Grain-Boundary Grooving of 7 wt% Yttria-Stabilized Zirconia Thermal Barrier Coatings

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Abstract

Thermal barrier coatings (TBCs) were studied to determine the mechanisms responsible for the microstructural changes that occur with annealing at temperatures within the normal operating range of heat engines (800°-1400°C). Mullins' thermal grooving theories were applied to the plasma-sprayed 7 wt% Y_2O_3-ZrO_2 TBCs to determine the dominant mass transport mechanism as a function of annealing temperature. Grain-boundary groove widths were measured using atomic force microscopy. The same collection of grains was analyzed after progressive heat treatments. Surface diffusion was found to be the dominant diffusion mechanism at 1000°C, corresponding to the disappearance of interlamellar cracks at that temperature. At 1100°C, both surface and volume diffusion were active. Volume diffusion, found to be the dominant diffusion mechanism at 1200°C and above, was responsible for the sintering of interlamellar pores observed from AFM analysis of a single, progressively heat-treated interlamellar boundary.