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MICROSTRUCTURE AND MECHANICAL PROPERTIES OF SPARK PLASMA SINTERED TUNGSTEN-COPPER – ZINC COMPOSITES

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ABSTRACT

Tungsten/Copper (W/Cu) composites, generally used for applications whereby the combination of high heat resistance, high electrical and thermal conductivity and low thermal expansion is required, are suitable for hard working conditions such as intensive electrical sparks, gouging spark erosion, surface melting, welding, material transfer etc. However, the large disparity between the melting point of tungsten (3410 °C) and that of copper (1083 °C) make their production through traditional processes very difficult. Furthermore the difficulty of approaching near theoretical densities even by using liquid phase sintering, due to the negligible mutual solubility of the constituents and high wetting angle of liquid copper on tungsten is quite challenging. In the present work, the densification mechanisms during spark plasma sintering of tungsten/copper and the effect of the addition of zinc on both microstructural and mechanical properties were investigated. Commercially pure tungsten powders were dry mixed with varied amounts of copper (25, 30 and 50 wt.%) with the addition of different weight fractions of zinc (Zn) (5, 10, 15 and 20 wt.%) using a T2F Turbular mixer for 8 h and at a speed of 49 rpm. The blended composite powders were then sintered using spark plasma sintering system (model HHPD-25 from FCT Germany) with varying dwell times, sintering temperatures, pressures and a constant heating rate of 100°C min^{-1}. The sintering of W/Cu was used as a base study prior to the addition of Zn for a better understanding of the interplaying mechanisms. Densification was monitored through the analysis of the recorded punch displacement and the measured density of the sintered samples using Archimedes method. Microstructural evolutions and phase changes were investigated using scanning electron microscope and X-ray diffraction techniques. The effect of Zn addition on the mechanical properties was investigated through hardness, three point bending flexural test and fracture toughness measurements as well as the analysis of fracture surfaces.