复合材料学报 2010, 27(3) 43-49 DOI: ISSN: 1000-3851 CN: 11-1801/TB

论文

内置高温热管C/C复合材料热防护结构热力耦合机制

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摘要：

采用内置高温热管的热防护结构是一种新型高效的热防护方式。建立了内置高温热管的C/C 复合材料热防护结构模型, 并通过罚函数的方法引入C/C 复合材料与高温热管间装配关系, 推导了一种顺序耦合的热力耦合有限元格式, 在此基础上对热防护结构进行了热力耦合计算分析, 最后对影响结构温度场与应力场的若干参数进行了参数影响分析。计算结果表明, 在典型飞行状态下, 采用内置高温热管的C/C 复合材料热防护结构能确保结构驻点温度在材料许用温度范围内; 同时, 采用预留装配间隙的方法可有效降低结构界面的接触应力。该方法也可进一步用于研究由接触热阻引起的热力耦合问题。

关键词： C/C 复合材料 热防护 高温热管 热力耦合

Mechanism of thermomechanical coupling of high temperature heat pipe cooled C/C composite material thermal protection structure

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Abstract:

To use heat pipe cooled thermal protection structure (TPS) is a noval efficient thermal protection method. A model of the heat pipe cooled C/C composite TPS was established herein, where the assembly relationship of the C/C composite material and the heat pipe was int roduced by the penalty method, and a finite element algorithm of the thermomechanical analysis by using the sequential coupling method was also developed. Based on the numerical method, the thermomechanical coupling and parametric analysis had been implemented. The numerical results show that, under the typical flying condition, the heat pipe cooled C/C composite TPS can make sure that the stagnation temperature is in the tolerance zone. The contact stress can be greatly reduced by allocating initial gap between the heat pipe and the thermal structure. The present method can also be used to investigate the thermomechanical coupling problems caused by thermal contact resistance.

Keywords: C/C composite material thermal protection high temperature heat pipe thermomechanical coupling

收稿日期 2009-06-17 修回日期 2009-11-17 网络版发布日期

DOI:

基金项目:

国家自然科学基金(10872104)

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