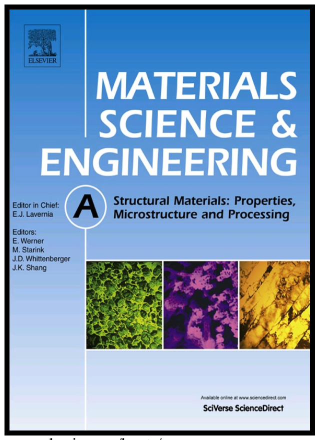

www.elsevier.com/locate/msea

Micro-Mechanical Characterization of Micro-Architectured Tungsten Coating

Quan Jiao, Gi-Dong Sim, Haidong Fan, Jaafar A. El-Awady

PII: S0921-5093(17)31077-8
DOI: http://dx.doi.org/10.1016/j.msea.2017.08.057
Reference: MSA35405

To appear in: *Materials Science & Engineering A*

Received date: 20 February 2017
Revised date: 2 June 2017
Accepted date: 16 August 2017

Cite this article as: Quan Jiao, Gi-Dong Sim, Haidong Fan and Jaafar A. El-Awady, Micro-Mechanical Characterization of Micro-Architectured Tungsten Coating, *Materials Science & Engineering A*, http://dx.doi.org/10.1016/j.msea.2017.08.057

Micro-Mechanical Characterization of Micro-Architectured Tungsten Coating

Quan Jiao[a], Gi-Dong Sim[a], Haidong Fan[b], Jaafar A. El-Awady[a,*]

[a] *Department of Mechanical Engineering, Whiting School of Engineering, The Johns Hopkins University, Baltimore, MD 21218, USA*

[b] *Department of Mechanics, Sichuan University, Chengdu 610065, China*

Abstract

The current work provides a detailed analysis of the microstructure, mechanical properties, and out-of-plane compression failure modes of tungsten micro-architectured coatings. These coatings are candidates for extremely high temperature applications and for plasma facing components. The current analysis reveals that these coating are multi-layered coatings composed of columnar grains with many pre-existing voids/cracks along grain boundaries. By means of *ex situ* and *in situ* micro-compression experiments of microcrystals fabricated into these coatings, the mechanical response and possible failure modes have been investigated. These experiments show a size-dependent response in both the flow stress and deformation modes. Smaller microcrystals show a higher strength and large strain burst followed by catastrophic failure dominated by intergranular fracture assisted plastic buckling of the limited number of grains that comprise the microcrystal. Larger microcrystals also show intergranular fracture, however, a continuous hardening response is driven by restricting the lateral movement of the columnar grains by other grains in the crystal. In addition, three-dimensional finite element method simulations were performed to further shed light on the influences of microstructural configurations on the post-yielding behavior, as well as providing a predictive tool of the deformation of these coatings. This work underscores the importance of microstructural design and control of the grain aspect ratio and grain boundary cohesive strength in an effort to extend the life of such micro-architectured coatings.

Keywords: Tungsten, Micro-Architectured Coating, Intergranular fracture, Cohesive Zone Model, In-situ testing