SM9S_12492

XXI International Congress of Theoretical and Applied Mechanics
Warsaw, Poland, August 15–21, 2004

# Creep Deformation in Thermal Barrier Coatings due to the Effect of Thermal Growth Oxidation and Temperature Gradient

**Y.C. Zhou**, D. Wu

*Xiangtan University, Hunan, China*

Thermal barrier coatings (TBCs) have been utilized in order to increase the turbine inlet temperature and hence increase the efficiency of turbine engines. Due to the fact that the TBCs system was working at high temperature, a thermal growth oxidation(TGO) would form at the interface of top ceramic coating and bond coat and the deformation of the TBCs system would be creep. The creep deformation and TGO, especially their nonlinear effect would induce the failure of the TBCs. In the paper, the creep deformation in thermal barrier coatings due to the effect of thermal growth oxidation and temperature gradient were theoretically and experimentally studied. In the theoretical investigation, the residual stress in the thermal barrier coating due to the effect of creep deformation and thermal growth oxidation at the condition of temperature gradient along the thickness direction of TBCs were analytically obtained for a plane rectangle sample. It was found that the temperature gradient and TGO have great effect on the residual stress. In some cases, the residual stresses in ceramic coating are compressive, but in other cases the residual stress are tensile. As we know, the failure mode is very different for different residual stresses. For compressive residual stresses, the ceramic coating would fail due to the buckling of the ceramic coating, however, for tensile residual stresses, the ceramic coating would fail due to the surface crack in the ceramic coating. In the paper, we obtained the failure map in the general space of ceramic surface temperature, the substrate surface temperature and heating time. In the experiment, the samples were heated in high temperature furnace at different temperature and with different time. In this case, the uniform high temperature in TBCs reduced the formation of thermal growth oxidation at the interface of top ceramic coating and bond coat and the thickness was measured by three methods. The oxidized and non-oxidized samples were again heated by a laser beam and in this case there was a high temperature gradient along the thickness direction of TBCs. It was found that the failure modes would be surface crack or interface crack for different thickness TGO and different temperature gradient. The experimental results were good agreement with the theoretical results. Key Words thermal barrier ceramic coating, thermal growth oxidation, creep deformation, residual thermal stress, temperature gradient.

View the extended summary