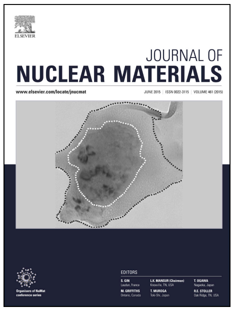

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Hydride Reorientation in Zircaloy-4 Examined by In Situ Synchrotron X-ray Diffraction

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Abstract

The phenomenon of stress-reorientation has been investigated using *in situ* X-ray diffraction during the thermomechanical cycling of hydrided Zircaloy-4 tensile specimens. Results have shown that loading along a sample's transverse direction (TD) leads to a greater degree of hydride reorientation when compared to rolling direction (RD)-aligned samples. The elastic lattice micro-strains associated with radially oriented hydrides have been revealed to be greater than those oriented circumferentially, a consequence of strain accommodation. Evidence of hydride redistribution after cycling, to α-Zr grains oriented in a more favourable orientation when under an applied stress, has also been observed and its behaviour has been found to be highly dependent on the loading axis. Finally, thermomechanical loading across multiple cycles has been shown to reduce the difference in terminal solid solubility of hydrogen during dissolution ($\mathrm{TSS_{D,H}}$) and precipitation ($\mathrm{TSS_{P,H}}$).

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1. Introduction

Zirconium alloys are used extensively in structural applications in water reactor cores, due to their low neutron absorption, adequate strength at operating temperatures and corrosion resistance. At elevated temperatures, during reactor operation, these components are highly sensitive to hydrogen absorption as a result of aqueous corrosion. Whilst at operating temperature, $\sim$600 K, hydrogen solubility in α zirconium is around 100 ppmw, on cooling to ambient temperature the solubility decreases to <20 ppmw[1]. This results in the precipitation of zirconium hydrides. As the hydrides are, themselves, brittle, their precipitation results in severe embrittlement of the accommodating zirconium metal component. To an extent, this is controlled by engineering the crystallographic

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