DREXEL UNIVERSITY
Materials Science and Engineering
College of Engineering

Department of Materials Science and Engineering,

PhD Defense

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Hill Conference Room
LeBow Engineering Center, Room 240

Raman Spectroscopy of MXenes Beyond $Ti_3C_2T_x$: Characterization and Applications

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https://drexel.zoom.us/j/84815377765

Abstract

The MXene family has been rapidly expanding, with over 70 compositions synthesized to date, and hundreds of structures predicted with varying transition metals, carbon/nitrogen content, and surface terminations. While $Ti_3C_2T_x$ remains the most extensively studied MXene, the pursuit of novel properties has shifted attention to other MXenes that would outperform $Ti_3C_2T_x$ in various applications, such as electromagnetic interference (EMI) shielding, energy storage, catalysis, and biomedicine. The performance of a device cannot be optimized without establishing a structure-property-performance relationship, which relies on robust characterization techniques.

Within the field of 2D materials, Raman spectroscopy has become one of the most impactful and widely used tools: it is fast, non-destructive, offers high resolution, provides structural and electronic information, and can be applied in both small-scale research and large-scale manufacturing. This thesis investigates the Raman spectroscopic characterization of MXenes beyond $Ti_3C_2T_x$ and MXene-based systems, aiming to understand how their structure and composition influence vibrational properties, and to elucidate charge storage and degradation mechanisms in electrochemical cells in situ. This requires a combination of experimental and computational data.

Additionally, this work explores the use of MXenes as surface-enhanced Raman spectroscopy (SERS) substrates for molecular sensing. These findings broaden the analytical toolbox available to the MXene research community and lay the foundation for engineering better, more reliable MXene-based devices.