

Announcing the Final Examination of Javaneh Boroumand for the Degree of Doctor of Philosophy in Physics

Date: Friday, March 10, 2017

Time: 03:00 p.m.

Room: PSB 445 (Physical Sciences Building, Room 445)

Dissertation title: LIGHT TRAPPING IN THIN FILM CRYSTALLINE SILICON SOLAR CELLS

Abstract:

This dissertation presents numerical and experimental studies of a unified light trapping approach that is extremely important for all practical solar cells. A 2D hexagonal Bravais lattice diffractive pattern is studied in conjunction with the verification of the reflection mechanisms of single and double layer anti-reflective coatings in the broad range of wavelength 400 nm - 1100 nm. By varying thickness and conformity, we obtained the optimal parameters which minimize the broadband reflection from the nanostructured crystalline silicon surface over a wide range of angle 0° - 65° . While the analytical design of broadband, angle independent anti-reflection coatings on nanostructured surfaces remains a scientific challenge, numerical optimization proves a viable alternative, paving the path towards practical implementation of the light trapping solar cells. A 3 μm thick light trapping solar cell is modeled in order to predict and maximize combined electron-photon harvesting in ultrathin crystalline silicon solar cells. It is shown that the higher charge carrier generation and collection in this design compensates the absorption and recombination losses and ultimately results in an increase in energy conversion efficiency. Further, 20 μm and 100 μm thick functional solar cells with the light trapping scheme are studied. The efficiency improvement is observed numerically and experimentally due to photon absorption enhancement in the light trapping cells with respect to a bare cell of same thickness.

Outline of Studies:

Major: Physics

Educational Career:

M.S. in Physics, University of Central Florida, 2013

B.S. in Physics, Shahid Beheshti University, 2009

Committee in Charge:

Dr. Debashis Chanda (chair)

Dr. Robert Peale

Dr. Enrique del Barco

Dr. Elena Flitsiyan

Dr. Winston Schoenfeld (External Committee Member)

Approved for distribution by Dr. Debashis Chanda, on March 3, 2017.