SUPERNOVA

A Solar Thermophotovoltaic Cell

Team J-05

Adi Nata, James Raphael Tiovalen, Theodore Leebrant
St. Andrew's Junior College

Abstract

Solar photovoltaic cells are constantly being improved and developed upon, being a renewable and sustainable source of energy. Generating electricity through solar photovoltaic (PV) cells involved it being put under direct sunlight, increasing its temperature over time; this contributes to the Urban Heat Island effect. Furthermore, the heat generated also lowers the efficiency of the solar cells (Figure 1). The thermoelectric cells can convert heat flux into electrical energy by utilising the Seebeck effect. Integration of these thermoelectric cells can be used to take advantage of the high temperature of the solar cells, lowering the temperature at the posterior side of the solar PV cell, increasing its efficiency as well as generating a higher power output.

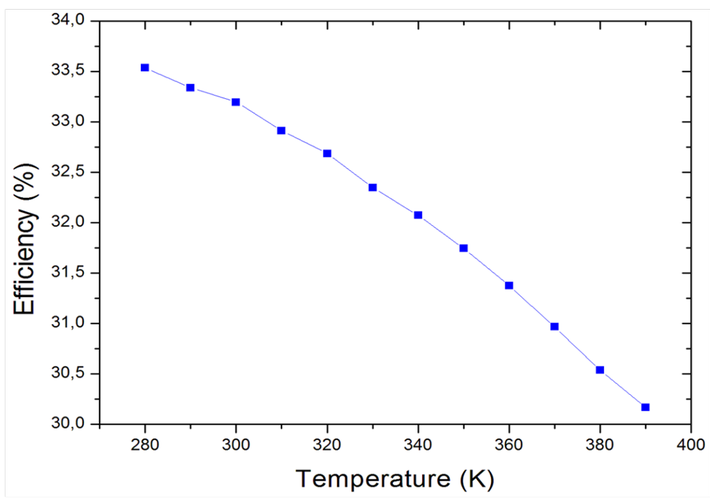

Figure 1. Efficiency-Temperature graph of a solar PV cell

Methodology

Bismuth-Telluride (Bi2Te3) thermoelectric cells act as N-doped and P-doped semiconductors, creating a thermoelectric generator. They are put under the solar cell (Figure 2) to fulfill two objectives: allowing the light energy to be sorbed by the solar PV cells while at the same time ensuring that there is a temperature difference between the two sides of the thermoelectric cells. Encapsulating layers made out of ethylene vinyl acetate are applied to prevent cracking of the solar cells, but a layer of aluminium foil is placed between the thermoelectric cells and the solar cell as to circumvent the thermal insulation of the polymer for greater thermal difference. (Figure 3)

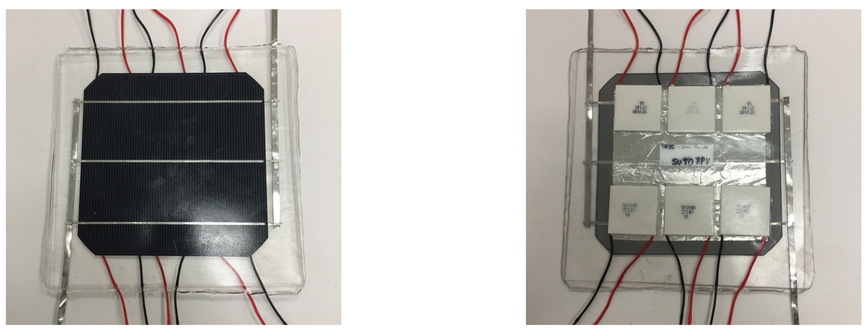

Figure 2. Front and back view of the solar thermo-photovoltaic cell

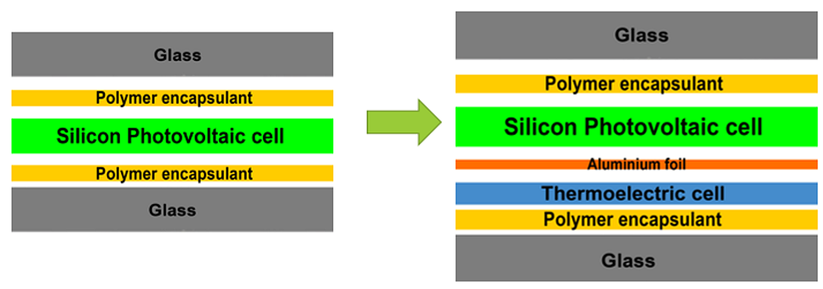

Figure 3. Cross-section of solar PV and solar thermophotovoltaic cells

Discussion and Conclusion

Experiments are conducted at various times of the day with different weather conditions, with an average power output of 2.0 Wh per cell. There are several improvements that can be made: increasing the temperature difference between the two surfaces of the thermoelectric generator by applying heat sinks to increase electrical output, prevent formation of air bubbles during the production of the cell, as well as more research and development to improve the overall efficiency of the cell.