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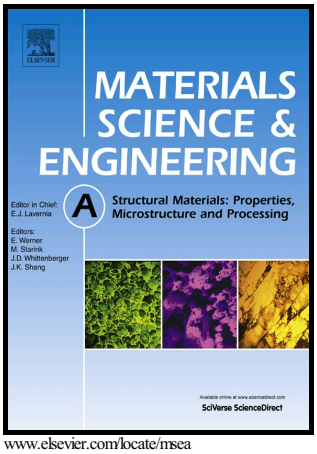

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On the Creep Behavior of Dual-Scale Particle Strengthened Nickel Based Alloy

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Abstract

A novel dual-scale particle strengthened Ni-20Cr based alloy was developed with addition of 1.2 wt.% nano-Y_2O_3 and 5 wt.% sub-micron Al_2O_3 via mechanical alloying. The Ni-20Cr-1.2Y_2O_3-5Al_2O_3 alloy exhibited significant reduction in the minimum creep rate (in the order of 10^{-9} s^{-1}) at 800 ^oC and 100 MPa.

Keywords

Oxide dispersion strengthened alloy; Creep; Transmission electron microscopy; Three-dimensional atom probe; Nano-indentation

1. Introduction

Development of high temperature structural materials is essential to fulfill the growing need for advanced coal-power plants, gas turbine inlets, and other high temperature applications. These materials should possess a combination of high creep resistance, stiffness and corrosion resistance in the highly pressurized oxygen- and hydrogen-rich environments. Nickel-based oxide dispersion strengthened (ODS) alloys are considered as promising candidate materials for such applications [1]. Dispersion strengthening has emerged as the most promising mechanism to provide high strength and stability at elevated temperatures [2]. This is in large part because of the attractive dislocation – particle interaction at high temperature via "departure side pinning" phenomenon, first reported by Nardone and Tien [3].

ODS alloys are typically processed via mechanical alloying of elemental or pre-alloyed powders in combination with nano-sized Y_2O_3 powder (or other rare earth oxides such as Ce_2O_3, La_2O_3) followed by hot extrusion or hot isostatic pressing (HIP) [4]. Homogeneous and uniform distributions of nano-sized and stable Y_2O_3 particles in the matrix of Ni-20Cr are potential