Department of Materials Science and Engineering
Ph.D. Candidacy Examination

MXenes in Hydrogen Technology

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Abstract

Due to an ever-increasing global demand for energy, alternative energy sources are important to offset the economic and environmental challenges presented by an overreliance on unsustainable and pollutive fuels. Hydrogen is an attractive candidate for energy production and storage due to its high energy density and lack of harmful by-products when consumed. As hydrogen technology continues to develop, MXenes, a class of atomic layered transition metal carbide nanomaterial, have shown promise in both hydrogen production and hydrogen storage. Two ways hydrogen is produced is through purification from mixed gases and the hydrogen evolution reaction. MXene membranes have been shown to effectively separate hydrogen gas from other gases with high permeance and selectivity; in addition, MXenes can be used as catalysts to improve the kinetics of the hydrogen evolution reaction. For storage, MXenes have been used as additives to metal-based hydrides to improve the hydrogen loading kinetics of these promising materials, bringing them closer to commercial viability. Also, hydrogen can be directly stored in the MXenes themselves, potentially on the surface, between the atomic layers, or inside the layer lattices. Due to the many possible hydrogen storage sites, MXenes could attain a high volumetric energy density, and hydrogen stored in MXenes bypass any safety or logistical issues caused by pressurized gaseous hydrogen. In this presentation, the impact of MXenes on hydrogen for energy applications will be discussed.