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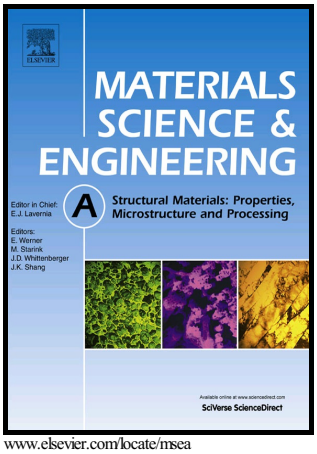

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Mechanical properties of a new high entropy alloy with a duplex ultra-fine grained structure

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Abstract

A new approach to increase the tensile performance of high entropy alloys (HEAs) by producing a duplex ultrafine-grained (UFG) structure was reported in this work. A novel HEA based on the CoCrFeNiMn system with substantial amounts of Al and C was used for the illustration of this approach. In the as-cast condition the alloy had almost entirely a single face-centered cubic (fcc) phase structure with an insignificant amount of $M_{23}C_6$ carbides. After cold rolling and annealing at 800-1000°C an increased amount of fine second phases, namely $M_{23}C_6$ carbides and B2 phase, effectively pinned boundaries of recrystallized fcc grains. As a result, a duplex UFG structure composed of the recrystallized fcc grains and $M_{23}C_6$ and B2 particles was produced. The alloy with the UFG structure demonstrated attractive mechanical properties. For example, after annealing at 900°C the alloy had the yield strength of 785 MPa, the ultimate tensile strength of 985 MPa, and elongation to fracture of 32%. The phase composition of the alloy in different conditions was compared with the equilibrium phase diagram obtained using a Thermo-Calc software. Strengthening mechanisms were qualitatively analyzed, and some possibilities for further improvement of strength of the alloy were discussed.

Keywords: High entropy alloys; UFG structure; phase transformations; mechanical properties; grain boundary strengthening.

Introduction

Since their introduction in 2004, so-called high entropy alloys (HEAs) - multicomponent alloys of 5 or more principal elements taken in (nearly) equiatomic concentration - have become a highly attractive research field in materials science [1–4]. Although the main researcher's attention was initially focused on alloys with a single solid solution phase structure, it is unclear yet if