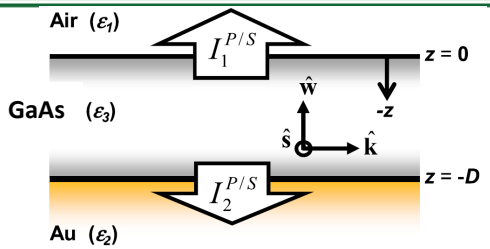
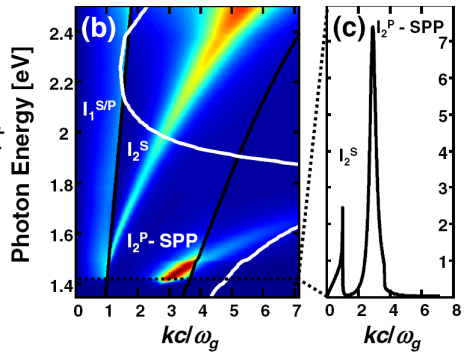
New Electromagnetic Theory of Ultra-Thin Solar Cells

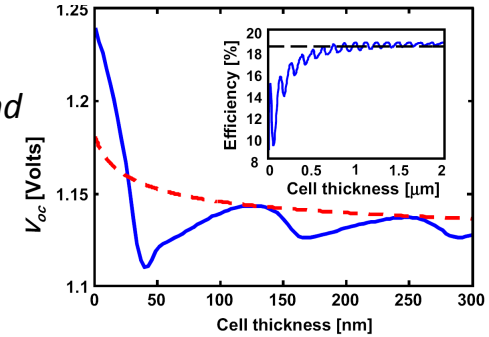
GaAs Solar cell



emission map at 40nm thickness



cell voltage and efficiency vs. thickness



A GaAs solar cell with gold back reflector is modeled using the developed theory. A strong I_2^P-SPP mode emission to gold appears at 40nm thickness. This leads to anomalous dip in the cell voltage.

Work was performed at Lawrence Berkeley National Lab

Scientific Achievement

A new electromagnetic theory is developed, which enables the efficiency calculation for solar cells with absorber layer much thinner than the typical wavelength of sun light.

Significance and Impact

The model allows design and optimization of new generations of solar cells with higher efficiency and less material consumption for cost-effective photovoltaics.

Research Details

- Emission leaving a solar cell is calculated using Fluctuation-Dissipation theorem by including all near-field optical effects.
- The balance between absorption and emission is used to calculate the solar cell efficiency.
- The theory is applied to an ultra-thin solar cell to demonstrate the effect of electromagnetic design on cell performance.

Avi Niv, Majid Gharghi, Chris Gladden, Owen Miller, and Xiang Zhang, Phys. Rev. Lett. 109, 138701 (2012).