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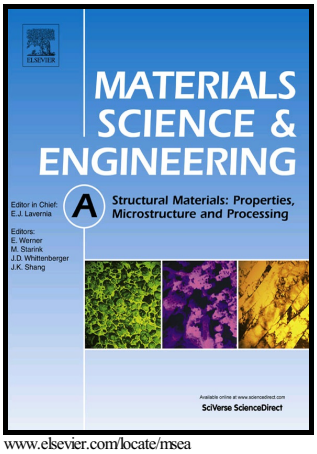

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Phase stability and mechanical properties of AlHfNbTiZr high-entropy alloys

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Abstract

Refractory high-entropy alloys (HEAs) have potential to be high temperature structural materials, but poor ductility and phase stability have been remaining the key issues for their application. In this paper, the phase compositions, phase stability and mechanical properties of $Al_x(HfNbTiZr)_{100-x}$ (x = 0, 3, 5, 7, 10 and 12 in atomic percent) HEAs have been systematically studied. It has been shown that after cold-worked and heat-treated at 1273K for 0.5 h, all the HEAs formed a single solid solution (SS) phase with BCC structure. For the HEAs with more than 7% Al, a (Al, Zr)-rich phase with hexagonal structure was precipitated when aged at 873K. The yield strength increases linearly with the content of Al for the SS treated HEAs. Typically, $Al_5(HfNbTiZr)_{95}$ exhibits the fracture strength and elongation of 915.2 MPa and 31.5%, respectively, resulting in the product of strength and elongation up to 28828 MPa%, which is comparable to that of FCC HEAs with excellent ductility. The strengthening mechanism for these HEAs has been discussed based on the solid solution strengthening effects. Atomic size effect and electron concentration are considered to attribute to the rapid solid solution strengthening. And dislocation substructure evolution was also evaluated for current HEAs.

Keywords: high-entropy alloys; solid solution; phase stability; strength; ductility

1. Introduction

Nowadays, the high-performance metallic materials applied for high-temperature fields, such as aerospace and petrochemical industries, are urgently demanded. Ni-based superalloys have being applied widely for turbine blades and discs of aerospace engines and the components of ground combustions. Due to the incipient melting point at around 1573 K, however, Ni-based superalloys have their applicability only up to the temperatures between 1433 and 1550 K [1]，thus new metallic alloys developed based on refractory elements have been considered as a feasible choice. Recently, a new kind of metallic materials, namely,

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