E1-47: Solar energy conversion using solid state photoelectrochemical solar cells based on solid polymer electrolyte, polyethylene oxide

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Photoelectrochemical (PEC) solar cells provide a convenient and inexpensive method of converting solar energy into electricity. Conventional PEC cells are made by dipping a photoactive cathode made of a semiconductor into an electrolyte solution. However, there are several drawbacks in these conventional PEC cells. Photocorrosion of the electrodes and side reactions limit the working life time of these cells. They are difficult to pack.

In this work, we have fabricated all solid state photoelectrochemical solar cells using a polyethylene oxide (PEO) based solid polymer electrolyte, a dye sensitized, nano-porous TiO_2, photoactive electrode and an ITO conducting glass counter electrode. Ethylene carbonate (EC) and propylene carbonate (PC) were used as plasticizers to enhance the room temperature conductivity of the PEO:KI:I_2, electrolyte with I^{-3}/I^- redox couple. Dye-sensitized photoactive electrode was made by incorporating ruthenium bipyridine dye into the nano porous n-TiO_2 film prepared on an ITO conducting glass plate. An ITO conducting glass was used as the counter electrode.

Temperature dependence of ionic conductivity of the polymer electrolyte, current-voltage characteristics of the PEC cell under different sources of illumination, and photocurrent action spectrum were investigated. Under direct sunlight($1.2x10^5$ lux) the device yielded an open circuit voltage of 670 mV and a short circuit current of 67 $\mu A/cm^2$. The solar energy conversion efficiency of the device is 0.74 %. Although the above cell is still far away from a practical solar energy conversion device, results suggest the possibility of utilizing PEO based electrolytes in combination with TiO_2 for developing a low-cost solid state solar cell.

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