MODELING HYDROGEN DIFFUSION IN PRECIPITATION HARDENED NICKEL ALLOY 718

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Nickel-based alloy UNS07718 is a precipitation hardened alloy extensively used in marine applications, both for naval applications and offshore drilling. It shows for both direct seawater exposure and under cathodic protection a combination of good strength and general resistance to chloride and sulfide stress corrosion cracking; in hydrogen producing environments it shows a generally good resistance to hydrogen embrittlement. Failures are observed despite the use of specific grades, such as API 6A CRA, which require tighter control on the composition, heat treatment, strength, hardness, and microstructure of the resulting material.

In this work we take a modeling approach to guide the understanding of the mechanical behavior of the material microstructure and to represent the driving forces for environmentally assisted cracking (EAC) in UNS07718 alloys. Based on SEM and TEM characterizations of UNS07718 API in its 120 ksi and 150 ksi grade, we build a representative meso-scale model of the materials, calibrate the material behavior to represent their global stress-strain behavior, and use the measured diffusivities to simulate the ingress and diffusion of hydrogen ahead of an advancing crack. Results show how the size, shape, distribution of the γ' ($Ni_3(Ti,Al)$) and γ'' (Ni_3Nb) phases can affect the mechanical response and the driving force for hydrogen diffusion ahead of a growing crack.