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### 重复使用飞行器金属热防护系统的有限元分析与设计

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### Analysis and Design of Metallic Thermal Protection Systems for Reusable Launch Vehicle

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摘要

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**摘要** 金属基热防护系统具有轻质、耐用、可操作性、成本高效等特点,是实现降低重复使用飞行器费用的一个关键技术。通过比较分析超耐热合金防热板和改进型防热板,给出了金属热防护系统的各个部分的设计准则。建立了蜂窝夹芯板和纤维隔热毡的有效热导率的数值预报模型,算例研究表明本文给出的数值预报方法正确。使用二维热分析模型和三维承载分析模型,实现了传热和承载分析的迭代计算,算例表明迭代方法有效、可行,可用于可重复使用飞行器金属热防护系统的分析与评价。

**关键词:** 金属热防护系统 有效热导率 迭代分析 设计准则

**Abstract:** Metallic thermal protection system is not only lightweight, but also durable, operable as well as cost effective, so it is a key technology for reducing the cost of reusable launch vehicle. The designing rules for primary components of Metallic Thermal Protection System (TPS) are given by comparing and analyzing the difference of superalloy honeycomb TPS panel and improved TPS panel. A numerical model was developed to predict the effective conductivities of the honeycomb sandwich panel and fibrous insulation, and example demonstrates the accuracy of the method. An iterative analysis alternating between thermal and structural analyses is completed using two-dimensional thermal model and three-dimensional structural model. The numerical examples show that the iterative method is effective and performable and it can be used to analyze and evaluate the metallic TPS for reusable launch vehicles.

**Keywords:** metallic thermal protection system (TPS) effective conductivities iterative analysis design guideline

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