Durable Polyimide Aerogels

Stronger and flexible, polyimide aerogels provide insulation and structural support

Innovators at NASA's Glenn Research Center have developed cutting-edge polyimide aerogel technologies that are 500 times stronger than traditional silica aerogels. These durable polyimide aerogels are highly flexible and foldable in contrast to traditional silica aerogels, which shed dust particles and are notoriously fragile and brittle. Polyimide aerogels possess remarkable strength, flexibility, and moisture resistance and make excellent "wrappable" insulators. No other aerogel possesses the compressive and tensile strength of this organic polyimide aerogel while still retaining its ability to be flexibly folded to contour to whatever shape is needed such as automotive shields, pipeline insulation, and protective clothing. Glenn's durable polyimide aerogels combine the robust nature of a polyimide network with low thermal and sound conductivity. This unique combination of strength, flexibility, and exceptional insulating properties make these aerogels ideal for insulation (thermal, electrical, and acoustic), structural elements and more - at a fraction of the weight of similar materials.

**BENEFITS**

- **Strong**: 500 times stronger than traditional silica aerogels
- **Low thermal conductivity**: 2 to 10 times improved performance over polymer foam insulation
- **Easy to produce**: Simple fabrication techniques enable lower costs
- **Flexible and lightweight**: Can be crafted into thin, lightweight films (as thin as 0.5 mm) and "wrappable" insulation
- **Robust**: Can retain physical and mechanical properties in thermally and chemically demanding environments
THE TECHNOLOGY

Aerogels are highly porous, low-density solids with extremely small pore sizes, fabricated by forming a gel from a solution in the wet-gel state that is then converted to the dry-solid state without compaction of the porous architecture. Aerogels make excellent electrical, thermal, and acoustic insulators. However, most inorganic silica aerogels are fragile and shed dust. The NASA Glenn team is the first to synthesize three-dimensional polymer aerogel networks of polyimides cross-linked with multifunctional amine monomers. Compared to silica aerogels, these aerogels retain small pore sizes and low thermal conductivities, but are distinguished by their flexibility. Polyimide aerogels are not brittle, fragile, or dusty like silica aerogels. Plus, polyimide aerogels possess the beneficial characteristics of polyimide materials. The results are cross-linked polyimide aerogels with little shrinkage, low densities, high compression and tensile strengths, and good moisture resistance. They can be fabricated or machined into net shape parts, which are strong and stiff, or cast as thin flexible films with good tensile properties. Extremely customizable, polyimide aerogels can be formed into any configuration (e.g., wrapped around a pipe, sewn into protective clothing, or molded into a panel to act as a heat shield in a car). In short, Glenn’s innovation improves the performance, adaptability, and affordability of aerogels in a broad number of applications.

APPLICATIONS

The technology has several potential applications:
- Aerospace
- Antennas
- Automotive
- Biotech (e.g., tissue engineering scaffolds)
- Chemical manufacturing (e.g., catalytic supports)
- Communications (e.g., wave guides, wire cladding)
- Filters
- High-performance sports
- Insulation
- Power (e.g., battery separators, capacitors)
- Protective gear
- Satellites
- Sensors
- Unmanned vehicles

PUBLICATIONS

Patent No: 9,309,369; 8,974,903; 9,109,088; 9,650,487; 9,434,832; 10,358,539; 10,066,073; 10,907,025; 10,723,857; 9,356,341; 10,446,920; 8,974,903

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