



Dye Photo Sensitizer-Based Modified Photo Galvanic Cell For Solar Energy Conversion And Storage

Dr. Sominath Sarangdhar Khade

Dept of Geography

Rastramata Indira Gandhi Arts, Science & Commerce College,

Jalna [Maharashtra]

sominath.khade@gmail.com

Abstract

A solar cell directly turns solar energy into electricity. Photo galvanic cells are unusual among such solar cells since they are the only solar cells that can generate and store solar power at the same time. As a result, such inherent solar power storage capacity, coupled with the high efficiency of these cells, must be utilized in order to make solar cell technology a stable source of power in the future. To illustrate the unique property of photo galvanic cells, fabrication and experimentation are relatively straightforward. The power, short-circuit current, open-circuit potential, conversion efficiency, and power storage (in terms of half change time) for photo galvanic cells. We use dye as a photosensitize material, which is excited and then stabilized by emasculation production, which aids in energy storage.

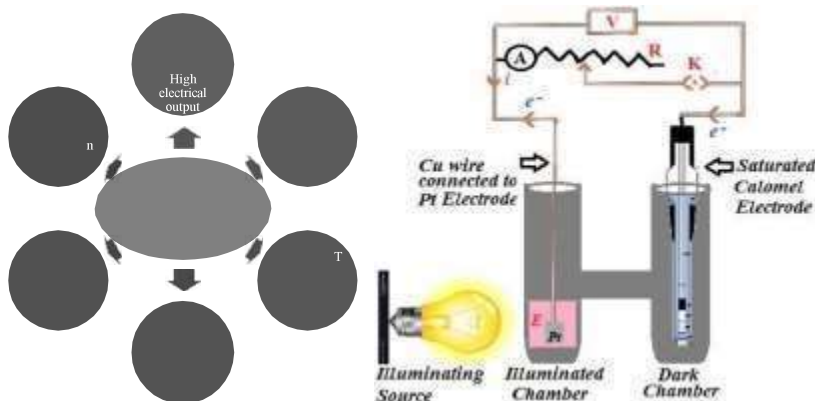
Keywords: - Photo Power, Photocurrent, Photo Potential, Fill-Factor.

Introduction

Solar energy is a low-cost, clean, abundant, and widely available renewable non-conventional energy source. The photo-galvanic cell approach is a promising yet underutilized method for solar energy generation and storage. A photo galvanic cell is a photo electrochemical device that uses ions as mobile charges that move in solution via diffusion. In this cell, the solution is in the absorber phase and is contacted by two electrodes with different redox selectivity. Photo chemically produced variations in the relative concentrations of reactants in a solution phase redox pair cause changes in current or voltage. In a photo galvanic cell, a dye in solution is photo excited to produce an energy-rich product that can be lost electrochemically to generate electricity with inherent storage capacity. They are preferable than photovoltaic cells due of their intrinsic storing. There is no chemical consumption during the charging and de-charging of these solar cells.

PG cells are based on the photo-galvanic effect, in which light influences the electrode potential via a photochemical reaction in the electrolyte's bulk. The photo galvanic effect is a form of Becquerel effect (with the Becquerel effect, photochemical or photoelectric processes occur on the electrode's surface layer). The photo galvanic effect was discovered by observing the influence of light on the equilibrium of ferrous iodine- iodide. Several reports have been found in literature with various blends of dye-reductant- surfactant and alkali. The dye-reductant-surfactant formulas such as glycerol- Azur-sodium lauryl sulphate (SLS),^[1] Indogo carmine-ascorbic acid,^[2] Brilliant green- ascorbic acid- ammonium lauryl ether sulphate (ALES),^[3] oxalic acid- Brilliant Cresyl,^[4] Tropaeline O- oxalic acid- benzalkonium chloride,^[5] Congo red- formaldehyde-SLS, ^[6] Sudan I-fructose- SLS,^[7] Congo red-D-Xylose-Cetylpyridinium

chloride,^[8] Indigo carmine-formic acid- SLS,^[9] Toluidine blue- oxalic acid- Tween 80,^[10] and so forth, have been reported to use in photogalvanic cell by various researchers and found various results. There are some mixed dye and mixed surfactant photogalvanic systems has also been reported with extraordinary results such as combination of Brilliant green Celestine blue and SLS+CTAB, respectively.^[11,12]



