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Surface cracking behavior and its influence on interfacial delamination of thermal barrier coating

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ABSTRACT

Thermal barrier coating (TBC) is widely used to lower the temperature of turbine blades and prevent the premature failure of superalloy substrates. Horizontal and vertical cracks play key roles in the thermal durability of TBC. It is believed that the surface cracks, which form perpendicular to the substrate surface, have a promising potential to improve the thermal life of TBC by increasing coating tolerance to thermal mismatch stresses. In contrast, as the density of horizontal cracks, especially the interfacial delamination increases TBC life decreases and TBC generally fails by coating spalling. This study aims to identify the surface cracking behavior of TBC and its influence on interfacial delamination. Multiple cracking behaviors in a thin elastic film bonded to a thick elastic substrate are firstly investigated by varying the morphology of segmentation cracks. Then, the effect of periodic surface cracks on the interfacial fracture is studied. It is found that surface crack spacing has significant effect on the initiation and propagation of interfacial delamination. A critical value is obtained based on the dependence of energy release rate on the surface crack density. The failure mechanisms of an advanced double-ceramic-layer TBC are also examined. It is found that the interface between two ceramic layers may directly influence the lifetime of TBC.