

## Science and Technology of Aerogels

Aerogels are excellent thermal insulators, have unique pore structures, and can be engineered into various netshapes to suit particular applications. Our research involves production of netshape aerogel articles from both polymeric substrates and silica. Of these, silica aerogels are more challenging as they do not offer desired mechanical integrity.

Efforts to crosslink networks of silica aerogels by epoxies and polyurethanes have resulted in some success at NASA and other research laboratories, but the compressive strengths of these materials are still poor. We have developed methods by which networks of aerogels can be crosslinked using silane modified polyurethanes, organic-inorganic hybrid nanoparticles, and self-crosslinkable multi-functional silanes. These have resulted in strong improvements in compressive strength. The research program has led to development for the first time, a low density shape memory aerogel composite material for potential applications in space suit and space shuttles, as depicted in the image below (Source: Randall, J. P., Meador, M. A. B., Jana, S. C\*. 2011 Tailoring mechanical properties of aerogels for aerospace applications. *ACS Appl. Mater. Interfaces*, 3, 613-626.)



The study investigates structure properties relationships, manufacturing methods, and the chemistry of crosslinking.

In addition, we are currently working on net-shape manufacturing of aerogel articles from silica and polymers. Our current project eliminates the need of batch-type, slow solvent exchange step by directly subjecting the aerogel sleeves to continuous solvent exchange. A netshape polymeric aerogel article is shown below.

