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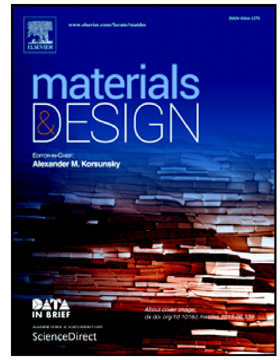

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Combined modelling and miniaturised characterisation of high-temperature forging in a nickel-based superalloy

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Abstract

Continuum models and miniaturised experiments are used to elucidate the high-temperature forgeability of the Ni-based superalloy Inconel 903. Uniaxial compression high temperature tests allow the derivation of an apparent activation energy and the strain rate sensitivity of the deformation process, and to propose a unified constitutive model that captures the underlying physics of deformation. Metallographic analysis is then used to elucidate changes in microstructure which arise during the deformation process; microstructure evolution models which define the changes in grain size and recrystallisation during high temperature compression are proposed. Miniaturised forging experiments in double-cone specimens validate the modelling approach under relevant forging conditions at different temperatures and deformation rates. Finally, the deformation behaviour of this material in an industrially relevant manufacturing scenario – the forging process of a turbine disc – is studied numerically.

Keywords: superalloys, forging, process modelling, continuum plasticity, turbine discs

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1. Introduction

Metals and alloys are often worked thermo-mechanically prior to their practical use in structural components. Why? The need to deform the material

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