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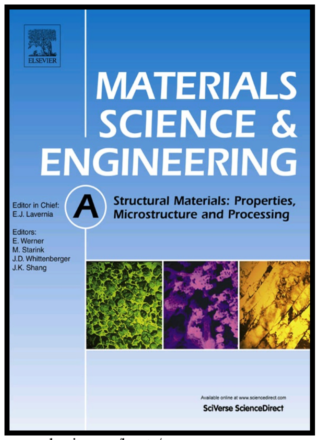

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A brittle fracture mechanism in thermally aged duplex stainless steels revealed by in situ high-energy X-ray diffraction

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Abstract

A direct relationship between the microstructural evolution and macroscopic fracture behaviors of a thermally aged (at 475 °C for 400 h) duplex stainless steel (DSS) has been established with experimental results from atom probe tomography (APT), nanoindentation and in situ synchrotron-based high-energy X-ray diffraction (HE-XRD). The APT experiments demonstrate that ferrite in DSS spinodally decomposes into Cr-enriched and Cr-depleted domains during thermal aging, which leads to a severe hardening effect in ferrite. The lattice strain development during deformation acquired with the in situ HE-XRD measurements confirms the cleavage fracture of α{110} and α{200} ferrite grains aligned perpendicular to loading direction. The thermally aged DSS can be readily fractured by connecting the cleavage cracks in ferrite. The spinodal-decomposition-induced hardening in ferrite and the premature failure of ferrite control the final brittle fracture in the aged DSS.

Keywords

High-energy X-ray diffraction; Duplex stainless steels; thermal aging; spinodal decomposition