Role of Stoichiometry on Ageing behavior in Nuclear Applications

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Abstract

Mechanical property degradation due to isothermal ageing is of potential concern for alloys based on the Ni-Cr binary system (e.g., Inconel 690, 625), particularly in nuclear power applications where component lifetimes can exceed 40 years. In the present research, the disorder-order phase transformation, which is the primary mechanism of ageing, has been studied in Ni-Cr model alloys with varying stoichiometry by a combined experimental and computational approach. Kinetic Monte Carlo simulation technique based upon density functional theory calculations to treat both the thermodynamic and kinetic aspects of the phase transformation. Experimental measurements of the change in lattice parameter and micro-hardness as a function of aging time and temperature are obtained in order to assess the model accuracy. The samples up to 10,000 hours high accuracy isothermal ageing with different stoichiometry are measured on lattice parameter via X-ray Diffraction (XRD), micro-hardness via nanoindentation, and image of nucleation of secondary phase via Transmission electron microscopy (TEM) technic.

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