

Densification, Creep and Oxidation Behavior of ZrB₂-SiC Based Ultra-High Temperature Ceramic Composites

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ABSTRACT

ZrB₂-SiC composites are candidate materials for use in thermal protection systems for leading edges and nose-cones of hypersonic vehicles. Densification of ZrB₂ is considered challenging, because of its covalent bonding, which is responsibility for sluggish rate of lattice diffusion. It has been noticed that addition of 20 vol% SiC not only improves the creep and oxidation resistance in air by formation of a protective scale borosilicate glass, but also densification by inhibiting grain growth. Whereas densification and oxidation resistance are improved by addition of Si₃N₄, creep resistance is adversely affected due to increased grain boundary sliding. Further, the oxide scale evolved during creep at 1300°C is found to be thicker than that developed by isothermal exposure for similar duration. Furthermore, it has been observed that the use of additives like B₄C and C along with LaB₆ aid in densification by reduction of interfacial impurity oxides, which promote grain growth. Investigations on the ZrB₂-SiC composites with 7, 10 and 14 vol% LaB₆ have shown that both densification and oxidation resistance scale with the amount of LaB₆ due to its role as oxygen scavenger and formation of protective scale, respectively. It has been observed that dislocation creep has been found to have a significant role in densification of the ZrB₂-SiC-LaB₆ composites. Further, the creep of the ZrB₂-SiC-LaB₆ composites at 1300°C appears to be controlled by grain boundary diffusion for the composites with 7 or 10 vol% LaB₆, and by dislocation glide for that with 14 vol% SiC. The difference between the operating mechanisms of creep is found to be related to the purity of the ZrB₂ matrix grain boundaries as well as ZrB₂-SiC interfaces.

