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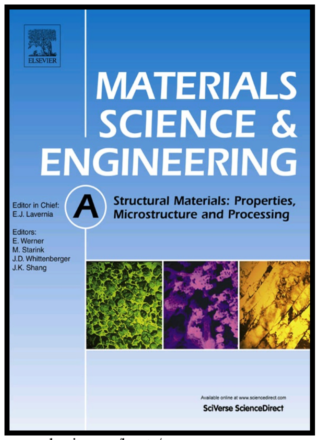

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Effect of Ti and C additions on the microstructure and mechanical properties of the FeCoCrNiMn high-entropy alloy

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Abstract

To improve the yield strength of an FeCoCrNiMn high-entropy alloy (HEA), elemental Ti and C were doped into the alloy. Subsequently, an in situ synthesized carbides particle-strengthened HEA matrix composite was prepared by mechanical alloying (MA), followed by a vacuum hot-pressing sintering (VHPS) method. The TiC nanoparticles were distributed along the grain boundaries. The microstructure of the alloy contained a face-centered cubic (FCC) solid solution as the matrix phase and small amounts of TiC, $M_{23}C_6$ and M_7C_3 (where M=Cr, Mn, Fe) carbides. The addition of elemental Ti and C significantly improved the room-temperature compressive yield strength of the FeCoCrNiMn HEA from 774 MPa to 1445 MPa (an 86.7% increase), accompanied by a decrease in the compressive strength and plasticity. Grain boundary strengthening and precipitation strengthening are the main strengthening mechanisms of the alloy doping with elemental Ti and C.

Keywords: High-entropy alloy; Powder metallurgy; TiC nanoparticles; Microstructure; Mechanical properties

1 Introduction

High-entropy alloys (HEAs) based on chemical disorder represent a new class of materials and have attracted considerable attention due to their unique properties and related scientific importance [1-3]. Among various the HEAs, an equiatomic alloy of Fe, Co, Cr, Ni, and Mn is considered promising. This alloy exhibits outstanding ductility and fracture toughness at room and cryogenic temperature, and its fracture toughness exceeds that of the most other materials [4-7]. However, its yield strength is relatively weak [7]. Therefore, it is important to improve the yield strength of this alloy.

The yield strength of the FeCoCrNiMn HEA can be improved by doping with alloying elements