Accepted Manuscript

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PII: S0925-8388(17)30725-9

DOI: 10.1016/j.jallcom.2017.02.277

Reference: JALCOM 41005

To appear in: *Journal of Alloys and Compounds*

Received Date: 4 January 2017

Revised Date: 16 February 2017

Accepted Date: 27 February 2017

Please cite this article as: F. Xiao, L. Xu, Y. Zhou, K. Pan, J. Li, W. Liu, S. Wei, A hybrid microstructure design strategy achieving W-ZrO_2(Y) alloy with high compressive strength and critical failure strain, *Journal of Alloys and Compounds* (2017), doi: 10.1016/j.jallcom.2017.02.277.

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A hybrid microstructure design strategy achieving W-ZrO_2(Y) alloy with high compressive strength and critical failure strain

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Abstract

In this article, we report a hybrid microstructure design strategy for preparing tungsten alloy reinforced by Y_2O_3-stabilized cubic ZrO_2 (W-ZrO_2(Y)) with high compressive strength and critical failure strain. The processing route involves a molecular-level liquid–liquid doping technique combined with vertical sintering and hot rotary swaging that causes the uniform distribution of cubic ZrO_2(Y) particles in the grain interior. The cubic ZrO_2(Y) particles in tungsten matrix are prepared by liquid–liquid incorporation of $Zr(NO_3)_4$ and $Y(NO_3)_3$ aqueous solutions. The alloy powders with 1.5 wt.% ZrO_2(Y) present nano/microbimodal distribution. The cubic ZrO_2(Y) particles are also uniformly distributed in the grain interior of refined tungsten grains, which consequently improves the relative density, Vickers hardness, compressive strength, and critical failure strain of alloy. The compressive strength and critical failure strain of the swaged W-1.5 wt.% ZrO_2(Y) alloy are 1680 MPa and 0.24, which are approximately 24.9% and 33.3% higher compared with those of pure tungsten, respectively. The strengthening mechanism of W-1.5 wt.% ZrO_2(Y) alloy is

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