



technology opportunity

Polymer Cross-Linked Aerogels (X-Aerogels)

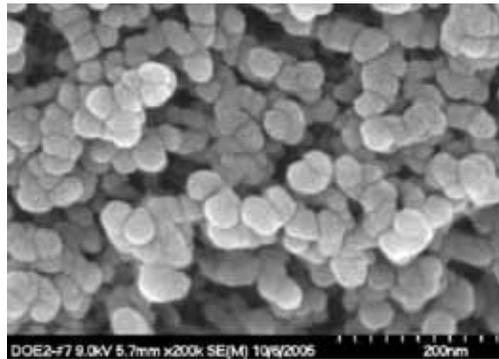
Improved environmental durability and elasticity for aerospace and terrestrial applications



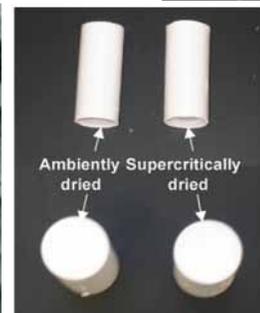
Plain silica aerogels (above left) are so fragile that they are broken by a light finger press, whereas a cross-linked aerogel supports a load (above right).



A sample (above) shows excellent recovery after being compressed twice.



The mesoporous structure is maintained after cross-linking (above).



X-Aerogels dried ambiently or supercritically maintain the same structural properties.

NASA Glenn Research Center (GRC) seeks to transfer technology for further development and production of its polymer cross-linked aerogels (X-Aerogels). These mechanically robust, highly porous, low-density materials are 3 times denser than native aerogels, but more than 100 times stronger.

Benefits

- **Improved strength:** More than 100 times stronger than conventional aerogels
- **Low thermal conductivity:** Enables application for a variety of temperature-challenging environments
- **Good optical transparency:** Some formulations offer light filtration while maintaining good insulation
- **Customizable:** Tailored chemistry enables customized polymers for specific mission requirements
- **Improved elasticity:** Maintain their shape even after repeated compression

Applications

- Thermal insulation for cryogenic containers
- Acoustic and vibration damping materials
- Ballistic impact absorbing materials
- Hose insulation
- Thermal pane skylights
- Catalytic supports
- Dielectrics for fast electronics
- Filtration membranes
- Membranes for fuel cells and batteries
- Optical sensors
- Aerospace components
- Structural components in layered or sandwich-type composites

Technology Details

How It Works

Aerogels are ultra-lightweight glass foams with extremely small pores (on the order of 10 to 50 nanometers). These materials are extremely good thermal insulators, with R values ranging from 2 to 10 times higher than polymer foams. Unlike multilayer insulation, aerogels do not require a high vacuum to maintain their low thermal conductivity and can function as good thermal insulators at ambient pressure. In addition, they are good electrical insulators and have low refractive indices—both approaching values close to air. Aerogels are also excellent vibration damping materials. Traditional aerogels, however, suffer fragility and poor environmental durability.

Researchers at NASA GRC have developed an approach to significantly improve the mechanical properties and durability of aerogels without adversely affecting their desirable properties. This approach involves coating conformally and cross-linking the individual skeletal aerogel nanoparticles with engineering polymers such as isocyanates, epoxies, polyimides, and polystyrene. The mechanism of cross-linking has been carefully investigated and is made possible by two reactions: a reaction between the cross-linker and the surface of the aerogel framework and a reaction propagated by the cross-linker with itself.

Why It Is Better

GRC's approach to creating aerogels helps sidestep the fragility and durability shortcomings of conventional aerogels, making them more desirable for both aerospace applications and commercial terrestrial applications. The resulting materials can have compressive strengths more than 100 times that of conventional aerogels, and still offer low thermal conductivities, good optical transparency, and low densities. By tailoring the aerogel surface chemistry, GRC's approach accommodates a variety of different polymer cross-linkers, including isocyanates, acrylates, epoxies, polyimides, and polystyrene—enabling customization for specific mission requirements. For example, polystyrene cross-linked aerogels are extremely hydrophobic, while polyimide versions can be used at higher temperatures. Recent work has led to the development of strong aerogels with better elastic properties, maintaining their shape even after repeated compression cycling. By tailoring the internal structure of the silica gels in combination with a polymer conformal coating, the aerogels may be dried at the ambient condition without supercritical fluid extraction.

Patents

Glenn has patented this technology (U.S. Patent No. 7,732,496).

Licensing and Partnering Opportunities

This technology is part of NASA's Innovative Partnerships Program, which seeks to transfer technology into and out of NASA to benefit the space program and U.S. industry. NASA invites companies to inquire about the licensing possibilities for the Polymer Cross-Linked Aerogels (LEW-17685-1) or for Aerogel/Composite Structures Using X-Aerogel Internal Structures (LEW-18017-1) for commercial applications.

For More Information

For information about this and other technology licensing opportunities, please visit:

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