GRAIN SIZE TAILORING OF TUNGSTEN COPPER NANOCOMPOSITES TO AFFECT LOCAL FRACTURE CHARACTERISTICS

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Tungsten offers outstanding material properties, and is therefore frequently considered as good candidate for high performance applications in harsh environments, e.g. fusion reactor shielding. However, tungsten lacks damage and fracture tolerance due to a high ductile to brittle transition temperature, thus remains hardly applicable to safety-relevant applications. By creating a composite and adding copper as ductile phase, damage as well as fracture tolerance are increased at the expense of material strength. Hence, additional strengthening of the ductile phase is desirable, i.e. by alloying copper with zinc. Elemental powders were used as a precursor to create alloys in the α -brass region, from 0 to 30 wt.% zinc, as in this compositional region brass exhibits high twinning tendency. To obtain brass powder, copper and zinc were alloyed via ball-milling in a preprocessing step, which was verified by XRD measurements. The bulk samples were subsequently fabricated with a constant tungsten content of 80 wt.% by consolidating the tungsten-brass powder mixture using high pressure torsion (HPT). Additionally, HPT was used to refine the grains to the nanocrystalline saturation regime to further increase strength while keeping the ductility as high as possible. To verify microstructural saturation, Vickers hardness measurements and microstructural investigations by means of SEM were performed, while TEM and TKD investigations provided insights regarding the grain size distribution. In-situ experiments on FIB milled micro-cantilevers were conducted in an SEM to analyze crack growth and determine the material's fracture characteristics. We show that the saturation grain size depends on the ductile phase strength and HPT deformation temperature. Furthermore, fracture analysis reveals that the fracture process is dominated by intercrystalline fracture and that primarily inhomogeneities determine the achievable fracture toughness.