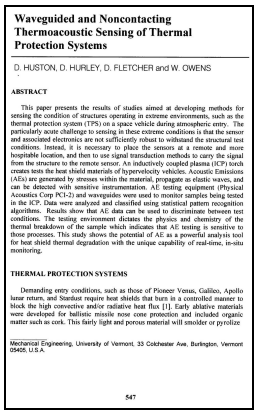

Waveguided and Noncontacting Thermoacoustic Sensing of Thermal Protection Systems

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ABSTRACT

This paper presents the results of studies aimed at developing methods for sensing the condition of structures operating in extreme environments, such as the thermal protection system (TPS) on a space vehicle during atmospheric entry. The particularly acute challenge to sensing in these extreme conditions is that the sensor and associated electronics are not sufficiently robust to withstand the structural test conditions. Instead, it is necessary to place the sensors at a remote and more hospitable location, and then to use signal transduction methods to carry the signal from the structure to the remote sensor. An inductively coupled plasma (ICP) torch creates tests the heat shield materials of hypervelocity vehicles. Acoustic Emissions (AEs) are generated by stresses within the material, propagate as elastic waves, and can be detected with sensitive instrumentation. AE testing equipment (Physical Acoustics Corp PC1-2) and waveguides were used to monitor samples being tested in the ICP. Data were analyzed and classified using statistical pattern recognition algorithms. Results show that AE data can be used to discriminate between test conditions. The testing environment dictates the physics and chemistry of the thermal breakdown of the sample which indicates that AE testing is sensitive to those processes. This study shows the potential of AE as a powerful analysis tool for heat shield thermal degradation with the unique capability of real-time, in-situ monitoring.

THERMAL PROTECTION SYSTEMS

Demanding entry conditions, such as those of Pioneer Venus, Galileo, Apollo lunar return, and Stardust require heat shields that burn in a controlled manner to block the high convective and/or radiative heat flux [1]. Early ablative materials were developed for ballistic missile nose cone protection and included organic matter such as cork. This fairly light and porous material will smolder or pyrolize

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Ключевые слова:

Содержание.