Surface Densification Of Phenolic Impregnated Carbon Ablator (PICA)

Modification of Surface Density of a Porous Medium

This technology from NASA allows a graded-surface densification of Phenolic Impregnated Carbon Ablator (PICA). PICA was developed at NASA Ames Research Center in the 1980s for the forebody heatshield of the Stardust Return Capsule. With a low density (~0.27g/cm), coupled with efficient ablative capability at high heat fluxes, PICA became an enabling technology for the Stardust mission. At the time of the mission, PICA was a developmental material, with no previous flight heritage. For missions with high heat flux, a lower overall mass can be obtained if the Thermal Protection System (TPS) composition changes from a carbon-based ablator at the heated surface to an insulator near the inner surface. This new process delivers a graded surface-densification application to PICA allowing for optimized performance and TPS weight reduction. The desired surface densification is adaptable in terms of density of the applied surface treatment and depth of the surface treatment.

BENEFITS
- Much lower density than other carbon/phenolic systems
- Efficient ablative capability at high heat fluxes
- Design optimization using composite response surfaces
- Improved robustness
- Applied without having an effect on the final tolerance
- Optimization of surface densification as needed
- Allows for monolithic and multi-tile thermal protection system designs for planetary entry or re-entry heat shield applications
THE TECHNOLOGY
The graded Thermal Protection System (TPS) offers a lower density than comparable state-of-the-art TPS systems operating at similar maximum heating conditions. This approach is straightforward in terms of processing and surface-treatment application and can be applied to machine PICA materials without having an effect on the final tolerance. The process results in increased usability and handling since standard uncoated PICA is relatively weak. Surface-densified PICA provides an approach for improvements in the robustness for the baseline CEV heat shield. A graded approach eliminates the need for joints and/or bonding agents between material plies. PICA surface densification offers robust mechanical protection against transit damage, handling damage, and in-flight object damage.

APPLICATIONS
The technology has several potential applications:
- Space exploration
- Systems engineering
- Thermal Protection Systems
- Materials engineering
- Mechanical engineering

PUBLICATIONS
Patent No: 9,440,752

The technology allows efficient ablative capability at high heat fluxes