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Lifetime Assessment and Shock Behavior of TBC in Gas Turbine Blades: Experimental and Numerical Investigations

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Thermal Barrier Coatings (TBCs) are multi-layer protective coatings used in the hot section components such as combustor and turbine of advanced gas turbine engines to protect them from degrading affects of hot gases. Due to lack of a reliable life time assessment, the potential of these coatings cannot be fully used. Understanding the damage mechanisms of thermal barrier coatings is the key factor to increase durability and reliability.
In this study, thermal shock behavior of the thermal barrier coating system of gas turbine engine's turbine blade of the space and aircrafts is evaluated. Thermal shock behavior of the thermal barrier coating system was investigated. Computer aided thermal and crack growth analyses were carried out with the help of the taken information. Thermal barrier coating system consists of stainless steel substrate, ytria stabilized zirconia (%8 YSZ) ceramic top coat and NiCrAlY bond coat and Plasma Spray Method was used for the coatings. Damages occurred in specimens were figured out by the cycle numbers, thermal stresses and heating time. With the help of experiments, stress analyzes of modeled TBC were performed. The crack profiles and crack growth rates determined. Finally the coating life was appointed. In the experiments, the number of cycles depending on the amount of crack growth and crack profile is determined. At the end of 1500 cycles, the crack moving 1mm from the edge toward the center of the specimen, at 1750 cycles the crack length of 1.5 mm, at 2000 cycles, the crack length reached 2.5 mm was determined. Analysis of estimated life cycle, at the end of 1500 cycles, the crack moving 1mm from the edge toward the center of the specimen, at 1750 cycles the crack length of 1.45 mm, at 2000 cycles, the crack length reached 2.6 mm was calculated. Comparison of the results of Finite Element Method (FEM) with the corresponding experimental results has been showed in good agreement.

Keywords
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