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**Substrate-constrained effect on the stiffening behavior of lamellar thermal barrier coatings**

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**Abstract**

Thermal exposure would compromise the compliance and thermal insulating performance of thermal barrier coatings (TBCs). However, most publications were based on free-standing coatings in which the stress resulting from substrate is essentially different from TBCs on superalloy substrate. In this paper, the constrained effect of substrate on the ceramic top-coat of plasma sprayed lamellar TBCs was investigated. Results showed that the structural changes evolve from micro-scale to macro-scale during thermal exposure. In a relatively shorter thermal exposure stage, the inter-splat pores became narrowed, whereas the intra-splat cracks became widened. Consequently, the healing kinetics of inter-splat pores was much faster than that of the intra-splat cracks. In a relatively longer thermal exposure stage, some macroscale cracks appeared in coating surface owing to the gradually stiffening coatings. As a result, the microscale intra-splat cracks near the macroscale cracks were healed rapidly. In brief, the substrate constraint induced structural changes were stage sensitive.

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