NEBRASKA CENTER FOR ENERGY SCIENCES RESEARCH

Cycle 18
January 2024

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Project Title.
Electrocatalysts for Green Hydrogen: Tailored 2D Materials based on Metal Carbide

Abstract.
Generating hydrogen with a low carbon footprint, at Kg of carbon dioxide per Kg of hydrogen, requires using renewable energy sources. The most effective method, compatible with renewable energy, is water splitting or green hydrogen. However, three significant challenges must be addressed. This includes managing issues around energy intermittency and storage for powering up the electrolyzers, ensuring process robustness and safety, and reducing cost. While water splitting using precious metal electrocatalysts is robust, the cost associated with these materials challenges the economy of green hydrogen. Therefore, as identified in the Department of Energy (DOE) hydrogen shot, it is essential to find alternative electrocatalysts and reduce the reliance on precious metal electrocatalysts.

The goal of this project is to develop a new set of tunable electrocatalysts that have demonstrated promising performance in hydrogen and oxygen evolution reactions (HER and OER). Toward this goal, catalysts will be synthesized, functionalized, and characterized for water splitting. Here, the choice of materials is MXenes, which are two-dimensional transitional metal carbides. MXenes are a large family of materials with properties that can be tuned via adjusting the composition and interfacial chemistry. A team with complementary expertise and experience in MXene and electrochemical processes, will leverage the existing knowledge of MXene electrochemistry and aim to develop MXene-based electrocatalysts for green hydrogen. In addition to investigating the catalytic properties of pristine MXenes, the team will also utilize the new approach for a single-step uniform modification of MXenes with transition/noble metals, which was recently developed by the PIs.

This new approach provides a very promising materials platform for HER/OER, in which MXenes serve both as a catalytic material and a high surface area support for dispersed catalytic metal atoms and clusters such as Nickel, Iron, and Cobalt.