Development of a High Efficiency Solar Cell Using Adaptive Self-Cooling

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In this project, a smart hybrid solar cell using self-powered adaptive temperature control is developed. Active temperature regulation is implemented using thermoelectric cooling modules and a synchronous switching circuit with variable duty cycle that periodically diverts the solar cell's output to a thermoelectric cooling module. A secondary watchdog circuit is implemented using an 8-bit microcontroller that periodically compares the cell temperature with the ambient air temperature and algorithmically adjusts the switching duty cycle to minimize the difference between the two temperatures. The performance of such a cell is compared to that of a conventional photovoltaic solar cell operating under identical environmental conditions. The basis of this comparison is the power output by each system. It is found that the hybrid self-cooled solar cell produces up to 10.25% more power when compared to a conventional solar cell operating under identical conditions. This project is expected to lead to a cost-effective and environmentally friendly energy source.

Awards Won:

Intel ISEF Best of Category Award of $5,000

First Award of $5,000