Natural Sciences Seminar Series

Dr. Unil Perera

Candidate, Associate Dean of Natural Sciences

February 22, DS 175, 1:30-2:30pm

Physics of Electronics to Optoelectronics:

Brief History of Electronics Leading to Infrared Detectors & Applications

How Physics is useful in day to day life will be the starting point of the presentation. A brief history of technology development allowing the advances we now have taken for granted, will be presented to set the background for the Infrared detector development and applications. Applying Physics principles to develop various types of Photon detectors, going beyond the standard response range will be the focus of describing various detector types developed in the laboratory. These include homo and heterojunction, split off, quantum dot and quantum ring, polarization sensitive and multiband detectors.

A Homojunction or Heterojunction Interfacial Workfunction Internal Photoemission (HIWIP or HEIWIP) infrared detector, formed by a doped emitter layer, and an intrinsic layer acting as the barrier followed by another highly doped contact layer, can detect near infrared (NIR) photons due to interband transitions and mid/far infrared (MIR/FIR) radiation due to intraband transitions. The threshold wavelength of the interband response depends on the band gap of the barrier material, and the MIR/FIR response due to intraband transitions can be tailored by adjusting the band offset between the emitter and the barrier. GaAs/AlGaAs will provide NIR and MIR/FIR dual band response, and with GaN/AlGaN structures the detection capability can be extended into the ultraviolet region.

In the quantum dot structures, transitions are from one state to another, while free carrier absorption and internal photoemission play the dominant role in homo or heterojunction detectors. Quantum Dots-in-a-Well (DWELL) detectors can tailor the response wavelength by varying the size of the well. A tunneling Quantum Dot Infrared Photodetector (T-QDIP) could operate at room temperature by blocking the dark current except in the case of resonance. Photoexcited carriers are selectively collected from InGaAs quantum dots by resonant tunneling, while the dark current is blocked by AlGaAs/InGaAs tunneling barriers placed in the structure. These detectors are useful in numerous applications such as environmental monitoring, medical diagnosis, battlefield-imaging, space astronomy applications, mine detection, and remote-sensing.