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Multiscale modelling of hydrogen embrittlement

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Hydrogen embrittlement(HE) is a costly problem in which structural degradation of the susceptible material leads to catastrophic failure. Hydrogen in structural materials may occur any time during its life time, during fabrication in a manufacturing process or during operational use under service environmental conditions. It is important problem need to be addressed in engineering industries such aerospace industries, automotive, civil and construction, semiconductor, offshore, ship, oil and gas, nuclear power and renewable energy including wind energy, fuel cells and hydrogen energy. HE play a prominent role in manufacturing engineering and aerospace components which are typically made of high strength, high toughness, and corrosion resistant as well as high temperature metallic materials such as nickel, titanium and nickel based super alloys. Nickel and nickel-based super alloys are made up of complex microstructures and have been used in aerospace applications for many years. Manufacturing process such as electrodeposition, welding etc... may introduce hydrogen into the aerospace components made of nickel and nickel based super alloys . And Several catastrophic failures have occurred in nickel and nickel-based super alloys due to environmental cracking, hydrogen stress cracking and HE.

This motivate us to investigate the HE in nickel and nickel based super alloys near weldment and weld base metal. This work aims to investigate HE in nickel and nickel based super alloy using Hydrogen induced cracking test, Slow strain rate test under cathodic protection along the welded region. And characterize the materials using TEM, SEM/EBSD, AFM, XRD and chemical analytical techniques to detect the hydrogen. Temperature dependent Permeation test to calculate the diffusion property of the material. To calculate dislocation density and hydrogen trap near weld heat affected region. To investigate the effect of hydrogen in mechanical properties of metallic materials.

Note: I am also wondering is there any facility to charge the material with deuterium. Inorder to study the segregation of hydrogen/deuterium in microstructure morphology of metallic material using Atom prob tomography(APT). In APT, hydrogen can detect as noise. So it is important to charge the material with deuterium. We already have collaboration for APT but we need to charge the material with deuterium.