World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:14, No:03, 2020

Modelling the Tensile Behavior of Plasma Sprayed Freestanding Yttria Stabilized Zirconia Coatings

Authors : Supriya Patibanda, Xiaopeng Gong, Krishna N. Jonnalagadda, Ralph Abrahams

Abstract : Yttria stabilized zirconia (YSZ) is used as a top coat in thermal barrier coatings in high-temperature turbine/jet engine applications. The mechanical behaviour of YSZ depends on the microstructural features like crack density and porosity, which are a result of coating method. However, experimentally ascertaining their individual effect is difficult due to the inherent challenges involved like material synthesis and handling. The current work deals with the development of a phenomenological model to replicate the tensile behavior of air plasma sprayed YSZ obtained from experiments. Initially, uniaxial tensile experiments were performed on freestanding YSZ coatings of ~300 µm thick for different crack densities and porosities. The coatings exhibited a nonlinear behavior and also a huge variation in strength values. With the obtained experimental tensile curve as a base and crack density and porosity as prime variables, a phenomenological model was developed using ABAQUS interface with new user material defined employing VUMAT sub routine. The relation between the tensile stress and the crack density was empirically established. Further, a parametric study was carried out to investigate the effect of the individual features on the non-linearity in these coatings. This work enables to generate new coating designs by varying the key parameters and predicting the mechanical properties with the help of a simulation, thereby minimizing experiments.

Keywords : crack density, finite element method, plasma sprayed coatings, VUMAT
Conference Title : ICAMAME 2020 : International Conference on Aerospace, Mechanical, Automotive and Materials Engineering
Conference Location : Paris, France
Conference Dates : March 26-27, 2020