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Failure Mechanisms in Zirconium Alloys during Wear and Corrosion

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Abstract : Zirconium alloys are used as core components of nuclear reactors due to their high wear resistance, good corrosion properties, and good mechanical stability at high temperatures. Water flows inside the pressure tube through fuel claddings, which produces vibration of these core components and results in the wear of some components. Some components are subjected to the environment of coolant water containing LiOH which results in the corrosion of these components. The present work simulates some of these conditions to determine the failure mechanisms under these conditions and the effect of various parameters on them. Friction and wear experiments were performed varying the surrounding environment (room temperature, high temperature, and water submerged), duration, frequency, and displacement amplitude. Electrochemical corrosion experiments were performed by varying the concentration of LiOH in water. The worn and corroded surfaces were analyzed using scanning electron microscopy (SEM) to analyze the wear and corrosion mechanism and energy dispersive x-ray spectroscopy (EDS) and Raman spectroscopy to analyze the tribo-oxide layer formed during the wear and oxide layer formed during the corrosion. Wear increases with frequency and amplitude, and corrosion increases with LiOH concentration in water.

Keywords : zirconium alloys, wear, oxide layer, corrosion, EIS, linear polarization
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