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COUPLED MODELS FOR ENVIRONMENTALLY ASSISTED DAMAGE

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ABSTRACT

Environmentally assisted damage arises from the combined effects of mechanical loading and aggressive environments on susceptible materials. The interaction between these factors can significantly reduce the degradation resistance of materials, promoting crack initiation and premature failure with potentially catastrophic consequences. Localized corrosion, stress corrosion cracking, and hydrogen embrittlement are among the most widely recognized forms of environmentally assisted material degradation. These complex and often hard to assess destructive failure mechanisms affect metallic engineering components across a wide range of industries.

Computational modeling has emerged as an effective method for assessing the degradation resistance of engineering materials and as a powerful tool for designing components against environmentally assisted failure. Recent advances in computational power have enabled the development of sophisticated multiphysics models and hybrid digital methods for predicting environmentally assisted damage. These approaches can track the evolution of the material-environment interface and account for the synergetic interactions between mechanical loading and environmental conditions that drive material degradation. They overcome the long-standing challenge of simulating coupled degradation processes that evolve across multiple interacting spatial and temporal scales. Advances in coupled modeling frameworks now enable the natural simulation of complex phenomena such as pit-to-crack transition and crack propagation in arbitrary domains.

This session will feature presentations and discussions on the modeling of environmentally assisted damage (pure fatigue is excluded). It will showcase state-of-the-art computational approaches for simulating a range of degradation and failure mechanisms, including localized corrosion, stress corrosion cracking, and hydrogen embrittlement. The session will cover recent methodological developments and advances in the field through presentations by leading experts in environmentally assisted degradation and computational materials engineering.