Announcing the Final Examination of Jesse Thompson for the degree of Doctor of Philosophy in Physics

Date: March 31, 2022
Time: 12:00 p.m.
Zoom Link: https://ucf.zoom.us/j/91468658349?pwd=eWJydjg0WDM1VVgyMzhoLzBKQW9Bdz09
Zoom Info: 914 6865 8349 (Meeting ID), 695016 (Passcode)
Dissertation title: Electronic and Optoelectronic Properties of Two-Dimensional Heterostructures for Next-Generation Device Technologies

Abstract:
Since monolayer graphene was isolated in 2004, there has been significant interest in integrating two-dimensional (2D) materials into innovative device designs and hybrid materials to help solve pressing technological challenges. This is partially because 2D materials can typically be thinned to a single atomic layer without suffering from roughness-induced scattering and can exhibit thickness-dependent variations in properties such as their energy band gap. This dissertation reports on investigations of electronic and optoelectronic device physics in 2D material heterostructures. The investigation of electronic device physics focuses on the interface between 2D molybdenum disulfide (MoS_2) and gold (Au), which behaves as a resistive switching element (RSE). RSEs are microelectronic switches whose resistances depend on the history of electrical stimuli they have experienced. Prototype computer memory cells utilizing RSEs have demonstrated non-volatile switching behavior and high data retention times, likely enabling more environmentally-conscious computing. The ultimate degree of lateral scaling that MoS_2-based RSEs can attain is currently unknown, but of great importance for determining their role in beyond-Si computing applications. This work demonstrates, using the metallic tip of a scanning tunneling microscope (STM) as an electrode in a model MoS_2-based RSE, that switching events can be recorded even in device areas on the order of tens of nanometers across without using lithographic techniques. The investigation of optoelectronic device physics focused on utilizing hexagonal boron nitride (hBN), an electrical insulator with an ~ 6.0 eV band gap, to fabricate ultraviolet photodetectors. The main advantage that hBN-based detectors have over Si-based detectors is that they are inherently insensitive to visible and infrared light without needing bulky or expensive optical band pass filters, thus eliminating signal contamination from ambient sources. This work describes the fabrication and characterization of several detectors featuring vertical designs, allowing for greater degrees of both vertical and lateral scaling.

Outline of Studies:
Major: Physics

Educational Career:
M. S. University of Central Florida, Orlando, FL, 2018
B. S. Gordon College, Wenham, MA, 2012

Committee in Charge:
Dr. Masahiro Ishigami (Chair)
Dr. Laurene Tetard
Dr. Tania Roy
Dr. YeonWoong Jung (External Committee Member)

Approved for distribution by Dr. Masahiro Ishigami, Committee Chair, on March 15, 2022.

The public is welcome to attend virtually.