DREXEL UNIVERSITY
Materials Science and Engineering
College of Engineering

Department of Materials Science and Engineering,

PhD Proposal

October 1st, 11 AM
https://drexel.zoom.us/j/82670725771

Transition Metal Oxide and Carbon Heterointerfaces: Structure, Synthesis Methods, and Performance in Energy Storage Materials

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Abstract

Secondary batteries are an important area of research to help create grid-scale energy storage solutions and improvements in smaller devices for use in electric vehicles and laptops. Various transition metal oxides have been studied extensively in these electrochemical systems due to their high theoretical capacity, low toxicity, and high natural abundance. Vanadium oxide is of particular interest due to vanadium's high redox activity in reversible charge storage reactions and its wide range of morphologies and structures. However, metal oxides are limited by their inherent low conductivity that can negatively impact rate performance and long-term stability.

Therefore, the goal of the proposed research is to investigate a variety of synthesize approaches to find new and effective methods to create robust heterointerfaces between conductive carbon and transition metal oxides. These heterointerfaces include stacked two-dimensional heterostructures and conventional nanocomposites. These materials can lead to batteries with improved charge storage, better rate capability, and longer lifetimes. This research will also explore the relationships between synthesis, structure, and the transport of ions during electrochemical cycling. The improved understanding of charge storage mechanisms in the heterostructures and nanocomposites achieved in this work is expected to lead to better electrodes and energy storage devices.