	214	390

We observed that the more intense the dye sample was, the better performance would be resulted. In addition, we discovered that poinsettia also showed a very good result compared with raspberries and blueberries. It was probably due to their concentrations and absorbing properties. Then, we repeated the above experiments using the dyes whose concentrations were doubled. The results were still more or less the same as the original one. So, all the dye solutions that we used to produce the solar cell were concentrated enough to saturate the titanium dioxide surface. Therefore, the good performance of the poinsettia was probably due to its good absorbing property .

SOLVENT EFFECT

The nature of the solvent affects the reduction and oxidation processes at the electrode. We have tried to replace potassium iodide by other species. However, due to the solubility problem, only tetrabutylammonium iodide was found in our laboratory that is soluble in an aprotic system. Ethylene glycol, dicholomethane and acetonitrile (using tetrabutylammonium iodide as the electrolyte) were used to investigate the effect of solvent. These solvents were used because they are common solvents for non-aqueous electrochemistry. Dicholomethane was found to have a slightly better performance. This may due to its good polarizability so that the electron transfer process is much enhanced as a result of the easier solvent re-organisation.

**Using Titanium Dioxide as the Semi-conductor,*
Red Dye from Poinsettia as the Sensitizer, and
Iodine and Tetrabutylammonium Iodide as the Electrolyte.

Table 5

Solvents	Maximum Current (μ A)	Maximum Voltage (mV)
Ethylene Glycol	300	343
Acetonitrile	359	315
Dichloromethane	391	305

CONCENTRATION EFFECT OF ELECTROLYTE

The current drawn remained more or less the same as the concentration of the electrolyte dropped for first three minutes and dropped rapidly afterward. This may due to the effect of saturated absorption of iodide and iodine on titanium dioxide and graphite electrodes respectively so that the current drawn initially is more or less the same. However, when most of absorbed species are used up, the less concentrated solution takes much more time to diffuse to the electrodes, thus the current and voltage drop more rapidly.

ACID EFFECT

We have studied the acid effect and ethanoic acid was added to the solvent.

**Using Titanium Dioxide as the Semi-conductor,*

Red Dye from Poinsettia as the Sensitizer, and
Iodine and Tetrabutylammonium Iodide in Dichloromethane as the Electrolyte,
Table 6

Number of Drops of Ethanoic Acid Added to Electrolyte	Maximum Current (μA)	Maximum Voltage (mV)
Control (dichloromethane)	431	442
2 (dichloromethane)	1370	428
Control (acetonitrile)	493	524
2 (acetonitrile)	540	488
Control (ethylene glycol)	125	340
2 (ethylene glycol)	200	320

**( ):electrolyte

Dichloromethane showed most pronounced effect than the more basic solvent acetonitrile and ethylene glycol.To understand the result, we studied both the acid effects on dye and that on electrolyte. We studied the acid effect on dye structure by visible spectrum. The result shown that there was a little or even no change of the absorption of the dye when acid was added to it, which showed that acid had no effect on the structure of the dye. Then, we concentrated on the acid effect on electrolyte. As we knew that the ethanoic acid contained both hydroxy group.

**Using Titanium Dioxide as the Semi-conductor,*
Red Dye from Poinsettia as the Sensitizer, and
Iodine and Tetrabutylammonium Iodide in Dichloromethane as the Electrolyte,
Table 15

Number of Drops of Ethylene Glycol Added to Electrolyte	Maximum Current (μA)	Maximum Voltage (mV)
Control	623	462
2	553	435
5	240	484
10	448	482

Thus, we added ethylene glycol to the electrolyte instead of ethanoic acid (since ethylene glycol contains hydroxy group) to a solar cell using dichloromethane as solvent. However it didn’t have a good result compared with that using ethanoic acid. Thus, we can conclude the better performance is due to the acid effect on electrolyte.
It is difficult to explain the result yet, but it may due to the interaction of hydrogen ions with iodide ions, as hydrogen iodide is more mobile than the ion pair, tetrabutylammonium iodide, a better current is resulted for the acidic condition.

CONCLUSION

After the extensive investigation, we found that the performance of the solar cell is not only affected by the nature of the solvent and the electrolyte, but also the particle size of the semi-conductor and the nature of the dye. When we use 0.5ml dichloromethane as the solvent with 2 drops of ethanoic acid, the maximum current achieved was 2.85mA under sunlight. Our results were 3 times better than that using the conditions recommended in the literature. Actually, conserving the world is one of the people’s responsibilities and so we hope that this dye sensitized solar cell will be widely used soon so as to provide another clean and cheap energy source.