

Effect of Tungsten Matrix on Mechanical Properties of SiC Fiber Reinforced W Composites

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Abstract

SiC fiber was used to strengthen tungsten due to its coefficient of thermal expansion close to W, high high-temperature strength and stability to neutron irradiation. Composites were prepared by hot press using W powders and W foils at different temperature (1500 °C, 1700 °C and 1900 °C). The results showed that composites sintered at 1500 °C and 1700 °C had obvious pseudo-ductile behavior.

Keywords: tungsten, SiC fiber reinforcement, composites, tensile test

1. Introduction

Tungsten is a candidate material for plasma facing material (PFM) in fusion application due to its unique thermo-physical properties, such as its high melting point (3440 °C), high thermal conductivity and high plasma sputtering and corrosion resistance. However, brittleness is the biggest drawback for tungsten. Thus, the objective of this research is to make tungsten ductile and hold higher toughness under service environment. Fiber reinforcement can be applied for tungsten to enhance its toughness and ductility. SiC fiber displays excellent properties (i.e., high high-temperature strength and stability to neutron irradiation), and its coefficient of thermal expansion (CTE) is close to W. Therefore, SiC fiber will be selected as the reinforcement to improve the performance of W in this work.

2. Experiment

Two methods were used to fabricate the composites. Tungsten powders with about 0.6 μm in size were used in this work. For method A (MA), W powder sheet was prepared first. Then woven fibers and the powder sheets were cold-pressed to sandwich-like under 5 MPa. For method B (MB), fibers were infiltrated in W slurry directly, then dried at room temperature. Subsequently, composites with or without W foil were hot-pressed in a graphite die at different temperature (1500 °C, 1700 °C and 1900 °C) for 1 h under a pressure of 20 MPa in argon atmosphere. Tensile test was used to evaluate mechanical performance of sintered samples. The size of testing bar is 1.5×3×40 mm³. And all surfaces were polished before tensile test. Microstructure was examined by scanning electron microscopy (SEM).

3. Conclusion

SiC fiber reinforced W composites with or without W foil were manufactured successfully by both methods. Samples prepared by MA was easy to delaminate, and pseudo-ductile behavior was not evident. While for MB composites, stress-strain curve showed obvious pseudo-ductile behavior for specimen sintered at 1500 °C and 1700 °C. However, there is no pseudo-ductile behavior when sintering temperature was increased to 1900 °C, and fibers were completely damaged owing to the interfacial reaction between W powder and SiC fiber.