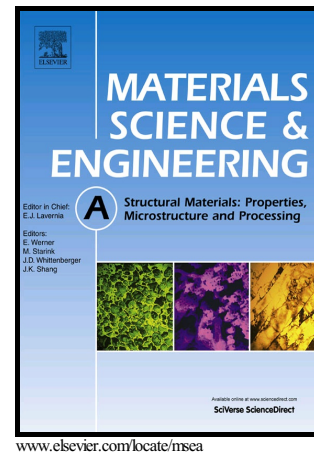


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Regression based novel constitutive analyses to predict high temperature flow behavior in super austenitic stainless steel

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Abstract

Constitutive analysis for hot deformation of super austenitic stainless steel have been performed in a wide range of temperatures (1173-1423 K), strains (0.05–0.6) and strain rates ($0.001-10 \text{ s}^{-1}$). The experimental stress-strain data are employed to develop constitutive equation which relates Zener-Hollomon parameter with flow stress employing regression methods. The regression is carried out using logistic and polynomial functions considering material parameter as strain-independent (method I). Further, efficacy of the method I is compared with flow predictions using modified-sine hyperbolic function in which strain-dependent material parameters are incorporated (method II). Although constitutive equations developed by both the methods exhibit similar predictability in terms of average absolute relative error (8.46-8.7%) and correlation coefficient (0.982-0.989), method I exhibits much better prediction at lower temperature and higher strain rate where flow softening due to adiabatic heating is predominant. Sensitivity analysis have revealed that developed constitutive models employing both the methods are robust as small changes in input materials parameter do not impair the predictability of the models. The predictability of the constitutive equations as a function of number of experimental inputs has been assessed through random sampling methodology. It has been observed that method I exhibits better predictions on lesser number of experimental inputs.

Keywords: Super austenitic stainless steel; Hot deformation; Constitutive equations; Material parameters; Regression

1. Introduction

Super austenitic stainless steels are promising material for structural applications in marine, chemical or nuclear industries due to its excellent creep and corrosion resistance [1]. The various components/parts of desired shape and size from this alloy are manufactured employing hot deformation. The flow behavior of a material during hot deformation is complex as it is found to be depending on various factors such as strain, strain rate, temperature, deformation mode etc. [2–5]. These factors also control microstructural mechanisms such as strain hardening, dynamic

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