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Micro-Mechanical Characterization of Micro-Architected Tungsten Coating

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Abstract

The current work provides a detailed analysis of the microstructure, mechanical properties, and out-of-plane compression failure modes of tungsten micro-architected 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-architected coatings.

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

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