

Announcing the Final Examination of Brandon Blue for the degree of Doctor of Philosophy in Physics

Date: March 30, 2020

Time: 9:30 a.m.

Zoom: <https://ucf.zoom.us/j/206322905?pwd=dmUwekVUNHJ1L1JEa0hldExsRjNwQT09>

Dissertation title: Atomic scale processes and electronic band structure engineering in thin layered materials

Abstract:

Modern technological challenges require understanding and control of processes which occur at the nanometer (10^{-9} m) scale or smaller still. In this dissertation, atomically precise scanning probe microscopy is combined with ensemble-averaged and theoretical techniques to reveal new aspects of the chemical and physical properties of thin films and layered materials. These results followed from four primary studies between the UCF and the U.S. Naval Research Laboratory.

In the first study, MoS₂, a transition metal dichalcogenide (TMD), was generated by an Au assisted exfoliation technique. Annealing under ultra-clean conditions showed that, rather than undergoing a structural phase transition, previously undescribed covalent bonding at the S-Au interface “switches” 2H-MoS₂ from semiconductor to metal. This process is expected to guide MoS₂'s use as an atomic scale switch for next-generation electronics. In an analogous study, TaS₂ on Cu was shown to host new electronic states at the valence band edge upon S defect generation. These states are critical to its use as a catalyst to convert waste carbon oxide to useful fuels and plastics.

In addition to the TMDs, many materials with promise for high-temperature superconductivity are highly sensitive to surface contamination. BaNi₂As₂, an iron pnictide superconductor, was exfoliated in ultra-high vacuum (UHV) to reveal a host of surface reconstructions. These reconstructions may have been taken as signatures for charge density waves (CDW) in previous studies and suggest that great care must be taken in generating and studying these materials in an ultra-clean, consistent way. Finally, the application of silicon-inspired thin film device fabrication to bioelectronics is discussed. H⁺ exchange across the interface between a shrimp-derived biofilm and metal hydride contact was used as a model system for opening the study of ion exchange in bioelectronics and related technologies. In total, these four studies represent new insights into materials engineering efforts across a broad range of potential applications.

Outline of Studies:

Major: Physics, Condensed Matter Specialization

Educational Career:

M. S. University of Central Florida, Orlando, FL, 2018

B. S. University of Central Florida, Orlando, FL, 2015

Committee in Charge:

Dr. Masahiro Ishigami (Chair)

Dr. Bo Chen

Dr. William Kaden

Dr. Jeremy Robinson (External Committee Member)

Revision approved for distribution by Dr. Masahiro Ishigami, Committee Chair, on March 25, 2020.

The public is welcome to attend remotely *via* Zoom or compatible methods at the URL above.