The Use of Convex Lens as Primary Concentrator for Multi-Junction Solar Cells

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Abstract – A concentrator lens system was designed for a multi-junction solar cell, CDO-100-C3MJ, with an added feature-a convex lens was added above the Fresnel lens, in order to improve the efficiency of the setup. The convex lens setup was tested with the Fresnel lens setup over a three-day photoperiod by measuring the voltage, current, irradiance, and temperature at every hour. The results showed that the convex lens setup produced 1.04 percent more power, but only at around midday. The power difference caused by the convex lens was determined by the Wilcoxon Signed Test to be significant for the photoperiod, as it focuses a greater amount of sunlight on the solar cell over the course of the day.

Introduction. – Solar cells can be composed of a single pair of semiconductor materials, called single junction solar cells (SJSCs), or multiple layers of different semiconductor materials, called multi-junction solar cells (MJSCs). These MJSCs can absorb a wider spectrum of wavelengths due to the different semiconductor materials present in the cell, making it more efficient. The highest recorded efficiency for SJSCs is only 28 percent, while MJSCs with concentrator lenses have reached an efficiency of 46 percent with the latest design from Fraunhofer Institute for Solar Energy Systems[1].

Efficiency in any device is measured by dividing the output over the input. It is measured with the use of a sourcemeter as it has varying resistances. The output from a solar cell is called performance. It is measured in Watts which can be measured by multiplying the voltage with the current. Several factors affect solar cell performance. These factors are dependent on the manufacturing and installation processes of the solar cell. Among those dependent on the manufacturing process are material composition, which determines the spectrum of wavelengths absorbed by the solar cell, and surface area, which determines the size of the cell. On the other hand, factors dependent on the installation of the cell include environmental factors such as cell temperature, wind exposure, and the amount sunlight received by the cell. In photovoltaic systems, light from the sun translates to a power input of around 1 kW/m^2. When light hits the solar cell, electrons are excited from a lower energy to an excited state where they can move freely. Electric current is then produced when the free electrons are extracted; thus, resulting to an electrical output[2].

To efficiently harness the sun's energy, there has to be a great amount of sunlight directed to a solar cell in order for it to generate a greater electrical output. Concentrators are able to reduce materials cost while at the same time increase the solar cells efficiency by concentrating a large surface area of sunlight onto a smaller and therefore cheaper solar cell. The most commonly used lens concentrator is the Fresnel lens[3], which has been used since the 1950s, when plastics were starting to be used for lenses. Plastics were determined to be effective due to their thermal stability and transmissivity which matches the solar spectrum and their index of refraction which is similar to that of glass.

Of the several factors affecting solar cell performance, the- for the full article visit http://bit.ly/2HZqGMb.