polysilsesquioxane cages decorated with surface amines can be co-reacted with anhydride capped polyimide/polyamic acid.

Cross-linked polyimide aerogels with their high porosity, combined with higher strength, have excellent thermal as well as sound-insulating qualities. In addition, their high specific surface area (e.g. on the order of 200–1,000 m^2/g) should make them well suited for numerous applications, including as adsorbent beds for chemical separations, and as platforms for solid-state sensors.

This work was done by Mary Ann B. Meador of Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18486-1.

Silica/Polymer and Silica/Polymer/Fiber Composite Aerogels

These materials resist compression better than pure silica aerogels do.

Lyndon B. Johnson Space Center, Houston, Texas

Aerogels that consist, variously, of neat silica/polymer alloys and silica/polymer alloy matrices reinforced with fibers have been developed as materials for flexible thermal-insulation blankets. In comparison with prior aerogel blankets, these aerogel blankets are more durable and less dusty. These blankets are also better able to resist and recover from compression — an important advantage in that maintenance of thickness is essential to maintenance of high thermal-insulation performance. These blankets are especially suitable as core materials for vacuum-insulated panels and vacuum-insulated boxes of advanced, nearly seamless design. (Inasmuch as heat leakage at seams is much greater than heat leakage elsewhere through such structures, advanced designs for high insulation performance should provide for minimization of the sizes and numbers of seams.)

A silica/polymer aerogel of the present type could be characterized, somewhat more precisely, as consisting of multiply bonded, linear polymer reinforcements within a silica aerogel matrix. Thus far, several different polymethacrylates (PMAs) have been incorporated into aerogel networks to increase resistance to crushing and to improve other mechanical properties while minimally affecting thermal conductivity and density.

The polymethacrylate phases are strongly linked into the silica aerogel networks in these materials. Unlike in other organic/inorganic blended aerogels, the inorganic and organic phases are chemically bonded to each other, by both covalent and hydrogen bonds. In the process for making a silica/polymer alloy aerogel, the covalent bonds are introduced by prepolymerization of the methacrylate monomer with trimethoxysilylpropylmethacrylate, which serves as a phase cross-linker in that it contains both organic and inorganic monomer functional groups and hence acts as a connector between the organic and inorganic phases. Hydrogen bonds are formed between the silanol groups of the inorganic phase and the carboxyl groups of the organic phase. The polymerization process has been adapted to create interpenetrating PMA and silica-gel networks from monomers and prevent any phase separations that could otherwise be caused by an overgrowth of either phase.

Typically, the resulting PMA/silica aerogel, without or with fiber reinforcement, has a density and a thermal conductivity similar to those of pure silica aerogels. However, the PMA enhances mechanical properties. Specifically, flexural strength at rupture is increased to 102 psi (≈ 0.7 MPa), about 50 times the flexural strength of typical pure silica aerogels. Resistance to compression is also increased: Applied pressure of 17.5 psi (≈ 0.12 MPa) was found to reduce the thicknesses of several composite PMA/silica aerogels by only about 10 percent.

This work was done by Danny Ou, Christopher J. Stepanian, and Xiangjun Hu of Aspen Aerogels, Inc., for Johnson Space Center. Further information is contained in a TSP (see page 1).

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

Aspen Aerogels, Inc.
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Refer to MSC-23736-1, volume and number of this NASA Tech Briefs *issue, and the page number.*

Alumina Paste Layer as a Sublimation Suppression Barrier for $Yb_{14}MnSb_{11}$

This material can be applied to any thermoelectric couples requiring sublimation suppression.

NASA's Jet Propulsion Laboratory, Pasadena, California

Sublimation is a major cause of degradation of thermoelectric power generation systems. Most thermoelectric materials tend to have peak values at the temperature where sublimation occurs. A sublimation barrier is needed that is stable at operating temperatures, inert against thermoelectric materials, and able to withstand thermal cycling stress.

A porous alumina paste layer is suitable as a sublimation barrier for $Yb_{14}MnSb_{11}$. It can accommodate stress generated by the thermal expansion discrepancy between the suppression layer and thermoelectric materials. Sublimation suppression is achieved by filling pores naturally with YbO_2, a natural byproduct of sublimation. YbO_2 generated during the subli-