Announcing the Final Examination of Fernand Eliud Torres-Davila for the degree of Doctor of Philosophy in Physics

Date: July 8th, 2021
Time: 10:30 a.m.
Zoom Link: https://ucf.zoom.us/j/95040304754?pwd=YWMrQVV6QUpSdEFNOFpVWDVmcVRNZz09
Meeting ID: 950 4030 4754
Passcode: 451879
Dissertation title: Toward In-situ Nanoscale Imaging and Spectroscopy: Applications in Growth and Catalysis of Two-dimensional Materials

Abstract:
Engineering defects in 2D materials has the potential to boost their functionalities. Their reactivity can drive targeted reactions relevant to sustainability, and shape the electronic properties of the host material locally for new applications. However, this reactivity also brings about the need to control the environment to explore these properties of defects without interference from air or moisture. This is particularly important to advance fundamental studies of catalytic processes in view of mimicking reaction pathways taking place in large scale reactors at various defect sites more closely. Characterization of processes taking place at and around defect sites constitute another outstanding challenge. It requires new tools with high spatial resolution and high sensitivity to detect, visualize, and monitor the structural and compositional changes occurring under various environments.
In this work, we focused on exploring novel approaches for engineering and characterizing 2D material defects for catalytic processes. Our first study evaluated chemical vapor deposition of zirconium disulfide (ZrS_2) and its characterization. This was followed by studying methods for large-scale defect engineering in 2D materials, in particular using ball milling and heat treatments to create defects in hexagonal Boron Nitride (h-BN). After optimizing the defect density in h-BN to achieve maximum gaseous adsorption, we established the photocatalytic activity of defect-laden h-BN under visible light. As a consequence of this photocatalytic process, we uncovered a new synthesis to grow carbonaceous microstructures at room temperature. Finally, we introduced a new approach to controllably create sub-100 nm defects in h-BN layers at selected locations using the tip of an atomic force microscopy probe coupled with pulsed infrared light and study their vibrational properties with nanoscale resolution. This work highlights the potential of *in-situ* imaging and spectroscopy to unveil important phenomena taking place at defect sites that are often overlooked, but of great consequences in applications beyond catalysis.

Outline of Studies:
Major: Physics

Educational Career:
M.Sc. University of Central Florida, 2017
B.S. Universidad de Puerto Rico-Humacao, 2015

Committee in Charge:
Dr. Laurene Tetard (Chair)
Dr. Talat Rahman
Dr. Abdelkader Kara
Dr. Richard Blair
Dr. Titel Jurca (External Committee Member)

Approved for distribution by Dr. Laurene Tetard, Committee Chair, on June 23 2021

The public is welcome to attend remotely.