Redesigning Surface Conduction Manifolds To Improve the Efficiency and Reliability of Solar Cells

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In a standard silicon solar cell, the photovoltaic effect generates excited electrons which are transported to the surface of the cell. The problem of collecting these excited charges from the top layer is a tradeoff between resistive losses of charges travelling to reach the surface metal contact and shading losses caused by the metal contact's blocking of light from reaching the silicon. The standard silicon cell design has a surface silver contact pattern consisting of two busbars and horizontal rows of fingers, the design which optimizes the ease of construction. But reliability and efficiency of the cell may be improved by alternative bio-inspired metal contact patterns modeled on venation patterns in leaves. In this project, the standard contact design was tested against six bio-inspired alternative designs, each characterized by a hierarchy of branching veins joined at acute-angle junctions. Each design was simulated by a copper surface print on a printed circuit board (PCB), with the charge upwelling of a solar cell simulated by a grid of vias which supply current from the bottom metal contact. The designs were tested at elevated voltage and current levels for reliability and expected power losses were calculated based on the surface geometry. The dual pinnate design was demonstrated to have the lowest rate of degradation and the highest power efficiency, making it an optimal design choice for improving the performance of the metal surface contact in solar panels.

Awards Won:

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