PHOTOVOLTAIC CELL [Solar Cell]

David d'Albany

Amon Rwito

Williams IB Middle School
5020 N. 47th Street, Tampa, Florida (813) 744-8600

National High Magnetic Field Laboratory

Apalachee Tapestry Magnet School of the Arts

Introduction

When light hits a metal or a metalloid[1] surface which has some oxidation or impurity, (through nature or doping techniques) [2], the degree of electron excitation within the metallic substance varies, and that creates static electricity. If such electricity is allowed to move in a circuit it will produce a measurable electric signal. Cu/CuO plates immersed into saline solution is a practical example of a research and classroom experiment that can be done since these materials are cheap and readily available.

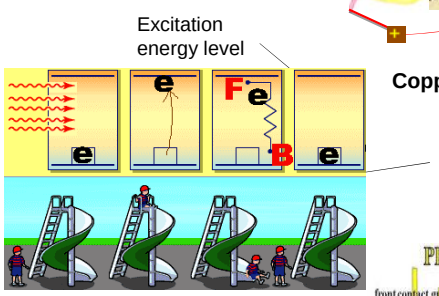
---

[1] Metalloids are seven elements: B, Si, Ge, As, Sb, Te and Po.
[2] Some examples of photovoltaic cells metals and metalloids are:
1- Silicon (Crystalline and Micro- Nano-Amorphous)
2- CdTe (Cadium Telluride) 3- $CuInSe_2$ (Copper Indium Diselenide)
4- CuInGaSe (Copper Indium Gallium Selenide)
5- GaAs (Gallium Arsenide) 6- InP (Indium Phosphide)
7- TiO_2 (Titanium Dioxide) 8- CuO (Cupric Oxide)
9- Si/SiO/sub x/ /Ag/Ag_2O (Silver and Silver Oxide)
10- S/Se/Te combination. 11- Cu/Ag/Au combination
12- Al/Ga/In combination

Theory

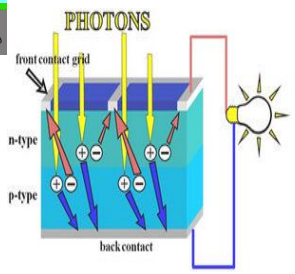
As the Sun light hits the Cupric Oxide (CuO) plate, electrons are energized to an excitation energy level. The NaCl solution allows the electrons to escape from CuO and generate an electric current.

Copper Cell Experiment



The electron **(e)** is shown interacting with light and climbing to a higher energy level. It subsequently dissipates the excess energy it receives from the light by doing work in an external circuit.

The electric current flows in and out of the cell through terminals B and F. The sequence involved is analogous to a child playing on a slide.

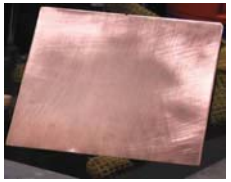


Solid state Solar Cell

Experiment

Preparation of Copper Plate: Sanding

Thorough washing with soap water

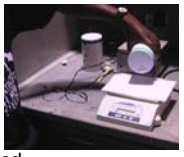


Clean Copper ready to be oxidized at 610ºF for 30 min. and cooled for > 4 hr.

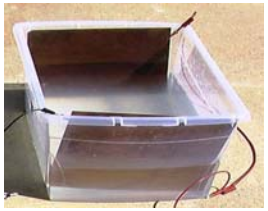
Electric oven

Final oxidized Cu plate

The oxidized plate is washed to remove fallen oxide flakes

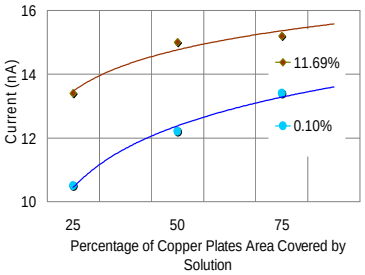


NaCl is weighed

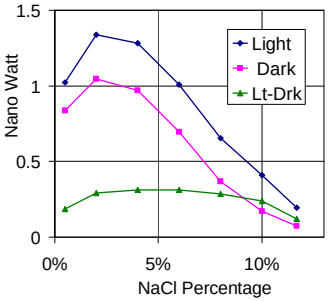


Cu Solar Cell is assembled

Readings of current and Voltage were taken in the dark and in the sunlight.



Current dependence on electrolyte volume at various salt concentration



Power Generated by the Incandescent Light

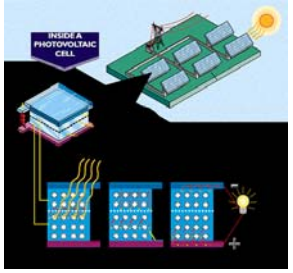
Conclusion

CuO/NaCl/Cu Solar Cell was designed and constructed. Different concentrations of NaCl were tested ranging from 0.10% to 11.69% and it is discovered that a 2% solution is the most effective. This may be due to the increased resistivity with the lower concentration and reduced voltage with higher concentration.

Tests were performed on 3 levels of solution allowing 25%, 50% or 75% of copper plates were submerged. The latter produced the highest current. The cell design did not allow for the battery to fill more than up to 75%.

To obtain a homogenous CuO, cooling must be very slow. If cooling is rapid, CuO may flake out and fall off in irregular clumps.

Solar Energy Applications



Further Scientific Investigations

1- A Photometer could be manufactured to measure the amount of light using LED indicators. But, our Cu Solar Cell produced a power in the amount of 1.3 nWatt. The LED requires 1.5 mWatt. A possible remedy would be to attach an amplifier circuit to illuminate the LED.

2- An attempt to make a solid Solar Cell using a permeable paper tissue filled with saline did not produce significant current. Further investigation with different types of solids and semisolids, permeable and semipermeable media and electrolytes may lead to a more important current.

Resources

• http://www.soton.ac.uk/~solar/intro/tech0.htm
•Sopori, Bhushan, J. of Electronic Materials, **34**, 564 (2005)
•Kar, S. , Varghese, R., J. Appl. Phys.,**53**, 4435 (1982)
http://www.sciencedaily.com/releases/2002/07/020705090714.htm (+ homepage)
• http://www.news.cornell.edu/stories/Jan08/mesoporous.ws.html
• http://scitoys.com/scitoys/scitoys/echem/echem2.html
• http://www.speedace.info/solar_cells.htm
• http://www.ipc.keio.ac.jp/english/inventions/material/2006_240984.html Keio University JAPAN and • Britannica Online

Acknowledgements

Dr. Alexey Souslov and all the NHMFL RET Team, especially Mrs. Pat Dixon and Mr. José Sanchez.