A SOCIETY OF PHYSICS STUDENTS (SPS)

presents: PHYSICS ALUMNI SERIES SEMINAR

Tabula Rasa Defect Engineering: Suppressing Oxygen Precipitates for Enhanced Photocarrier Lifetimes

Vincenzo LaSalvia, ’09 (BA Physics)

High-Efficiency Crystalline Photovoltaics Group

National Renewable Energy Laboratory Golden, CO USA

We explore a simple annealing technique that allows for monocrystalline n-type Czochralski silicon (n-Cz) wafers to avoid oxygen precipitation that occurs in thermal cycling during typical silicon-based photovoltaic cell processing. These oxide precipitates interact with, and nucleate at vacancy-rich regions that are grown into the crystal ingot during the Czochralski growth process and develop into recombination-active centers throughout cell processing through a variety of mechanisms including lattice strain, dislocation loops from precipitate accumulation, and energetically-irreversible impurity trapping – all which lead to diminished minority carrier lifetimes and eventually lower cell efficiencies. Carrier lifetime studies of our annealing technique, *Tabula Rasa,* offers several ways toward a pre-processing defect engineering of wafers. We analyze temperature and injection dependent carrier lifetime spectra in order to fully describe the recombination activity in phosphorus-doped photovoltaic grade wafers of both low and high interstitial oxygen (O_i) levels from separate crystal growths. These measurements in conjunction with qualitative photoluminescence imaging aim to reveal the evolution of grown-in point defects and impurity complexes from the Czochralski-growth along with injected point-defects during cell thermal processing, and how each of these crystalline defects interact with the O_i in n-Cz material throughout the cell processing sequence of thermal budgets. We submit wafers of both low and high O_i to various *Tabula Rasa* techniques that inject distinctly separate species of intrinsic point defects into n-Cz as a means to engineer the concentration and distribution of defects in the wafers. When applied properly, these defect interactions lead to minimized recombination activity and preferential gettering of photocarrier recombination-active impurities. We realize and elucidate these findings through our study and offer a simple and quick way to pretreat n-Cz wafers using *Tabula Rasa* that allows for solar cell processing while also avoiding efficiency-limiting lifetime degradation. nrel.gov/pv/high-efficiency-crystalline-photovoltaics.html

Vincenzo LaSalvia is an alumnus from Cleveland State University’s Department of Physics. Since 2010, he has held the position of silicon photovoltaics process engineer within NREL’s High Efficiency Monocrystalline Photovoltaics Group with extensive expertise in thermal and chemical processing of crystalline silicon wafers and solar cells. At NREL he has pioneered an investigation of defect generation and engineering in Czochralski-grown silicon through high-temperature annealing. In collaboration with the Massachusetts Institute of Technology, he has studied this phenomenon’s effect on carrier lifetime evolution throughout the solar cell process. Vincenzo is a key-contributor at NREL demonstrating the fabrication of a 21.5% efficient silicon solar cell, as well as the realization of a GaInP/Si dual-junction solar cells with 29.8% one-sun efficiency. He has a background in microfabrication and device design, silicon epitaxy via chemical vapor deposition, and thin film processing and characterization.

WHERE SR – 151

WHEN 11:30 – 12:20

Tuesday, November 21, 2017