



Materials and Coatings

High Efficiency Tantalum-based Ceramic Composite (HETC) Structures

Low catalytic efficiency and high-emittance ceramic materials

NASA has developed High-Efficiency Tantalum-based ceramics (HETC) composite structures that are suitable for use in thermal protection systems. These composite structures have high-efficiency surfaces (low catalytic efficiency and high-emittance), thereby reducing heat flux to a spacecraft during planetary re-entry. These low catalytic efficiency and high-emittance ceramic materials were developed in order to increase the capability of a Toughened Uni-Piece Fibrous Insulation (TUFI)-like thermal protection system, with its high-impact resistance, to temperatures above 3000 degree Fahrenheit (F) (1650 degree Celsius.). These ceramics have been applied to various aerodynamic configurations, such as wedge, wing-leading segment and conventional tile shapes used on high-speed atmospheric entry vehicles. In addition, this family of tantalum-based ceramics exhibits low catalytic efficiency to atom recombination during exposure to high-energy dissociated hypersonic flow.

BENEFITS

- ➔ Impervious to hot gas penetration
- ➔ Survives high heat fluxes 3000 degree F. and above
- ➔ Light weight
- ➔ Low cost to fabricate and maintain
- ➔ Performs at high-efficiency during hypersonic Earth atmospheric entry
- ➔ Easier to design
- ➔ Resistant to erosion and/or impact damage
- ➔ Provides a composite insulating structure

technology solution



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THE TECHNOLOGY

The various embodiments of this technology include insulating composites capable of surviving high heating rates and large thermal gradients in the aeroconvective heating environment that entry vehicles are exposed to characteristically. The tantalum-based ceramics contain tantalum disilicide, borosilicate glass and, optionally, molybdenum disilicide. The components are milled, along with a processing aid to facilitate sintering, then applied to a surface of a porous substrate, such as a fibrous or open-pored silica, carbon, aluminosilicate, silicon carbide or silicon oxycarbide substrate, as well as other substrates of silicon/carbon compositions. Following application, the coating is then sintered on the substrate. The composite structure is substantially impervious to hot gas penetration and capable of surviving high heat fluxes.



Thermal Protection System Material Vehicle Applications

APPLICATIONS

The technology has several potential applications:

- ➔ Reentry vehicles
- ➔ Aircraft
- ➔ Spacecraft
- ➔ Turbine engines
- ➔ Race cars
- ➔ Automobiles
- ➔ Heating elements for furnaces
- ➔ Any application that require thermal protection surfaces

PUBLICATIONS

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