Accepted Manuscript

Ultrahard bulk nanocrystalline VNbMoTaW high-entropy alloy

S.W. Xin, M. Zhang, T.T. Yang, Y.Y. Zhao, B.R. Sun, T.D. Shen

PII: S0925-8388(18)32832-9

DOI: 10.1016/j.jallcom.2018.07.331

Reference: JALCOM 47047

To appear in: *Journal of Alloys and Compounds*

Received Date: 18 April 2018

Revised Date: 26 July 2018

Accepted Date: 29 July 2018

Please cite this article as: S.W. Xin, M. Zhang, T.T. Yang, Y.Y. Zhao, B.R. Sun, T.D. Shen, Ultrahard bulk nanocrystalline VNbMoTaW high-entropy alloy, *Journal of Alloys and Compounds* (2018), doi: 10.1016/j.jallcom.2018.07.331.

Ultrahard bulk nanocrystalline VNbMoTaW high-entropy alloy

S. W. Xin[♀], M. Zhang[♀], T. T. Yang, Y. Y. Zhao, B. R. Sun, T. D. Shen*

State Key Laboratory of Metastable Materials Science and Technology, Yanshan University, Qinhuangdao 066004, People's Republic of China

Abstract

Coarse-grained high-entropy alloys (HEAs) have such excellent mechanical properties as high hardness and strength. The well-known Hall-Petch relation suggests that this high hardness should be further increased if the crystallite size of HEAs is decreased to nanometer scale. We prepared single-phased nanocrystalline (NC) refractory VNbMoTaW HEAs powders by mechanical alloying (MA). The achieved NC HEAs have a body-centered cubic (BCC) structure and an average grain size of approx. 6 nm. We further used a high-pressure/high-temperature (HPHT) technique to consolidate the NC powders to achieve bulk NC HEAs. The evolution of phases, microstructure and mechanical properties of the consolidated bulk NC HEAs were studied as a function of consolidating temperature. The bulk NC VNbMoTaW HEAs consolidated at an optimized temperature of 1150 °C have an average grain size of ~ 30 nm and a hardness of 11.4 GPa, ~ twice that of coarse-grained refractory HEAs. This ultrahigh hardness has three origins: solid solution, grain boundary and dislocation hardening.

Keywords: Nanocrystalline; High-entropy alloys; Single-phased; Microstructure; Ultrahigh hardness

***Corresponding author: (E-mail: tdshen@ysu.edu.cn; Fax: +86-335-8074545)**

[♀]These authors contributed equally to this work.