Yale Institute for Nanoscience and Quantum Engineering

Friday- April 25, 2014

12:00 to 1:00 p.m.

Becton Seminar Room

Light lunch will be served at 11:45 a.m.

Faustin W. Carter

Department of Physics, Yale University

"Towards The In-Situ Detection Of A Single He2* Excimer In Superfluid Helium"

Incident radiation can excite superfluid helium into a diatomic He2* excimer, which decays through the emission of a 15 eV photon. Such excimers have been used as tracers to measure the superfluid's quantum turbulence, thanks partly to the long half-life of the He2* triplet state (13 seconds). However, the efficient detection of these excimers remains a challenge. We present a detector capable of in-situ detection of the He2* excimers either directly (the excimer collides with the detector), or by collecting the 15 eV photon emission upon decay. This detector is based on a titanium or tungsten superconducting transition edge sensor (TES) and is designed to operate near 100 mK in a dilution refrigerator. This talk will present the progress to date of this project.

Stephanie Tomasulo

Department of Electrical Engineering, Yale University

"Wide-Bandgap Metamorphic Solar Cells Grown By Molecular Beam Epitaxy"

For the past decade, III-V-based triple-junction solar cells have held the record for solar cell efficiency by collecting a broad portion of the solar spectrum. As this technology matures, the next step is to increase to 4-6 junctions in order to collect a larger portion of the spectrum and surpass 50% efficiency. Maximizing efficiency in such designs requires a top junction with bandgap energy (E_g) of 2.0-2.2 eV. Here, we investigate $In_yGa_{1-y}P$ (y=0.42-0.30) as an Al-free option that has a direct bandgap in the desired range. However, such compositions are lattice-mismatched to conventional substrates of GaAs and GaP. While mismatched growth introduces extended defects to the cells, it has been shown that minimal efficiency degradation occurs if the threading dislocation density (TDD) can be kept at or below mid-10^6 cm^{-2}. After establishing high quality starting templates with appropriate TDD, we grew wide-E_g $In_yGa_{1-y}P$ solar cells with E_g of 1.93-2.23 eV. Devices on GaAs with E_g of 1.93-2.06 eV possessed high V_{oc} values of 1.37-1.49 V. We then grew novel $In_yGa_{1-y}P$ (y=0.18-0.30) solar cells on GaP with E_g=2.12-2.23 eV, representing the widest-E_g $In_yGa_{1-y}P$ solar cells to date. However, the V_{oc} values of 1.42-1.46 V indicate significant non-radiative recombination that must be reduced to obtain higher efficiency. The results indicate that with continued growth and device optimization, metamorphic $In_yGa_{1-y}P$ will be a promising candidate for the top cell in future 4-6 junction devices.

HOST: Paul Fleury