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Effect of Material Properties on Residual Stress Distribution in Thermal Barrier Coatings

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Abstract: Residual stress has a significant influence on the crack nucleation and propagation in thermal barrier coatings (TBC) system. In this work, the residual stress in the air plasma spraying (APS) TBC system during cooling process was numerically studied, and the influence of the material properties of each layer on the residual stress was investigated. The morphologies of the interface were described by a piecewise cosine function, and the amplitude for each segment gradually increases. The elasticity, plasticity and creep of top coat (TC), thermally grown oxide (TGO) layer and bond coat (BC) were considered and the elasticity and creep of the substrate layer were taken into account. The material properties of all layers vary with temperature. The results show that the material properties have complex influence on the residual stress during cooling. The effect of the material properties of TC and BC on the residual stress at the interface is relatively large, and that of TGO and substrate is relatively small. These results provide important insight into the failure mechanism of air plasma spraying thermal barrier coatings, and important guidance for the optimization of thermal barrier coating interfaces.

Key words: Thermal barrier coating; Residual stress; Finite element method; Material property

1. Introduction

In order to improve the fuel efficiency and thrust ratio of the aero-engine, the

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