Polyolefin-Based Aerogels

These aerogels can be used for thermal insulation and radiation shielding in apparel, aircraft, race car insulation, and military and recreation tents.

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An organic polybutadiene (PB) rubber-based aerogel insulation material was developed that will provide superior thermal insulation and inherent radiation protection, exhibiting the flexibility, resiliency, toughness, and durability typical of the parent polymer, yet with the low density and superior insulation properties associated with the aerogels. The rubbery behaviors of the PB rubber-based aerogels are able to overcome the weak and brittle nature of conventional inorganic and organic aerogel insulation materials. Additionally, with higher content of hydrogen in their structure, the PB rubber aerogels will also provide inherently better radiation protection than those of inorganic and carbon aerogels. Since PB rubber aerogels also exhibit good hydrophobicity due to their hydrocarbon molecular structure, they will provide better performance reliability and durability as well as simpler, more economic, and environmentally friendly production over the conventional silica or other inorganic-based aerogels, which require chemical treatment to make them hydrophobic.

Inorganic aerogels such as silica aerogels demonstrate many unusual and useful properties. There are several strategies to overcoming the drawbacks associated with the weakness and brittleness of silica aerogels. Development of the flexible fiber-reinforced silica aerogel composite blanket has proven one promising approach, providing a conveniently fielded form factor that is relatively robust toward handling in industrial environments compared to silica aerogel monoliths. However, the flexible silica aerogel composites still have a brittle, dusty character that may be undesirable, or even intolerable, in certain applications. Although the cross-linked organic aerogels such as resorcinol-formaldehyde (RF), polysioyanurate, and cellulose aerogels show very high impact strength, they are also very brittle with little elongation (i.e., less rubbery). Also, silica and carbon aerogels are less efficient radiation shielding materials due to their lower content of hydrogen element.

The present invention relates to maleinized polybutadiene (or polybutadiene adducted with maleic anhydride)-based aerogel monoliths and composites, and the methods for preparation. Hereafter, they are collectively referred to as polybutadiene aerogels. Spelocifically, the polybutadiene aerogels of the present invention are prepared by mixing a maleinized polybutadiene resin, a hardener containing a maleic anhydride reactive group, and a catalyst in a suitable solvent, and maintaining the mixture in a quiescent state for a sufficient period of time to form a polymeric gel. After aging at elevated temperatures for a period of time to provide uniformly stronger wet gels, the microporous maleinized polybutadiene-based aerogel is then obtained by removing interstitial solvent by supercritical drying. The mesoporous maleinized polybutadiene-based aerogels contain an open-pore structure, which provides inherently hydrophobic, flexible, nearly unbreakable, less dusty aerogels with excellent thermal and physical properties. The materials can be used as thermal and acoustic insulation, radiation shielding, and vibration-damping materials.

The organic PB-based rubber aerogels are very flexible, no-dust, and hydrophobic organics that demonstrated the following ranges of typical properties: densities of 0.08 to 0.255 g/cm³, shrinkage factor (raerogel/target) = 1.2 to 2.84, and thermal conductivity values of 20.0 to 35.0 mW/m-K.

This work was done by Je Kyun Lee and George Gould of Aspen Aerogels, Inc. for Johnson Space Center. Further information is contained in a TSP (see page 1).

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to: Aspen Aerogels, Inc.

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