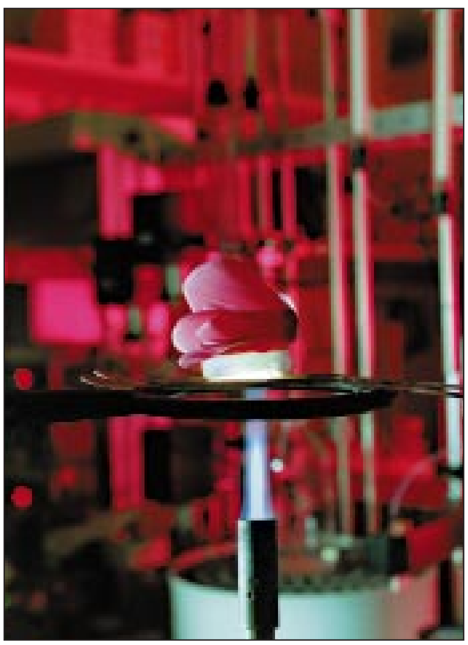
Aerogel: Working on a Clear View to the Future

It is 90-99 percent air, and if you could unfold a sugar-cube sized block of it, it would cover a basketball court. A block the size of an average human weighs only a pound, yet it can support the weight of a small car. A slab of it an inch thick can shield a human hand, or even a delicate flower, from the heat of a blowtorch and a single pane of it has the insulation equivalent of up to 30 panes of glass.



Though mostly air, Aerogel is an amazingly effective insulator.

This fascinating material is called Aerogel, and it has been cited as a "Technology to Watch" by *Fortune Magazine* because of the more than 800 product applications identified for it, ranging from surfboards to satellites. The interest in Aerogel is intense: Collaborative work is being done with Aerojet, 3M Corporation, Southern Research Institute, and Argonne National Laboratory. In addition, researchers

Space research may produce a clear Aerogel, opening the door to untold commercial applications.

at NASA Marshall Space Flight Center have provided technical information to more than 50 companies and universites including: McDonnell-Douglass, Kalwell Windows (the world's largest manufacturer of thermally insulated windows), Dynetherm (a large supplier of custom thermal insulated medical containers), Alladin Industries (a large supplier of thermal insulation for industrial use), the U.S. Navy Seals (for a thermally insulated diving fabric with Aerogel beads sewn into the lining), and Martin Industries (makers of Martin guitars, who have tight thermal shipping requirements for preserving acoustic tolerance and lacquer finish). The enormous commercial potential for Aerogel is why NASA's Space Product Development program is sponsoring research on STS-95.

Discovered by a Stanford University researcher in the 1930s, Aerogel is the lightest solid known, having a density just three times that of air. In its starting form, it is an alcohol-based gel containing silica particles and resembles a wet cube of Jell-O™. To make Aerogel, this cube has to be

Aerogel experiment training session

dried without allowing it to collapse in on itself, which is done by soaking the gel in liquid carbon dioxide and then evaporating it at high pressure. This leaves a structure of silica particles with air between them, and it is these “voids” that make it both light and a good insulator.

The problem with Aerogel currently produced on Earth is that it is hazy, resulting in the nicknames “Pet Cloud” and “Solid Smoke” for the substance. The haze comes from the different sizes of pores in the silica gel, and the creation of a clear Aerogel is described by one investigator as “the holy grail” for researchers. A clear Aerogel could be used for windows in buildings, windows in ovens, and open up a world of other opportunities. The goal of the research on STS-95 is to learn about the effects of gravity on production, so that pore size can be controlled and a clear Aerogel produced.

Microgravity reduces convection and sedimentation, and researchers believe that it may offer the chance to produce a clear Aerogel. The quiescent environment of microgravity should allow the voids, or bubbles, to be of a uniform size and distribution — making the Aerogel transparent.

Preliminary research by a team of investigators at the Marshall Space Flight Center has already been conducted, including a flight on a sub-orbital rocket. This showed an improvement in the microstructure of the material compared to ground-produced samples — and this was with only seven minutes exposure to microgravity.

The Aerogel payload will be activated early in the mission by mixing two solutions in end-facing, sealed syringes. The resulting mixture will then be allowed to gel over the course of hours to days in microgravity. While the mixing itself takes less than 30 seconds, unique technology was developed for trapping any bubbles generated in a passive mesh of coated beads. The gels will be removed from the shuttle after landing and dried using liquid carbon dioxide and high pressure. The resulting Aerogels will then be analyzed using a variety of analytical techniques, including porosity measurements and nuclear magnetic resonance imaging.

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