DREXEL UNIVERSITY
Materials Science and Engineering
College of Engineering

Department of Materials Science and Engineering
PhD Thesis Proposal

Monday, October 23, 2017 3:00 pm
Hill Conference Room

Solution Processing and Optical Properties of Two-Dimensional Transition Metal Carbides (MXenes)

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Since the discovery of graphene, the world of two-dimensional (2D) materials has become increasingly popular due to wide range of properties and various atomic compositions and structures, lending the class of materials to many potential applications. One promising 2D material family, transition metal carbides, nitrides, and carbonitrides (MXenes) are synthesized by selective etching of their MAX phase precursors to form layered structures which can be delaminated into 2D materials. The family of materials has shown early promise due to tunability of the metal (Ti, V, Mo, Nb, etc.) and structure (M_2X, M_3X_2, M_4X_3, Double-M, etc.), high conductivity, hydrophilicity, and ease of processing. The promising material properties have directly lead to performance in various applications along the electromagnetic spectrum including electromagnetic shielding, transparent conductors, femtoseconds lasers, and photothermal therapy.

The proposed research aims to evaluate solution-based stabilization and size selection techniques to control the properties of MXenes in solution and in thin films to investigate fundamental optical properties and performance. The first two objectives will outline the methods used to stabilize nanomaterials in aqueous or organic solutions as well as methods used to select and isolate 2D MXene flakes based on lateral size. The latter two objectives will focus on investigating fundamental light-matter interactions, the optical properties, and applied optical applications. The proposed work will open new avenues and expand on the knowledge regarding MXenes for optics by challenging the effects of lateral size and composition on properties. To bring the work full circle, the final objective will employ fabrication of MXene optical devices using thin film fabrication and conventional nanofabrication methods.