Department of Materials Science and Engineering,
Ph.D. Thesis Proposal

Development of Multifunctional MXene-PVDF Composites

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Abstract

As new generations of technology continue to shrink in size and expand in scope, the need for lightweight materials that can provide multiple functionalities grows. Composites of polymers and nanomaterials offer a valuable solution, bridging the properties of both components to create systems with multifunctional performance for a variety of applications. MXenes, a family of 2D transition metal carbides and nitrides, have attracted much attention in recent years in the field of nanocomposites. The unique electronic, mechanical, and optical properties as well as the tunable surface chemistry of these nanomaterials make them excellent candidates for multifunctional polymer composites. However, polymer selection for MXene composites can be limited due to interfacial compatibility issues with hydrophobic polymers. Typical methods for introducing MXenes into hydrophobic polymer matrices can involve excessive time and work, reduce the quality of MXene flakes, or utilize interfacial agents that alter the properties of the composite as a whole.

The goal of this work is to explore alternative methods for developing MXene composites, using a functional polymer, hydrophobic polyvinylidene fluoride (PVDF) as a benchmark system. The relationships between processing, structure, and properties of composites will be thoroughly examined, as the variety of methods and materials used in literature do not offer a clear story. By understanding the effects of MXene composition, surface chemistry and composite processing on electronic, optical and mechanical properties, guidelines will be established for fabricating systems tailored towards specific applications. Focusing on several unique use cases, this work aims to provide a roadmap towards the development of multifunctional MXene-PVDF composites.