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PII: S0263-4368(16)30450-4
DOI: doi: 10.1016/j.ijrmhm.2017.01.003
Reference: RMHM 4398

To appear in: *International Journal of Refractory Metals and Hard Materials*

Received date: 30 July 2016
Revised date: 8 November 2016
Accepted date: 13 January 2017

Please cite this article as: Fangnao Xiao, Liujie Xu, Yucheng Zhou, Kunming Pan, Jiwen Li, Wei Liu, Shizhong Wei , Preparation, microstructure, and properties of tungsten alloys reinforced by ZrO2 particles. The address for the corresponding author was captured as affiliation for all authors. Please check if appropriate. Rmhm(2017), doi: 10.1016/j.ijrmhm.2017.01.003

Preparation, microstructure, and properties of tungsten alloys reinforced by ZrO_2 particles

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Abstract

Tungsten alloys reinforced by in-situ tetragonal zirconia (W–ZrO_2) were developed via the azeotropic distillation method combined with the powder metallurgy method. The microstructure and abrasive wear properties were studied. The in-situ ZrO_2 particles in the tungsten matrix were obtained by the decomposition of zirconium nitrate after liquid–liquid incorporation of $(NH_4)_6H_2W_{12}O_{40}$ and $Zr(NO_3)_4$ aqueous solution. The ZrO_2 particles were distributed evenly in the tungsten matrix, which refined tungsten powders and the grains of tungsten alloys significantly. The density and Vickers hardness of the tungsten alloys decreased with increasing ZrO_2 mass fraction. However, the wear resistance increased firstly and then decreased with increasing ZrO_2 mass fraction. The optimal amount of ZrO_2 for improving wear property is 3%, with the wear resistance of W–3% ZrO_2 improving by approximately 20%–40% compared with that of pure tungsten. The proper amount of ZrO_2 particles can efficiently prevent microcutting to protect the tungsten matrix, thereby enhancing the wear resistance of tungsten alloys.

Keywords: Tungsten alloy; Zirconia; Azeotropic distillation; Wear resistance

1. Introduction