Tribological Damage Mechanisms from Experiments and Validated Simulations of Alloy 800H and Inconel 617 in a Simulated HTGR/VHTR Helium Environment

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ABSTRACT:

Alloy 800H and Inconel 617 are promising structural materials for high temperature and very high temperature gas cooled reactors (HTGRs/VHTRs); they possess excellent high temperature thermo-mechanical properties and also offer environmental protection. The structural and in-core components of a VHTR are exposed to small amounts of carbon dioxide, carbon monoxide, hydrogen, water vapor and methane. In components such as valve stems and seats, control rod drive mechanisms, fuel handling mechanisms, and helium circulators, fretting and wear as well as bonding between surfaces can significantly reduce the operational lifetime of these components.

To develop a mechanistic understanding of accelerated fretting and wear, and bonding between Alloy 800H and Inconel 617 surfaces, we propose a series of tribological experiments in a simulated helium environment with controlled concentrations of gaseous species followed by microstructure characterization using electron microscopy, spectroscopy, and atom probe tomography, and the development of validated macroscopic models informed by properties/mechanisms at the atomistic level.