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DD3 单晶粘塑性损伤本构模型研究

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STUDY ON DAMAGE COUPLED VISCOPLASTIC CONSTITUTIVE MODEL FOR DD3 SINGLE CRYSTAL

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摘要

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摘要

介绍了建立DD3单晶高温合金本构模型的理论 and 过程, 详细推导了DD3单晶损伤演化方程, 简要分析了模型的组成和特点。简单讨论了模型材料常数的标定方法, 具体标定了950℃下的模型材料常数。给出了模型的预测结果和试验结果的对比曲线, 从中看出, 该模型能够较准确地描述DD3单晶的力学行为特点, 可望用于单晶叶片的结构分析。

关键词: DD3单晶 粘塑性 损伤演化 本构模型

Abstract:

An introduction is given to the theories and procedure used for the development of DD3 single crystal constitutive model which is damage coupled, elastoviscoplastic and macroscopically anisotropic. A detailed deduction, which is based on the continua damage mechanics, is presented for the damage evolution equation of DD3 single crystal. The model composition and their characteristics, with meaningful model constants from engineering viewpoint, are analyzed. The model has a potential of concurrent accounting for creep damage, plastic damage and their interaction due to the special damage evolution equation. The definition methodologies of the model material constants are summarized. The model material constants for 950℃ are practically defined according to available test results. Some simulations are carried out to demonstrate the model and to understand the model's predictive ability. The simulations of the model to test results of various mechanical behavior show that the model is able to predict mechanical behavior of DD3 single crystal to a certain degree of accuracy and suitable for structural analysis of DD3 single crystal turbine blade.

Keywords: DD3 single crystal viscoplasticity damage evolution constitutive model

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