# Mechanical Engineering Thesis Defense

## Synthesis and Property Characterization of the MXenes

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## Abstract

Nanomaterials redefine the lens through which the world is viewed today. The miniaturization of devices and systems to the nanoscale explodes the realm of what is possible as the interactions with neighboring atoms and molecules increase. This interactivity creates ripple effects that lead to superior mechanical, thermal, electrical, and optical properties that are highly desired across several industries. Two-dimensional (2D) materials are a branch of this family, and the focus of this paper revolves around a recent addition to this category called MXenes. The versatile properties of these 2D nanomaterials have made them unique, as they have the desired performance that can be utilized in several industries, especially energy management, wastewater treatment, and microelectronic devices.

Followed by the MAX phase synthesis, hydrofluoric (HF) acid has been the primary etchant utilized to derive these 2D nanoparticles. However, alternative etchants via reactions are desirable to achieve similar selective etching without involving highly toxic HF. Therefore, this study investigated MXene synthesis and applications in 3D printing, followed by the formation of the precursor MAX, an optimized in-situ etching method, and streamlined post-etching processes to maximize 2D MXene yield. The etched powders were then analyzed using scanning electron microscopy (SEM), x-ray diffraction (XRD), atomic force microscopy (AFM), and energy-dispersive x-ray spectroscopy (EDS) characterization methods to verify and validate the MXene dimensions, chemistry, and crystal structures. Simple applications, such as the dispersion feasibility for customizing micropatterns via 3D printing, were also demonstrated as examples. Finally, this research showed the simple processing of 2D MXenes and their potential in structural support, heat dissipation, microelectronics, optical meta-surfaces, and other areas.

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Zoom Link: https://asu.zoom.us/j/86133329037