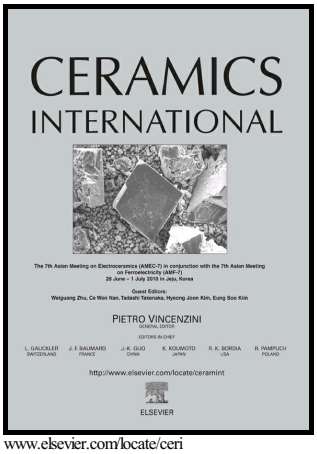

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Effect of oxide growth on the stress development in double-ceramic-layer thermal barrier coatings

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Abstract

A numerical study is conducted to investigate the effect of oxide growth on the stress development within the plasma sprayed double-ceramic-layer thermal barrier coatings. The roles of oxide morphology, growth rate, and oxidation duration are discussed. A two-dimensional periodical unit-cell model is developed, taking into account the different interfacial roughnesses among the coatings layers. Thermal gradient conditions are imposed during the high-temperature period to represent the non-uniform temperature distributions throughout the coatings thickness. It is found that stresses in the regions that close to the interface of the ceramic layers result from the thermal expansion mismatch and the non-uniform temperature field, in which the oxide growth reveals negligible influence on the development of the stresses. The gradually thickening thermally grown oxide (TGO) mainly contributes to the variations of stress and inelastic strain evolutions in its nearby regions. The residual stress fields in the coatings are almost unaffected by the oxide thickness after operating for a sufficiently long time. During long-term operation, the large inelastic deformation is found to be the intrinsic reason responsible for the cracking in the vicinity of TGO.

Keywords: Thermal barrier coatings; Double ceramic layer; Thermally grown oxide; Stress development

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