Announcing the Final Examination of Zackary S. Parsons for the degree of Doctor of Philosophy in Physics

**Date:** March 20, 2023  
**Time:** 10:00 a.m.  
**Room:** Business Administration I (BA1), Room 110

**Dissertation title:** Probing the Structure-Activity Relationships of Electrocatalytic Nanomaterials using Scanning Electrochemical Microscopy

**Abstract:**
Electrocatalysis plays a central role in the development of renewable energy technologies as it enables direct conversion between renewable electricity and chemical energy. To design efficient electrocatalysts, it is essential to understand the relationship between the structure and the activity of electrocatalytic materials. Scanning electrochemical microscopy (SECM) is a scanning probe technique capable of imaging local electrocatalytic activity under operating conditions, of which the spatial resolution depends on the shape and size of the probe. Compared to commercial SECM probes which have limited resolution, I have developed novel nanoelectrode probes by etching sharp platinum tips followed by electropolymerization coating of the tip except at the apex, which can greatly reduce the exposed electrode area of the probe to improve the spatial resolution of SECM imaging. These nanoelectrode probes were successfully used to image the activity of single platinum nanoparticles dispersed on a silicon support, thus surpassing the resolution capabilities of the best commercially available probes. This demonstrates the improved ability to reveal the local activity of nanostructured electrocatalysts. In addition, I used conventional electrochemical methods to investigate the structure-activity relationships of nanomaterials for important reactions, including ruthenium and copper nanoparticles for the nitrate reduction to ammonia, as well as cobalt oxide nanosheets supported on nickel foam for the oxygen evolution reaction. In summary, I developed novel nanoelectrode SECM probes for the mapping of electrocatalytic activity of nanomaterials, and I also revealed the structure-activity relationships of nanomaterials for nitrate reduction and oxygen evolution.

**Outline of Studies:**
Major: Physics

**Educational Career:**
B.S. in Physics, California State University, San Bernardino, CA, 2018  
B.A. in Chemistry, California State University, San Bernardino, CA, 2018

**Committee in Charge:**
Dr. Xiaofeng Feng (Chair)  
Dr. William Kaden  
Dr. Mihai Vaida  
Dr. Denisia Popolan-Vaida (External Committee Member)
Approved for distribution by Xiaofeng Feng, Committee Chair, on February 27, 2023.

The public is welcome to attend.