DREXEL UNIVERSITY
Materials Science and Engineering
College of Engineering

Department of Materials Science and Engineering,

PhD Candidacy

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MXene-derived Complex Functional Materials

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Abstract:
Functional materials exhibit intrinsic properties that are tailored around a particular application. These specialized functions are typically determined by the material's structure, composition, and morphology, which are in turn determined by the synthesis route used to produce the material. Identifying new precursors to use as reactants can therefore enable the development of novel functional materials. MXenes are two-dimensional transition metal carbides that have become well known for their electronic properties and chemical versatility. During synthesis, the surface of the MXene tends to oxidize due to the chemical etching process of its MAX phase precursor. This concept is expanded to a full oxidation of the MXene into transition metal oxides, either by thermal reaction or by dissolution in an oxidizing agent. The synthesis methods can be modified using supporting elements like alkali and alkali earth metals, as well as limiting the reaction to produce an intimate MXene/oxide two-phase system. Approaches can be combined, resulting in structurally and chemically complex materials. All the effects of the synthesis approaches can be tracked by the performance of the material in a given system, such as energy storage. By expanding on these approaches, new materials can be developed for novel and exotic functions.