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ANISOTROPIC HEAT-SHIELDING MATERIALS BASED ON GLASS CARBON AND PYROLYTIC GRAPHITE: EVALUATION OF EFFECTIVENESS IN CASE OF A RE-ENTRY MODULE OF A LUNAR PROBE

Abstract

Unlike orbital spacecraft, a reentry module for an lunar probe would approach the Earth atmosphere at near-parabolic velocity. Therefore it experiences intense heat along the atmospheric part of its trajectory.

As the thermal load distribution around the module's surface is not uniform and the heat transfer properties of the traditional heat shield materials are low, in the areas where the heat load is the greatest, spots where temperatures exceed the material's maximum temperature limits may appear. That could destroy the device's heat shield coating. That is natural for ablating heat shield coatings that worked well for orbital and lunar expeditions. Obviously, speaking generally, preserving integrity of heat shield coating structures increases reliability of the spacecraft in question.

One of the ways to reduce the negative impact of intense local heat on heat shield coating function is to use materials with high heat transfer anisotropy or anisotropic heat shield materials. High tangential heat transfer capacity of those materials enables them to re-distribute thermal energy coming from the shell's outer surface, in a more uniform way throughout the entire anisotropic layer.

This paper presents thermal strength analysis for the lunar probe reentry module's anisotropic heat shield coating. A material with anisotropic glass carbon matrix and anisotropic pyrolytic graphite inclusions was selected as heat shield. A bilateral assessment of the material's characteristics depending on temperature and volume fraction of components is presented.