Characterization of novel W alloys produced by HIP

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Tungsten is considered as a candidate material for plasma-facing components (PFCs) in a future fusion power reactor because of its refractory characteristics, low tritium retention and low sputtering yielding. However, its use in PFCs requires the development of a tungsten material that, in addition to these properties, maintains good mechanical properties after a prolonged exposure at high temperatures. Sintering would be the most suitable method to produce tungsten materials for these applications if their recrystallization temperature is high enough and the grain growth is restrained. Usual sintering conditions for tungsten requires very high temperatures that induces a coarse grained structure in the sintered material, and a low recrystallization temperature in the hot worked material. This causes the failure of its mechanical properties. The combined addition of a sintering activator, which lowers the sintering temperature and favors the densification, and an insoluble oxide that produces a dispersion strengthening and grain growth inhibition, may result in a tungsten material with improved mechanical characteristics. Cu, Ni and Fe are the most used activators to produce tungsten heavy alloys but they may be no recommendable for PFCs. The present work assesses the possibility of using jointly Ti as sintering activator and Y\textsubscript{2}O\textsubscript{3} particles as strengthening dispersoids in tungsten.

Pure tungsten and tungsten alloys having 0.5 wt % Y\textsubscript{2}O\textsubscript{3}, \(x\) wt % Ti and 0.5 wt % Y\textsubscript{2}O\textsubscript{3}+\(x\) wt % Ti have been prepared by powder metallurgy; \(0 \leq x \leq 4\%\). Elemental powders were blended or ball milled, canned, outgassed and finally consolidated by a two-stage HIP process under a pressure of 200 MPa. The first stage was performed at 1523 K for 2 h, and after uncanning, the second HIP at 1973 K for 30 min. It is found that Ti addition favors the densification attaining a fully dense material, while pure W and W-0.5Y\textsubscript{2}O\textsubscript{3} achieve 93% and 90% of theoretical density, respectively. XRD, SEM and EDS analyses of the material with Ti addition reveal the formation of a structure consisting of tungsten particles embedded in a W(Ti) matrix. Microhardness measurements and pin-on-disk wear tests have also been performed on these materials.

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