

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

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Abstract

SiC fibers were used to strengthen tungsten due to its coefficient of thermal expansion close to W, high high-temperature strength and good irradiation resistance. Composites were prepared by hot-press using W powders and foils. The results showed composites had pseudo-ductile behavior except 1900 °C sintered sample, and composite with foils have higher strength.

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

1. Introduction

Tungsten is a candidate material for plasma facing material 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. 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 fibers were selected as the reinforcement to improve the performance of W in this work.

2. Experiment

Unidirectional Hi-Nicolon type S SiC fibers and tungsten powders with about 0.6 μm size or 0.05 mm thick W foils were used in this work to fabricate composites. Two different kinds of composites (1. composites synthesized by fibers and powders, 2. composites synthesized by fibers and foils,) were synthesized by hot-press with 40 × 40 mm size at 1500, 1600, 1700, 1900 °C respectively in Ar atmosphere for 1 h with 20 MPa pressure. Tensile test carried at room temperature 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 measurement. Microstructure was examined by scanning electron microscopy (SEM). Element analysis was measured by electron probe micro analyzer (EPMA).

3. Conclusion

SiC fiber reinforced W composites with or without W foils were manufactured successfully. The sintering temperature is higher than 1500 °C, which is higher than the recrystallization temperature of W. While stress-strain curve obtained at room temperature showed obvious pseudo-ductile behavior for specimen sintered at 1500 °C, 1600 °C and 1700 °C for both kinds of composites, but there is no observation about fiber pull-out. And composites with foils display relative high strength because of the almost 100 % dense matrix. However, there is no pseudo-ductile behavior when sintering temperature was increased to 1900 °C. And interfacial reaction can be observed for all composites, in which fibers in 1900 °C sintered composites were completely damaged.

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