The Theoretical Calculation and Numerical Simulation for Thermal Stress Generated in TGO Subjected to Cycled Thermal-Mechanical Loading

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Abstract: The thermal growth stress in thermal growth oxide (TGO) is a key factor leading to failure of thermal barrier coating system (TBCs). Based on the Fecralloy metal rectangular thin plate model, the stress and strain in the oxidation process of TGO in TBCs without initial defect under thermodynamic coupled cyclic loading were analyzed by using the circumferential stress theory, and then the thermal growth stress in TGO was analyzed and calculated by substituting the relevant material parameters. In order to verify the correctness of the theoretical analysis, a finite element model of metal rectangular thin plate was established. In the process of finite element simulation, the material properties transformation from layer of material by layer material with time step under thermodynamic coupled cyclic loading is realized by the idea of material attribute conversion. The dynamic continuous growth of TGO was simulated. The thermal growth stress of TGO was obtained by simulating the dynamic growth process of TGO, and the theoretical results were compared with the simulation results. The results show that the theoretical results are in good agreement with the simulation results, and the correctness of the theoretical analysis was proved. The results can provide a theoretical reference for the failure analysis and fatigue life prediction of the defective thermal barrier coating system.

Keywords: TGO; Thermodynamic; Thermal Growth Stress in TGO; Circumferential Stress