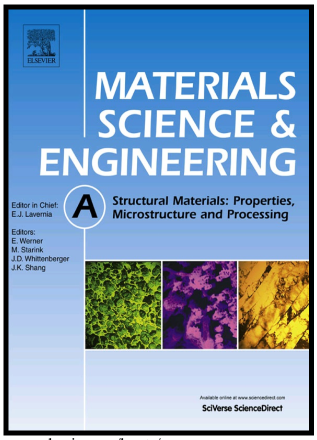

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Abstract

$Al_{0.1}CoCrFeNi$ is a single-phase *FCC* high entropy alloy (HEA) that promises remarkable work-hardening due to its low stacking fault energy (SFE) resulting in suppression of cross-slip and dynamic recovery. The cast material of low yield strength was cold-worked to enhance strength; and then subjected to recovery and recrystallization treatments to improve ductility. Mechanical responses from standard tensile testing at quasi-static strain rate of 10^{-3} s^{-1} were coupled with dynamic deformation from split-Hopkinson pressure bar (SHPB) testing at 10^{3} s^{-1} to study strain rate sensitivity (SRS) and its microstructural dependence in various conditions generated by thermomechanical processing. While dynamic work-hardening remained high in all microstructural conditions, SRS was highly sensitive to the nature of obstacles in each condition. The cast condition showed a moderate SRS of 0.017, but introduction of dislocation tangles and large deformation twins with cold work rendered a sharp drop in SRS to ~0. As the density of these defects is reduced during low-temperature annealing treatments, the recovered microstructures showed SRS recuperating back to original SRS level of 0.017. Higher temperature treatments resulted in partial recrystallization and lower SRS < 0.008 due to additional strength contribution from grain refinement in the recrystallized portions and remnant cold work in unrecrystallized portions. Dynamic work-hardening remained very high at ~ 1600 MPa in all conditions from a combination of dynamic recovery suppression and intense twinning that is inherent to the HEA due to its low SFE.

Keywords:
High entropy alloy; $Al_xCoCrFeNi$; strain rate sensitivity; dynamic mechanical behavior; thermomechanical processing.

Introduction

A new paradigm of metallic alloy development by stabilizing simple microstructures with multiple elements in equimolar proportions has emerged. This class of materials known as high entropy alloys (HEAs) was proposed to have significant multi-element effects as compared with conventional alloys. The four core effects of high entropy, sluggish diffusion, lattice distortion and cocktail effects have been studied extensively [1-4]. They offer potential for promising properties such as high strength combined with good ductility from simple crystal structures. $Al_xCoCrFeNi$ is prominent among the several alloy systems identified on the basis of this design strategy. It changes from *FCC* to *BCC* structure with increasing aluminum content and demonstrates a wide spectrum of mechanical behavior [5-8]. $Al_{0.1}CoCrFeNi$ (x=0.1) is a single-phase *FCC* HEA which is stable even at high temperatures [9]. Strengthening from multi-element solid solution, which is controlled by thermally activated deformation, can offer higher strain rate sensitivity (SRS) in this HEA than conventional FCC metals. $Al_{0.1}CoCrFeNi$ (x=0.1) is