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Predicting the Tribocorrosion Behavior of Aluminum Alloys using Finite Element Multiphysics Modeling

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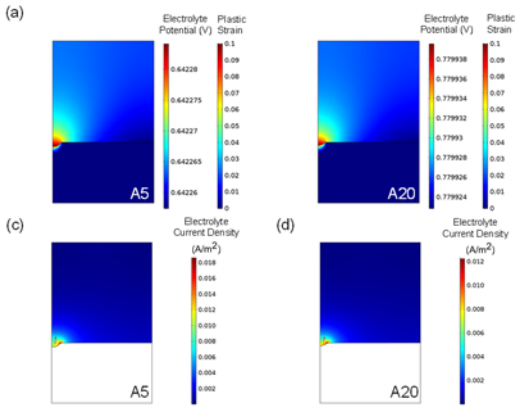
Abstract

The design of robust and reliable metals that are simultaneously wear and corrosion resistant is crucial for various applications such as oil and gas pipelines, underwater vehicles, batteries, and biomedical devices where high mechanical stress and corrosive environment coexist. This is especially evident for passive metals such as aluminum and its alloys which relies on the presence of a thin oxide layer for corrosion protection. When this protective layer is mechanically deformed or removed, accelerated material degradation is often observed. Past research in tribocorrosion mainly relies on costly and trial-and-error experimental methods for alloy design and optimization.



This work aims to develop a model, validated by existing tribocorrosion experiment of two Al alloys, to help understand the mechanism of tribocorrosion. The simulation showed good agreement with experimental facts that wear would cause depassivation at the surface and stress distribution beneath the surface which accelerate the corrosion process. The model revealed the stress and strain distribution when the sample undergoes the wear test, generated the wear track and predicted the evolution of the surface caused by tribocorrosion. The model could also act as a tool to predict the ability of materials with different mechanical and electrochemical properties to resist tribocorrosion under different loading and corrosive conditions.

Biography

Kaiwen Wang is currently pursuing a PhD degree at VT, starting from 2018. He is a member of Professor Wenjun Cai's group. His current project is mainly on Exploring the Tribocorrosion Phenomenon of Metals Using Finite Element Simulation.