Investigation of Thermal Degradation in Structural Alloys for Nuclear Power Systems

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Abstract

Ni-based and Fe-based alloys, such as 690, 625, 304, and 316, are widely used in nuclear industry as structural components due to the extraordinary corrosion resistance and mechanical properties in radioactive environment. Therefore, the thermal degradation of structure materials is considered to be a key factor for evaluating the lifetime of current nuclear power plants. In this research, the thermal degradation of Ni-Cr model alloys and additively manufactured AISI 316L stainless steel were investigated by microstructural characterization including X-ray diffraction, transmission electron microscopy and micro-mechanical testing including nanoindentation, and in situ micro compression testing. Results show a significant change in deformation behavior due to either thermally-induced precipitation or dual-phase structures. Heterogeneous structure induced-twinning deformation occurs in both isothermally aged Ni-Cr model alloys and printed 316L stainless steel instead of slipping.

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