Effect of Er_2O_3 interphase on SiC fiber reinforced W composites

*Yina Du[1], and Tatsuya Hinoki[1]
[1]Kyoto University

Abstract (approx. 55words)
Er_2O_3 with or without C were used to protect the SiC fiber from the reactions with W in SiC_f/W composite. And the results show limited reaction zone can be observed in the composite with only Er_2O_3, but the pseudo ductile behavior is not obvious due to the strong interface between Er_2O_3 and SiC fiber. While for composites with C, weak interface can be obtained.

Keywords: composite, toughening, diffusion barrier, SiC fiber, tungsten, Er_2O_3

1. Introduction

To ameliorate the brittleness of W, SiC fiber was selected as reinforcement to improve its toughness, because of high strength at high temperature, and the close coefficients of thermal expansion between W (4.6×10-6 /°C, RT) and SiC (4.7×10-6 /°C, RT). However, severe interfacial solid-state reactions happened after high temperature sintering, generating carbides and silicides. Then, the damaged SiC fiber and generated ceramic phases will deteriorate its thoughness. And the lower content of W cuased the low thermal conductivity of composites. Therefore, an effective diffusion barrier is very essential for SiC and W composites. Er_2O_3 was selected as diffusion barrier in this work.

2. Experiment

SiC fiber reinforced W composites diffusion barrier were fabricated In this work. And the diffusion barriers were only Er_2O_3, Er_2O_3 with carbon black powder, or C layer formed by phenolic resin coated firstly then only Er_2O_3 respectively, in which Er_2O_3 slurry were infiltrated in fibers. Then the slurry filled fiber was dried at room temperature. Subsequently, the coated fibers and 0.08 thick W foil were cut to the size of 40×40 mm^2. Then they were stacked together and hot-pressed at 1700 °C for 1 h under a pressure of 20 MPa in Ar atmosphere. Tensile tests were carried out at room temperature to evaluate mechanical performance of the sintered composites. The geometry of testing bar is 1.5×3×40 mm^3. And all surfaces were polished before tensile test. Microstructure was examined by scanning electron microscopy (SEM).

3. Conclusion

Diffusion barrier to prevent the reactions and the interface to deflect the cracks in composite is mutually exclusive, and similar phenomenon can be found in this work. In the composite with only Er_2O_3 as diffusion barrier dominates in the composite, revealing that the thickness of reaction zone reduced a lot compared with composites without diffusion barrier, but only limited pseudo ductile behavior can be found according to the stress-strain curve because of the strong interface between fiber and Er_2O_3. Then C was used to get the weak interface between of fiber and Er_2O_3, in which carbon black powder or C by phenolic resin were used. And the results show C/Er_2O_3 composite can obtain more pseudo ductility than other composites, while with low strength. Besides, short fiber pull-out behavior can be observed. But for both composites with C, the thickness of reaction zone is a little thicker than composite with only Er_2O_3. Besides, almost no silicides were generated. Therefore, it is meaningful to use C for weak interface to acquire the pseudo ductility and Er_2O_3 as the diffusion barrier to impede the reaction, but the most suitable thickness need to be further studied.