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NASA TECH BRIEF

Ames Research Center

Reflecting Heat Shields Made of Microstructured Fused Silica

The problem:

To develop fused-silica heat shields that are efficient reflectors of visible and near-UV radiation generated in the shock-layer of a space probe during atmospheric entry.

The solution:

Construct heat shields from selected monodisperse distributions of high-purity fused-silica particles.

How it's done:

Scattering of electromagnetic radiation is a function of the particle size of the material of construction and the uniformity of interparticle voids; for optimum scattering of a particular wavelength, particle and void sizes must be maintained at close tolerances. Ordinary slip-cast silica matrices are composed of silica particles that have a continuous and broad size-distribution, with diameters typically ranging from 60 μm down to less than 1 μm; voids which could be effective scatterers are occupied by smaller particles, and the entire matrix is permeated with silica dust. On the other hand, when silica matrices consist of selected monodisperse distributions of silica particles, or blends of monodisperse distributions, the microstructure of the fused mass has particles that present a more uniform scattering array, and reflectance is increased.

Monodisperse silica particles are prepared by the classification of continuous particle size high-purity silica slip. The continuous slip is classified into discrete particle-size ranges (e.g., 5—11, 10—20, 20—40 μm) by successive sedimentation in distilled water. The collected size fractions are dried, roasted to burn out organics, and then stored in covered containers. The powders are used to make high-solids aqueous slips; hydrochloric acid is used to regulate the pH and control the electronic double layer of the particle—solution interface. Small amounts of experimental high-purity colloidal silica are added to the slips to aid deflocculation of the silica particles and to serve as a binder. Without the 0.01-μm colloidal silica, the slip-cast configuration has almost no green strength.

The plaster molds used for casting the slips are first coated with 5 to 10 layers of 2-% ammonium alginate to retard the rapid drainage characteristic of momodisperse particles. Firing schedules are more severe than those required for continuous slip-cast silica and vary, depending on particle size, from 2 to 5 hours at 1260°C.

The density of the improved configuration is about 20 to 30 percent less than that of the continuous slip casting, but fused monodisperse silica castings have good strength; the monodisperse heat shields are better thermal insulators as well as better scatterers of radiation than are shields prepared from continuous particle size-distributions.

Notes:

1. The following documentation may be obtained from:
   National Technical Information Service
   Springfield, Virginia 22151
   Single copy price $3.00
   (or microfiche $0.95)
   Reference: NASA CR-137574 (N75-13035), High-Purity Silica Reflecting Heat Shield Development.

(continued overleaf)

2. Requests for further information may be directed to:
   Technology Utilization Officer
   Ames Research Center
   Moffett Field, California 94035
   Reference: TSP 75-10144

Patent status:

NASA has decided not to apply for a patent.

Source: William M. Congdon of
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