National Aeronautics and
Space Administration

# TECHNOLOGY SOLUTION

## Materials and Coatings

# A New Family of Low-Density, Flexible Ablators

Simple and versatile manufacturing approach to produce heat shields

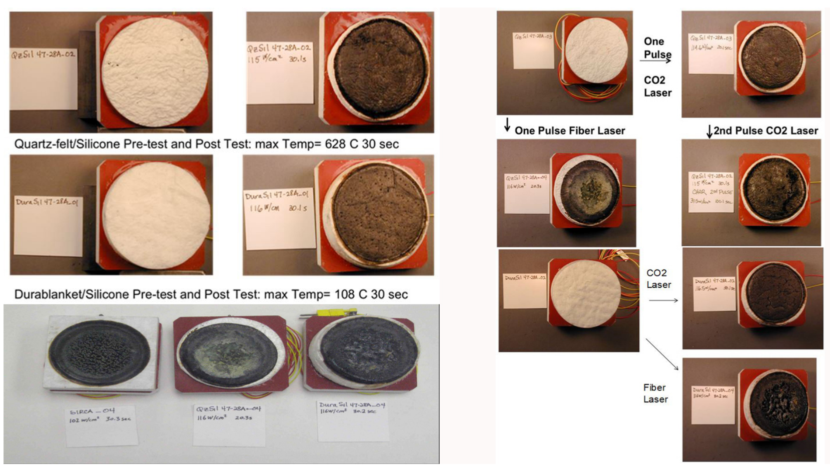
NASA has developed a method for producing a flexible, fibrous ablator thermal protection material for use on space vehicles experiencing temperatures of 1000° F (550° C) or above upon atmospheric re-entry. The flexible ablator has controllable elastic modulus and controllable flexibility to withstand a wide range of heating rates comparable to rigid ablators, such as PICA and Avcoat. A phenolic resin and/or a silicone resin can be used. The elastic modulus of the resulting material is low, in a preferred range of about 200-5000 kPa, and can be controlled by choice of a curing temperature and/or a time interval length for curing.

### BENEFITS

- Simple and versatile manufacturing, machining and attachment methods
- Withstand a wide range of heating rates
- Potentially lower lifecycle cost compared to rigid TPS
- The amount and composition of pyrolyzing resin and fiber substrate can be readily tailored

## THE TECHNOLOGY

The invention provides a family of low density, flexible ablators comprising of a flexible fibrous substrate and a polymer resin. The flexible ablators can withstand a wide range of heating rates (40-540 Watts/cm2) with the upper limit of survivable heat flux being comparable to the survivable heat flux for rigid ablators, such as PICA and Avcoat. The amount and composition of polymer resin can be readily tailored to specific mission requirements. The material can be manufactured via a monolithic approach using versatile manufacturing methods to produce large area heat shields, which provides a material with fewer seams or gaps. The goals of the work are primarily twofold: (i) to develop flexible, ablative Thermal Protection System (TPS) material on a large, blunt shape body which provides aerodynamic drag during hypervelocity atmospheric entry or re-entry, without perishing from heating by the bow shock wave that envelopes the body; and (ii) to provide a relatively inexpensive TPS material that can be bonded to a substrate, that is unaffected by deflections, by differences in thermal expansion or by contraction of a TPS shield, and that is suitable for windward and leeward surfaces of conventional robotic and human entry vehicles that would otherwise employ a rigid TPS shield. This technology produces large areas of heat shields that can be relatively easily attached on the exterior of spacecraft.




Array of photos contrasts the surface before and after different radiation exposures Left Bottom: Fiber Laser response of three SIRCA type family materials: Silica/ Ceramic fiber with Silicone resin

## APPLICATIONS

The technology has several potential applications:

- Space exploration
- Systems engineering
- Thermal Protection Systems
- Materials engineering
- Mechanical engineering

## PUBLICATIONS

Patent No: 10,752,386

https://arc.aiaa.org/doi/10.2514/6.2011-2511

https://ntrs.nasa.gov/citations/20140004894

## More Information

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**Ames Research Center**

MS 202A-3
Moffett Field, CA 94035
202-358-7432
Agency-Patent-Licensing@mail.nasa.gov

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