Advantage of photogalvanic cell and H-type cell

Apparatus used

The apparatus as the digital pH meter model LMPH-9 (*Labman Scientific Instruments Pvt. Ltd., Chennai, India*) for measuring the potential in millivolt (mV) having mV range ± 1999 mV, Accuracy 0.1%. a micro-ammeter (*OM Meter, Ambala Cantt Haryana, India*) for measuring the current in microamperes (μA), a carbon pot log470 K devices for changing the resistance of the circuit, copper wires as connecting wires for completing the external circuit, a brass plug circuit key (*AIM SCIENTIFIC, New Delhi*) for closing the circuit, a platinum electrode (*PSP Instruments nasik, maharashtra*) as the negative terminal of the cell, a saturated calomel electrode (SCE) (*PSP Instruments nasik, maharashtra*) as the positive terminal of the cell, a cylindrical-shaped glass tube (simple boiling tube) for accommodating the electrolyte, a 200 wattage incandescent tungsten filament bulb for getting artificial sunlight, and a HTC Instrument LX-101A Light Meter Luxmeter (accuracy: ± 5 percent of the reading) for measuring the sunlight intensity, have been used.

Experimental Method

The required amount of electrolyte (dye sensitizer, reductant, surfactant, alkali, and water) is poured in the transparent, cylindrical glass tube with a non-blackened outside, and both electrodes (Pt and SCE) are immersed in the electrolyte solution. Every piece of equipment in the experimental setup is connected to one another in a circuit, according to the schematic. The circuit is initially left open in order to establish a steady potential, and the cell is placed in a dark environment (dark potential- V_{dark}). While the circuit is still open, the electrolyte solution can be illuminated with artificial sunlight to charge the cell.

The photo-potential value is recorded at various time intervals. V_{max} , or maximum potential, is the maximum potential that can be measured during illumination. When the cell reaches a stable potential value known as open-circuit potential, or V_{oc} (V_{oc} is slightly lower than V_{max}), it is said to be fully charged. The illumination in the cell is then turned off. The circuit is then disconnected. Maximum

current (i_{max}) is defined as the maximum current obtained immediately after closing the circuit at resistance zero. Short-circuit current (i_{sc}) is caused by the current having a relatively constant value over time. The potentiometer is used to adjust the circuit's resistance. The i - V characteristic of the cell is explored by adjusting the current value from i_{sc} to zero and noting the associated potential value (by varying the circuit resistance, zero current is achieved at the largest resistance). The term "power at power point" refers to the greatest product of current and matching potential (maximum power extractable from the cell, P_{pp}). Current at power point (i_{pp}) and potential at power point (V_{pp}) are abbreviations for current and potential at power point, respectively. The formula for calculating the charging time (t) is charging time = (time at which V_{oc} is attained) - (time at which illumination is started). The fill factor (FF) and conversion efficiency (CE) have been calculated using the formulas $(i_{pp} \times V_{pp}) / (i_{sc} \times V_{oc})$, and $(i_{pp} \times V_{pp} \times FF \times 100\%) / (A \times P)$, respectively. Where "A" stands for Pt electrode area (cm^2) and "P" stands for average artificial solar intensity ($mWcm^{-2}$), respectively. The half change time ($t_{0.5}$), which is the amount of time it takes for the cell's power to drop to half of its highest level while being extracted from it in the dark at a particular external load, is used to measure the power storage capacity of a cell (resistance).

Conclusion

When we construct a cell we have to find the optimum values of concentration of each component present in electrolyte and we observed and increase cell parameter at low concentration and get maximum and then decreases for all reason behind that result are

For Pt electrode area: It occurred as a result of the optimal amount of electrons impacting the smaller sized Pt electrode and faster electron mobility. Smaller electrodes with modified photogalvanic cells operated well and had the highest electrical output.

For P^H of electrolyte solution: It happened because of the interaction between alkali and reductant, and the optimal pH value enhances the availability of reductant in its anionic form, putting it in a better position to donate electrons. Thus, the performance of the modified photogalvanic cell was improved at a particular P^H .

Concentration of surfactant: It occurred as a result of the critical micelle concentration (CMC) of the surfactant used to generate the dye-micelle system. This technology enables dye molecules to discharge electrons from the dye-micelle system and into the aqueous system. The expelled electrons are subsequently drawn by the Pt electrode, resulting in the best performance of the modified photogalvanic cell.

Concentration of reductant: It occurred as a result of the optimal concentration of reductant, which donates a suitable amount of electrons to dye and results in the best performance of the modified photogalvanic cell. A larger concentration of reductant, on the other hand, will not allow dye molecules to absorb a suitable quantity of solar energy and will restrict dye molecules' mobility, resulting in a decrease in the performance of the modified photogalvanic cell.

Concentration of dye: It occurred as a result of the optimal concentration of dye, which absorbs an acceptable quantity of solar energy and donates an appropriate number of electrons to the Pt electrode, resulting in the maximum performance of the modified Higher dye concentrations, on the other hand, prevent the necessary quantity of solar energy from being absorbed, resulting in a decrease in the performance of the modified photogalvanic cell.



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