NREL Highlights SCIENCE

NREL Measures IMM Solar Cell Performance for CPV

New measurement capability supports the development of high-efficiency solar cells for concentrating photovoltaic (CPV) application.

NREL scientists recently completed a set of measurements on the performance of an inverted metamorphic multijunction (IMM) solar cell as a function of concentration and cell operating temperature. The triple-junction cell had subcell bandgaps of 1.81, 1.40, and 1.00. Much of the work focused on developing and validating the measurement techniques (i.e., the spectral response of the three subcells was measured at five temperatures, and those data were used to properly adjust the solar simulators at each temperature).

Multijunction concentrator solar cells are typically evaluated under flash illumination at 25°C, but this condition significantly underestimates the thermal load on the cell in an actual real-world module, where the steady-state concentrated illumination can raise the operating temperature to as high as 100°C. The NREL-developed measurement technique addresses this issue.

This work demonstrated that the IMM cell has better temperature coefficients than its traditional upright, germanium-based, lattice-matched counterpart and will thus perform better in actual CPV applications. This new measurement capability will support NREL's development of IMM cells that are optimally designed for operation at temperatures relevant to actual systems operation.

NREL scientists invented the IMM solar cell; it won an R&D 100 Award in 2008 for NREL and its commercial partner EMCORE.

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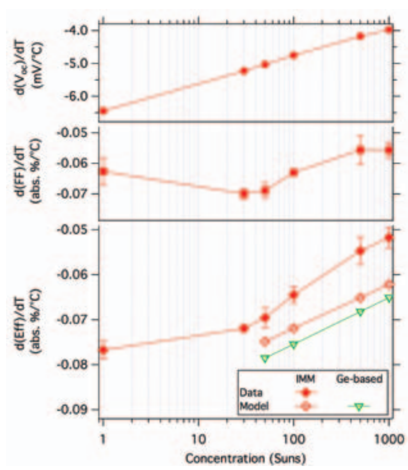

Open-circuit voltage, fill factor, and efficiency versus concentration, based on measurements from 25°–125°C. The open symbols in the bottom frame show modeled results for the IMM cell and for an industry-standard, germanium-based, triple-junction cell.

Key Research Results

Achievement

NREL scientists developed and validated a set of measurement techniques to predict the performance of a triple-junction solar cell in real-world conditions such as elevated temperatures and concentration levels.

Key Result

Using these techniques, scientists demonstrated that the inverted metamorphic multijunction (IMM) cell has better temperature coefficients than its traditional upright, germanium-based, lattice-matched counterpart and will thus perform better in actual CPV applications in real-world conditions.

Potential Impact

The IMM cell has allowed designers to fabricate high-efficiency solar cells with bandgaps that approach the ideal combination. Because of the freedom to choose the bottom subcell bandgap, the IMM cell has the capability, in principle, of increasing the energy production under real operating conditions compared to germanium-based cells.

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