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PROCEEDINGS

Analysis of Thermomechanical Delamination Mechanisms in Segmented High-Temperature Protective Coatings and Design Maps for the Durable Coatings

Biao Li[1,*]

[1]School of Aeronautics, Northwestern Polytechnical University, Xi'an, 710072, China
[*]Corresponding Author: Biao Li. Email: libiao@nwpu.edu.cn

ABSTRACT

Protective coatings play a crucial role in preserving high-temperature engineering components from environmental degradation [1-3]. The durability of these coatings is crucial for maintaining the structural integrity of the components. Introducing a segmented microstructure was recognized as an effective strategy for enhancing the strain tolerance of coatings by mitigating the in-plane stiffness of the coatings, thereby alleviating interface stresses and delamination driving forces. While previous studies on delamination mechanisms in high-temperature protective coatings have predominantly focused on either pure mechanical loading or pure thermal loading conditions (i.e., residual stress) due to their ease of implementation, the combined influence of both loads remains relatively unexplored. This work systematically studies delamination problems in segmented multilayered high-temperature coatings subjected to thermomechanical loadings using computational fracture mechanics [4]. A representative unit cell model is introduced, which is used to analyze coatings over a broad range of material properties, geometries, and loads. The findings suggest that, for a given coatings system, the mechanical load carried by the top-coat layer is the only force driving delamination along the top-coat/bond-coat interface. A mathematical model is established using combined multiple regression analyses and the design of experimental method to evaluate the delamination driving forces and rank the importance of various influential factors. Design maps are constructed to facilitate the development of durable coatings.

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