DREXEL UNIVERSITY
Materials Science and Engineering
College of Engineering

Department of Materials Science and Engineering,

PhD Thesis Proposal

November 2, 2023 - 10:30 am EST
Bossone 302 and https://drexel.zoom.us/j/89110633797

Nanomaterials and their use in cathodes for lithium-sulfur batteries with carbonate-based electrolytes

Name: Mary Qin Hassig
Advisor: Dr. Michel Barsoum

Abstract:

With carbon dioxide emissions on the constant rise and the effects of climate change becoming more evident every year, many automotive companies are developing zero emission electric vehicles. Lithium-Sulfur (Li-S) batteries are of increasing interest for transport technology as their theoretical energy density is ~2,600 Wh/kg, more than 7x the theoretical energy density of a Li-ion battery, which is the current electric vehicle industrial standard. Li-ion batteries used in cars use a carbonate-based electrolyte, compared to an ether-based electrolyte, for safety concerns. However, more than 90% of Li-S battery research is performed with an ether electrolyte due to polysulfide (PS) and carbonate species incompatibility. The goal of this thesis is to explore chemical and physical confinement techniques to trap sulfur within a host nanomaterial to create a cathode for use with carbonate-based electrolytes in cells. The combination of the two methods should lead to increasing S loadings and S utilization for an increased energy density. This proposal focuses on Ti3C2 MXene and 1-Dimensional Lepidocrocite as the cathode host as they can be chemically and physically tuned to optimize surface area and sulfur loading. We propose that the confinement helps optimize the sulfur loading percentage and helps minimize the creation of electrolyte soluble (PS) through solid-to-solid direct conversion. Thus, the PS do not irreversibly react with the carbonate species, losing active material, and shut down the battery. Additionally, this lack of PS also helps decrease the amount of shuttling and limits the decrease in battery performance.