NEBRASKA CENTER FOR ENERGY SCIENCES RESEARCH

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Project Title.
Discovery of Multiple Element Alloys for Preventing Hydrogen Embrittlement

Abstract.
The Earthshots initiative specifically identifies the science of materials in coupled (temperature, stress, chemical environment) extreme environments as critical, for example, corrosion, embrittlement, and dimensional instabilities. The commonality is the microstructural structural changes driven by complex environments which can degrade performance but also inform new materials discovery. This proposal focuses on *discovery of new material chemistries and microstructures and understanding and predicting the dynamic evolution of material structure and properties, across linked scales from nano- to meso-, in concurrent coupled extreme environments, such as Hydrogen damage and embrittlement (HE)*. HE can be defined as the hydrogen-caused deterioration of the mechanical properties of most metallic materials and alloys, such as the loss of ductility and tensile strength, which usually result in a decrease of fracture resistance and subcritical cracking from the presence of dissolved hydrogen. Multiple-element alloys exhibit lower plastic losses than traditional alloys under the same hydrogen charging conditions.

To develop a comprehensive understanding and discover the underlying mechanisms for improving HE resistance of multiple-element alloys, a three-element alloy (FeCrAl alloys), one example of multiple-element alloys (MEAs), is selected as primary testing material. By integrating theorical calculations and experimental measurements, three issues will be studied: (1) Hydrogen migration behavior in multiple-element alloys. (2) Factors affecting HE (hydrogen concentration, alloy elements and microstructure); (3) Tensile mechanical properties in the presence of hydrogen and micro-damage HE mechanisms. These results will be used to develop an NSF-DMREF proposal and a DOE-NEUP proposal in 2025.