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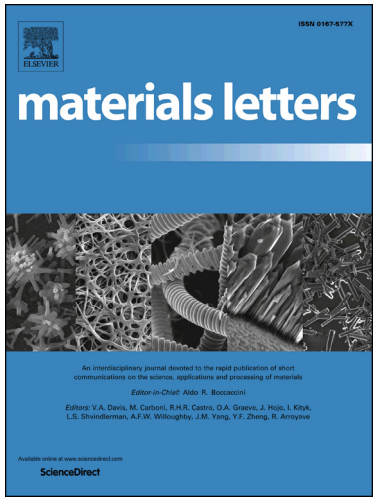

On effect of rhenium on mechanical properties of a high-Cr creep-resistant steel

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On effect of rhenium on mechanical properties of a high-Cr creep-resistant steel

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Abstract

9-12%Cr martensitic steels are perspective materials for critical components of new high-efficiency power plants working at ultra-supercritical parameters of steam. Addition of 0.2% rhenium in the experimental steel improved the short-term creep strength at 650°C. Comparison of kinetics of tungsten depletion from the matrix in different high-Cr martensitic steels showed that rhenium in the experimental 10Cr-3Co-3W-0.2Re steel did not lead to retaining an increased amount of solute W in the ferritic matrix during both aging and creep at 650°C. At the same time, the precipitation of the high fraction of the fine Laves phase particles provided the effective particle strengthening.

Keywords: Metals and alloys, Creep, Electron Microscopy, Microstructure, Particles, Diffusion.

1. Introduction

The heat-resistant steels with 9-12%Cr like a TOS series are used for critical components of boilers, steam main pipes and turbines of fossil fuel power plants with increased thermal efficiency [1-7]. TOS203 steel was developed by Toshiba in 1980's for high-temperature blade [2,4-6] which had the increased W and decreased Mo contents and an addition of Re, comparing with the TOS202 and TOS110 rotor steels [2]. Rhenium has been suggested an effective contributor to creep strength of nickel-base superalloys [8]. In the TOS203 steel, rhenium acts as a solid solution strengthener and maintains an increased amount of solute tungsten in the matrix during creep or thermal aging at 600 and 650°C [2,4-6,9]. Moreover, Re significantly suppresses the W diffusion in Fe-15 mol.%Cr-based alloy [10].

It is worth noting that experimental data on the Re effect on creep behavior were obtained during creep at 550-650°C for high-chromium martensitic steels with standard N content (0.03-0.05 wt.%), high Ni content (about 0.6 wt.%) and low Co content (about 1 wt.%) [2,4-6,9]. However, the recent investigations of alloy design [11-15] showed that modification of the TOS110 steel by reducing nitrogen