Selective-Spectral and Radiative Cooling to Improve Performance and Reliability for Solar Modules (PV-4)

A joint India-U.S. research consortium funded under the *Joint Clean Energy Research & Development Center (JCERDC)*

Scientific Achievement:

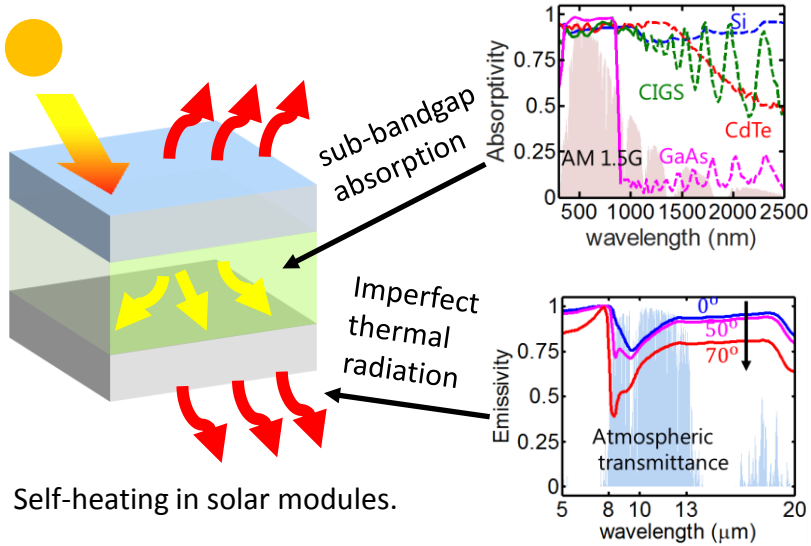
We identified the physical origins of self-heating in solar modules to parasitic sub-bandgap absorption and imperfect thermal radiation and proposed the corresponding cooling schemes—selective-spectral and radiative cooling.

Significance and Impact:

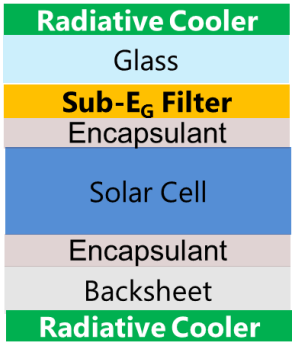
By applying the cooling methods to conventional and low-concentrated silicon modules, temperature reduction of 6 °C and 20 °C is predicted—increasing the absolute efficiency by 0.5% and 1.8 % and potentially prolonging the lifetime by 80% and 260%, respectively.

Research Details:

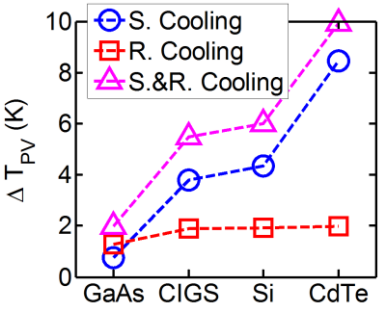
- Developed a sophisticated opto-electro-thermal coupled simulation framework to identify the sources and magnitudes of self-heating in solar modules (validated against experiments).
- Predicted the temperature reduction by the proposed cooling methods for different solar technologies and application.
- Explored the short-term and long-term implications of the cooling methods on PV energy yield.



Self-heating in solar modules.



Implementing selective-spectral and radiative cooling.



Cooling gain for different technologies

Publication(s): X. Sun, T.J. Silverman, Z. Zhou, M.R. Khan, P. Bermel, and M.A. Alam, "An Optics-Based Approach to Thermal Management of Photovoltaics: Selective-Spectral and Radiative Cooling," *in IEEE Journal of Photovoltaics, 2016*. (Under review)

Contact(s): Muhammad A. Alam (alam@purdue.edu)