Hybrid PV/ Thermal Solar Cell
With Significantly Increased Efficiency and Longevity

Invention
Methods and designs for significant improvement in solar cell efficiency and longevity by utilizing a hybrid construction of photovoltaic and reversible thermoelectric cell elements in three different operating modes.

Advantages
• PV cells can operate with significantly increased efficiency per unit area and increased longevity, even under extreme temperatures, thus increasing the reliability of the PV cells
• Prevents the build-up of ice or snow on the PV cells, which renders PV systems inoperable for long periods of time, unless expensive and damaging manual de-icing procedures are performed
• Prevents most negative mechanisms (including oxidation, delamination and encapsulation failure) which are often accelerated by high operating temperatures, therefore significantly reducing the cost of maintenance of the PV cells

Background
Photovoltaic (PV) cells, or solar cells, are devices that convert light directly into electricity by the photovoltaic effect. Solar cells are often physically connected and encapsulated as modules, which are used for grid connected power generation. Unfortunately current solar cells suffer from efficiency limitation when their temperatures begin to rise, due to the subsequent increase in the resistance of the system. To solve such problems, while simultaneously providing heated water for other applications, PV/thermal hybrid solar cells were created. These modules exchange the heat of the sun's rays away from the solar cells greatly increasing their efficiency. Still current designs have complications with the hot water generated within the system, which can cause unwanted thermal stress on the PV cells. In addition, the cooling effect of these designs for the PV solar cells is often negligible, allowing unacceptable thermal cycling stress on all components. Moreover, such methods fail to operate efficiently in variable weather conditions, especially in cold weather where ice and snow buildup on PV panels, thereby causing encapsulation failure. Therefore, there is a continuing need for an integrated hybrid solar cell that operates in different ambient weather conditions with increased efficiency and longevity.

UCF researchers have developed a unique design for PV and thermoelectric (TE) cells to form a hybrid solar cell having this increased efficiency and longevity. The design combines PV and TE elements in three possible modes of operation to significantly increase electrical output. The first mode of operation uses heat generated from absorbed solar energy and other heat generating processes to produce electric energy with high effectiveness. The second focuses on reducing prolonged operation at high temperatures, the single greatest contributor to the physical end-of-life for any cell. The third mode of operation can be used during extremely cold nights, protecting the hybrid solar cell from such thermal stresses by warming the solar cell with the TE element, and keeping the photovoltaic cell free of snow and ice, which is a significant detriment to PV systems in cold, wet climates.

Application
Using this technology, a more efficient thin film solar cell can be produced, resulting in lower costs to produce solar energy. Any existing Solar Cell manufacturer could implement this technique to lower their costs, thus increasing their profit margins, or decreasing costs to their customers.

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