National Aeronautics and
Space Administration

Aeronautics

HEAT Sensor for Thermal Protection Systems

Isotherm tracking and char measurement in ablative materials

This invention is an ablation sensor for a thermal protection system of a spacecraft experiencing atmospheric re-entry. The Hollow aErothermal Ablation and Temperature (HEAT) sensor provides a mean for evaluating in-depth material thermal response characteristics. The sensors design evolves from the Analog Resistance Ablation Detector (ARAD) used in the NASA Galileo heat shield. The HEAT sensor is part of the instrumentation suite installed and flown in the heat shield of the Mars Science Laboratory entry vehicle. The acquired data supports future NASA entry and aerocapture missions by providing flight data on heat shield material performance for comparison with computational models. The purpose of this innovation, in comparison to the ARAD sensor, is to develop a multifunction sensor with higher performance and reliability, extend functionality and field of application, and decrease manufacturing complexity and expenses.

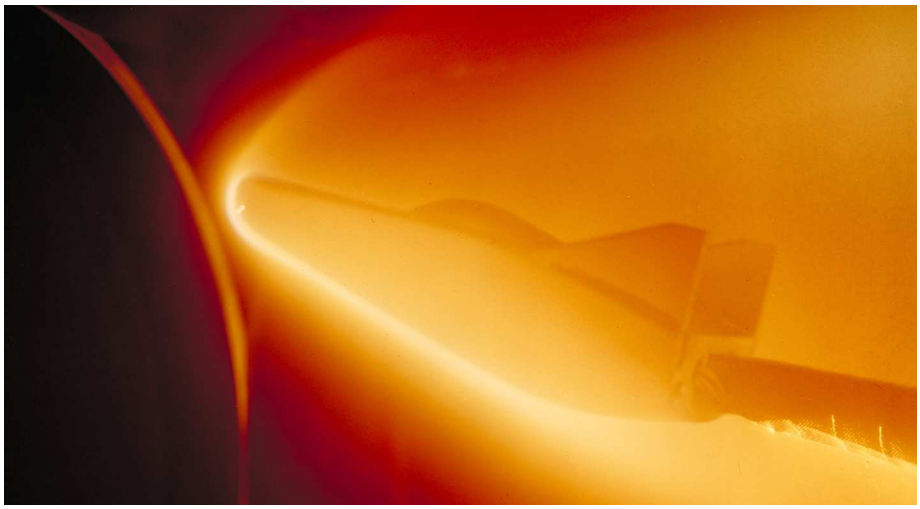
BENEFITS

- Can be implemented in any TPS material
- Reliable performance
- Low fabrication and assembly cost
- Hollow core allows installation of temperature measuring device inside the sensor

technology solution

THE TECHNOLOGY

The Hollow aErothermal Ablation and Temperature (HEAT) sensor is a multifunction sensor designed to track an isotherm by making an independent transient measurement at a defined location in the sensor that is equal to the temperature at which its constituent materials char. By this same operating principle, the HEAT sensor tracks the transient char depth progression within a thermal protection system (TPS) material. In the case of a material that sublimes (such as Teflon), or when the aerothermal environment induces steadystate ablation, the HEAT sensor measures material ablation directly. The sensor design consists of two identical resistive Pt-W wires wound around a hollow Kapton tube; the wires are electrically insulated from each other with a polyimide coating that chars at higher temperatures. The two wires are welded together at the tip of the sensor to provide an initial electrical connection. At higher temperatures, the electrical connection between the two resistive Pt-W wires is formed by the electrically conducting char. The wires become shorter as ablation proceeds, and the time history of wire resistance is continuously monitored to relate the measurement to sensor length. Another key feature is a thermocouple or other temperature measuring device which can be installed into the hollow portion of the HEAT sensor due to its extremely small size.



Heat Sensor for Thermal Protection Systems

APPLICATIONS

The technology has several potential applications:

- Manned spacecraft
- Unmanned exploration vehicles
- Ground test specimens (arc jet, propulsion tests)
- Commercial aerospace companies providing access to space
- Rocket nozzles
- Any other application where ablative materials are used

PUBLICATIONS

Patent No: 8,069,001

More Information

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