Accepted Manuscript

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PII: S0925-8388(18)32843-3

DOI: 10.1016/j.jallcom.2018.07.342

Reference: JALCOM 47058

To appear in: *Journal of Alloys and Compounds*

Received Date: 27 May 2018

Revised Date: 28 July 2018

Accepted Date: 30 July 2018

Please cite this article as: Z. Li, L. Xu, S. Wei, C. Chen, F. Xiao, Fabrication and mechanical properties of tungsten alloys reinforced with c-ZrO_2 particles, *Journal of Alloys and Compounds* (2018), doi: 10.1016/j.jallcom.2018.07.342.

Fabrication and mechanical properties of tungsten alloys reinforced with c-ZrO_2 particles

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ABSTRACT: The tungsten alloys reinforced by ZrO_2 were prepared using azeotropic distillation method combined with powder metallurgy method, and then the sintered tungsten alloys were swaged to obtain compact bars. The microstructures of W-$x$$ZrO_2$ (x = 0, 0.25, 1.0 and 1.5 wt%) alloys were investigated by means of SEM, XRD and TEM. The results show that ZrO_2 exist as a stable cubic phase in tungsten alloys by adding Y_2O_3. Fine ZrO_2 particles (500~800 nm) are dispersed in the tungsten matrix, and thus refine the grain size and improve the physical properties and strength of tungsten alloys. With the increase of the ZrO_2 content, the relative density, hardness and compressive strength of tungsten alloys were all increased. The swaged W–1.5 wt%ZrO_2 alloy shows the finest microstructure with an average grain size of 47.18 μm, reducing 34.76% compared with that of pure tungsten. And thus, the swaged W–1.5 wt%ZrO_2 alloy achieves the highest compressive strength (1941.3 MPa) and failure strain (23.1%) at the same time, increasing 23.27% and 22.37%, respectively, compared with that of pure tungsten.

KEY WORD: tungsten alloy; ZrO_2; grain size; hardness; compressive strength; failure strain

1. Introduction

Tungsten and its alloys have a wide range of applications in the fields of national defense, medical treatment, aerospace and other high-tech fields. It can be used to make mould, armor,