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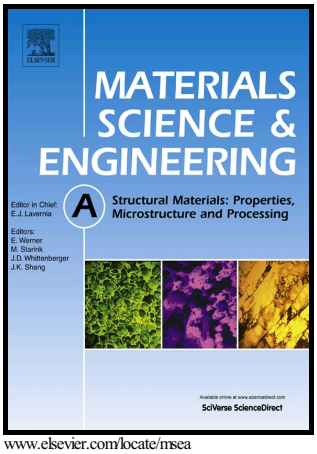

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High temperature deformation behavior of as-produced and retired 9-12% Cr power plant steel

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Abstract

This work aims to compare and analyze the high temperature behavior of as-received and retired 9-12% Cr steel, at high temperatures to elucidate the dominant deformation mechanism. The retired material was selected from retired shrouds used at the third stage of gas-turbine power plant which served for 30,000 hrs. at about 550-600°C (823–873°K). High temperature tensile testing in the range of 813 to 933 °K and different strain rates of $1x10^{-3}$to $1x10^{-5}$ s^{-1}, were conducted on the two material conditions. The microstructural characterization showed that both microstructures were typical tempered martensite composed of large prior austenite grains containing martensite laths as well as occasional ferrite islands. EBSD was used to reveal grain characteristics for the two material conditions. The deformation was found to be controlled by low temperature climb. This was confirmed by the values of true activation energies which were close to 60% of lattice diffusion of ferrite for both material conditions. This inference was concealed by the presence of threshold stresses that initiated due to the interaction of dislocations with carbides. The data was consolidated using the Zener-Holloman parameter, for both material conditions, and a constitutive model was proposed based on the normalized effective stress.

Keywords: Martensitic steel; High temperature tensile test; Strain rate; Activation energy; Stress exponent.

1. Introduction

High temperature applications such that found in power plants for electrical energy generation, oil refineries and petrochemical industries share a common problem; namely ageing of its parts and its consequent degradation or even failure due to their prolonged high temperature- operation. Hence, in