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ANALYSIS AND TEST RESULTS ON HEAT INSULATION PERFORMANCE OF LIGHTWEIGHT THERMAL PROTECTION STRUCTURE

Abstract

During the suborbital high-speed flight, the thermal protection system was subjected to severe aerodynamic heating. The thermal protection system needed to meet the requirements of thermal insulation performance, and the corresponding quality and space constraints should be satisfied. Based on the engineering requirements, this paper designed a typical lightweight thermal protection structure in the 20mm height space constraints, the thermal characteristics of the different structural scheme were analyzed by using finite element analysis software ABAQUS, the typical flight environment was simulated by ground thermal test, whose aim was to study the thermal insulation performance of engineering feasible scheme. The lightweight thermal protection structure designed in this paper mainly included super nanometer thermal insulation material layer, reflective screen and C/SiC thermal protection layer. The results showed that, in a certain space constraint scope, there was a certain difference between the surface reflection screen of super nanometer thermal insulation material and the effect of different thickness cavity on the thermal insulation performance of lightweight thermal protection structure. In theory, there was an optimal thickness composite structure range of cavity and nanometer thermal insulation layer, and engineering feasibility was also considered in practical application. The simulation results of the finite element software in this paper were basically consistent with the results of ground test, and the results were of high reference value for the design and optimization of similar lightweight thermal protection structures.