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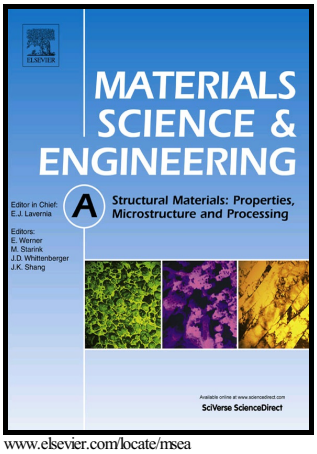

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Creep deformation mechanisms and CPFE modelling of a nickel-base superalloy

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Abstract

Different cooling paths from a supersolvus temperature have been applied to FGH96, a polycrystalline nickel base superalloy for turbine disc applications, in order to simulate the different microstructures that exist through the thickness of a disc following an industrial heat treatment. The microstructures have been evaluated in terms of γ' size distribution, morphology and volume fraction for the different heat treatments using SEM and post digital image software. The results illustrate that γ' size decreases with cooling rate and interrupted cooling leads to a higher tertiary γ' but lower secondary γ' volume fraction. The heat treated samples were creep tested under 690MPa at 700°C. It was found that the creep response it inversely proportional to secondary γ' size. Tertiary γ' volume fraction was also found having a great impact on the material's creep properties. The TEM micrographs show that matrix dislocations could be the precursor of microtwin formation and creep deformation modes are closely related to tertiary γ' precipitates. Tertiary γ' size determines whether *a*/2<110> dislocations shear or dissociate before entering tertiary γ' and the tertiary γ' volume fraction determines how matrix dislocation dissociates. A CPFE model has been developed based on the experimental results. The simulation results for both the single element and the poly-crystalline model indicated that the modelled secondary stage creep rate is in very good agreement with the experimental results. The modelling enables the consequences of this to be investigated for representative different spatial microstructural disc conditions.

Keywords: Nickel base superalloy, Creep deformation mechanism, Transmission electron microscope, CPFE modelling.