MSE Seminar

Modality: In-Person

Friday, Sept. 24, 2021

Goodwin Hall 155

10:10 AM – 11:00 AM

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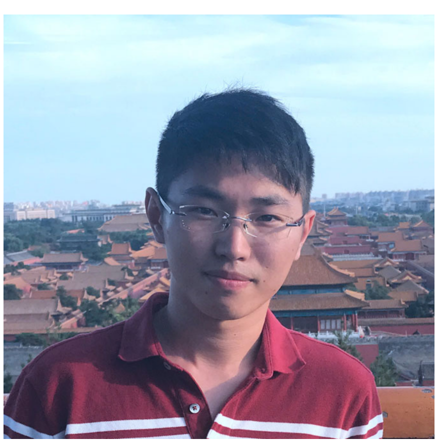
"Ultrahigh tribocorrosion resistance of metals enabled by nano-layering"

Tribocorrosion damage on metal surfaces imposes a great challenge to their reliable long-term performance in corrosive environment. In the present work, we showed that nanostructured metallic multilayers (NMMs) exhibited ultrahigh tribocorrosion resistance owing to abundant interfaces and nanoscale chemical modulation that effectively restricted plastic deformation, reduced micro-galvanic corrosion and surface reactivity. Specifically, the tribocorrosion behaviors of equal-spaced Al/X (X = Ti, Mg and Cu) NMMs with ~3 nm individual layer thickness were studied in 0.6 M NaCl aqueous solution under room temperature. Nanomechanical and electrochemical measurements were coupled with advanced material characterization tools to study the effects of constituting materials on the deformation and degradation mechanisms. It was found that while corrosion dominated in Al/Mg and Al/Cu NMMs, severe plastic deformation dominated in Al/Ti during tribocorrosion due to sustained surface passivity. A finite element (FE) based computational model was developed and validated to quantify the tribocorrosion behavior of all NMMs, which showed accelerated material loss at layer interfaces as well as wear track edge resulting from the synergistic effects of wear and corrosion. Finally, density functional theory (DFT) calculations were carried out to uncover the origin of corrosion resistance in NMM. It was found that via nanolayering, the surface work function of Al was increased while Cl adatoms adsorb less strongly than that on pure Al, thus reducing the surface reactivity and pitting susceptibility. The combined experimental and computational study provides a guideline for future material selection and design of multilayered and multi-phase metals for use under extreme environment.



Wenbo Wang obtained his master's degree at University of South Florida in 2017. He is pursuing his Ph.D. degree in Dr. Cai's group at Virginia Tech since fall 2018 and expected to graduate in spring 2022. His research focuses on understanding the corrosion and tribocorrosion mechanism of metals and coatings using electrochemical measurements, tribocorrosion testing and advanced materials characterization.