2.2 Durable Aerogel Technologies

Statement: New material for thermal insulation and lightweight structures, the polyimide aerogels are 500 times stronger than conventional silica aerogels. The innovation represents a revolutionary advance over fragile silica aerogels because it is highly flexible and foldable in thin film form.

Problem addressed: Aerogels are highly porous, low-density solids with extremely small pore sizes, making them superior insulators. However, most silica aerogels are fragile and shed dust particles.

Solution: The cross-linked polyimide aerogels 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, the innovation 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).

Technology description: Polyimide aerogels are synthesized by cross-linking through an aromatic triamine or polyhedral oligomeric silsesquioxane, octa-(aminophenyl) silsesquioxane, and chemically imidizing at room temperature. The result is a cross-linked polyimide aerogel that retains the beneficial characteristics and strength of polyimide materials and adds the beneficial properties of aerogels, but without the brittle and fragile nature of silica aerogels.

Benefits of the product: The new material has superior thermal and mechanical properties.

- Thin and flexible, it can be manufactured in a flexible form yet maintain excellent tensile properties.
- Strong, it is five hundred times stronger than traditional silica aerogels; thick panels can be used as multifunctional insulation.
- Versatile, it can be custom manufactured as molded shapes and thin films.
- Low thermal conductivity, 2 to 10 times improved performance over polymer foams in ambient condition and up to 30 times improved performance in vacuum conditions.
- Heat resistant up to 200 to 300°C for long-term use.
- Moisture resistant.

Areas of application: The material could be used in industry and recreation.

- Thermal insulation for refrigeration, housing, industrial pipelines, automotive, and medical supplies.
- Lightweight sandwich structures to reduce weight of automobiles and boats.
- Low dielectric materials for antennas (aircraft, cell phones, satellites, etc.)
- Filtration media for air and water purification and gas separation.
- Flexible, thin insulation for protective clothing, camping gear, and shelter applications.