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Experimental Investigation of Silicon and Dye Sensitized Solar Cells Based on Wavelength Dependence

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Abstract

As fossil fuels, the major source of energy used today, create the greenhouse gas carbon dioxide which causes global warming, alternative energy sources are necessary in the future. There is a need for different types of renewable energy sources. Photovoltaics use the energy of the sun and convert it into electricity. Photovoltaics PV, called also solar cells are made from light-absorbing materials. When the cell is joined with a load, optically generated carriers create an electric current. The conventional material used for solar cells is the silicon.

Another type of solar cells is dye-sensitized solar cells, which is a field of applied research that has been growing rapidly in the last decade leading to power-conversion efficiency of 10 percent. One major reason for this field is a potentially low-cost production of solar modules on flexible (polymer) substrate.

The aim of this research is to compare the performance of dye-sensitized solar cells to silicon based solar cells in order to reduce the cost of solar cell and increase the efficiency by analysis of their characterization. This work is based on experimental work for solar cells comprising.

The current-voltage characteristics (I–V) of a solar cell reflect the electrical processes in the device. Therefore, the (I–V) curve is selected as means of comparison between experimental data. These (I–V) characteristics were measured for different light wavelengths. The parameters of each solar cell, the short circuit current, open-circuit voltage, fill factor and efficiency were determined in the wavelength range 460 nm to 589 nm.

The experimental results show that the cell efficiency for poly-crystalline silicon and dye-sensitized solar cells are nearly constant while it increases towards longer wavelengths for mono-crystalline and thin film silicon solar cells.

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1. Introduction:

Photovoltaics (PV), discovered by Edmond Becquerel in 1839, is the collective name for devices converting the energy of the sun, photons, into electricity. The photovoltaic effect refers to when photons are falling upon a semiconductor and generating an electron-hole pair. The electron and the hole can be directed to two different contacts, a circuit can connect the two and an electric potential difference will be established. The unique features of semiconductors are their electrical conductivity which could be controlled by doping, optical properties and photoconductivity. Photovoltaic occurs in its simplest form, when light Photons having energy greater or equal to the band gap energy of the semiconductor are absorbed. The photon energy strikes the electron in the valence band; transfers it to the conduction band. This leaves behind a positively charged hole particle in the valence band. Then, the built-in field (due to p-n junction) pulls the excited electrons away before they can relax, and feeds them into an external circuit-load. In crystalline silicon solar cells, the generation of the electron-hole pair occurs mainly in the p-type layer. In the second-generation solar cells, the electric field spreads through the whole device and the electron-hole pair is immediately separated after generation and if the photo-generate charge carriers have not recombined in the process, they arrive at the terminals of the device, generating an electric charge across them [1].

The solar cell conversion efficiency is used to compare the performance of solar cells. It’s the ratio of output power from the solar cell to input solar radiation power. The performance of a solar cell depends on the spectrum, intensity of the incident sunlight and the temperature of the testing location. Fill factor, FF, is defined to be the ratio of the maximum power generated by the cell divided by open circuit voltage and short circuit current [7].

The common Types of the Solar Cells are: