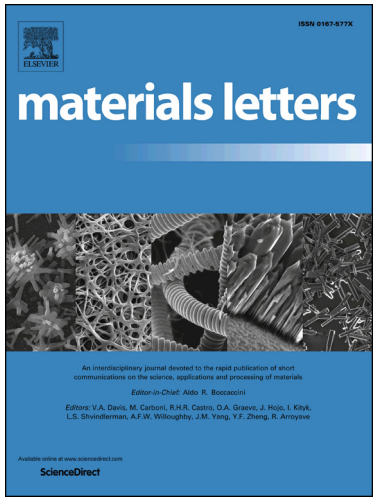

Deformation twinning structure and interface in a FCC-based $Al_{0.3}FeNiCo_{1.2}CrCu$ high-entropy alloy matrix composites

Shaofeng Yang, Jinhong Pi, Wei Yang, Hang Zhou, Dezhi Zhu

PII: S0167-577X(17)31607-5
DOI: https://doi.org/10.1016/j.matlet.2017.10.131
Reference: MLBLUE 23366

To appear in: *Materials Letters*

Received Date: 4 August 2017
Revised Date: 29 October 2017
Accepted Date: 31 October 2017

Please cite this article as: S. Yang, J. Pi, W. Yang, H. Zhou, D. Zhu, Deformation twinning structure and interface in a FCC-based $Al_{0.3}FeNiCo_{1.2}CrCu$ high-entropy alloy matrix composites, *Materials Letters* (2017), doi: https://doi.org/10.1016/j.matlet.2017.10.131

Deformation twinning structure and interface in a FCC-based $Al_{0.3}FeNiCo_{1.2}CrCu$ high-entropy alloy matrix composites

Shaofeng Yang [a, b, *], Jinhong Pi [a, b], Wei Yang[b], Hang Zhou[b], Dezhi Zhu[c]

[a] Jiangsu Key Laboratory of Advanced Structural Materials and Application Technology, Nanjing, China;

[b] School of Materials Science and Engineering, Nanjing Institute of Technology, Nanjing, China;

[c] Guangdong Key Laboratory for Advanced Metallic Materials Processing, South China University of Technology, Guangzhou, China.

Abstract: High entropy alloy composites (HEACs) ,$Al_{0.3}FeNiCo_{1.2}CrCu$ reinforced by Titanium carbide (TiC) particles were produced by mechanical alloying (MA) and spark plasma sintering (SPS). The results from X-ray diffraction (XRD) and transmission electron microscopy (TEM) shows that a single FCC solid-solution phase with certain nanoscale deformation twins are produced following SPS. Subsequent investigations characterize the mechanical properties and microstructure of nanocrystalline twin HEAs by high resolution electron microscope (HREM) and compression tests. The produced interface was found to be clear and well bonded. The compressive yield strength, fracture strength, plastic strain and hardness are found to be 1730±15MPa, 2260±15 MPa, 29.50% and 645Hv, respectively. This is attributed to the twin strengthening and the presence of uniformly distributed TiC particles.

Keywords: High-entropy alloy; Microstructure; Powder technology ;Interfaces

1. Introduction

High-entropy alloys (HEAs) have attracted extensive research attention during recent years due to their promising mechanical properties[1-3]. A single-phase solid solution HEA such as CoCrFeMnNi can be desirable for certain physical and mechanical properties as reported by Cantor et al[4]. The evident feature of the CoCrFeMnNi alloy system is that the improved strength and the performance of ductility increases significantly at low temperatures which has been attributed to deformation-induced nano-twinning[5]. Although nanoscale twins were observed in some HEAs as a consequence of mechanical alloying (MA) and spark plasma sintering (SPS) but the fraction of nanoscale twins in such alloys was found to be small.

The focus of the present study is concentrated on the effect of TiC on the volume fraction of nano-twinning in HEACs and the interface microstructure between the TiC particles and the alloy matrix.

2. Experimental procedure

Ten percent of TiCby volume-reinforced $Al_{0.3}FeNiCo_{1.2}CrCu$ HEAC is prepared by dry milling of mixed elemental powders in a high energy planetary ball mill (QM-3SP4 Planetary Ball Mill) at 580rpm under an Argon atmosphere. The elemental powders of Fe, Ni, Cr, Co, Ti, Cu, Al and C with high purity (>99.9 wt.%) and particle size of ≤ 45 μm (325 mesh) are processed by mechanical alloying. In order to avoid the reactions between carbon and iron, cobalt and other metals, the weighted Ti, Al and C are firstl subject to 10 h of dry milling. Then Fe, Ni, Cr, Co and Cu (expressed in molar ratio) are added to the Ti , Al and C mixture , followed by a further 45h of dry milling. The ball milled powders then are consolidated by SPS (Dr. Sinter 825, Sumitomo Coal Mining Co. Ltd., Japan) in a graphite die at 1323K for 10 min at a pressure of 30MPa under vacuum. Microstructural characterization of the crystal structure is carried out by a transmission electron microscope (JEM-2010) and Bruker D8 ADVANCE X-ray diffractometer (XRD) with a Cu Kα radiation target.

3. Results

X-ray diffraction patterns of bulk $Al_{0.3}FeNiCo_{1.2}CrCu$ (HEAC) after consolidation by SPS at 1273 K are shown in Figure 1. Two groups of diffraction peaks can be clearly observed in the XRD patterns of $Al_{0.3}FeNiCo_{1.2}CrCu$ HEAC. One corresponds to the FCC solid solution phase and the other corresponds to the TiC