



Improved Aerogel Vacuum Thermal Insulation

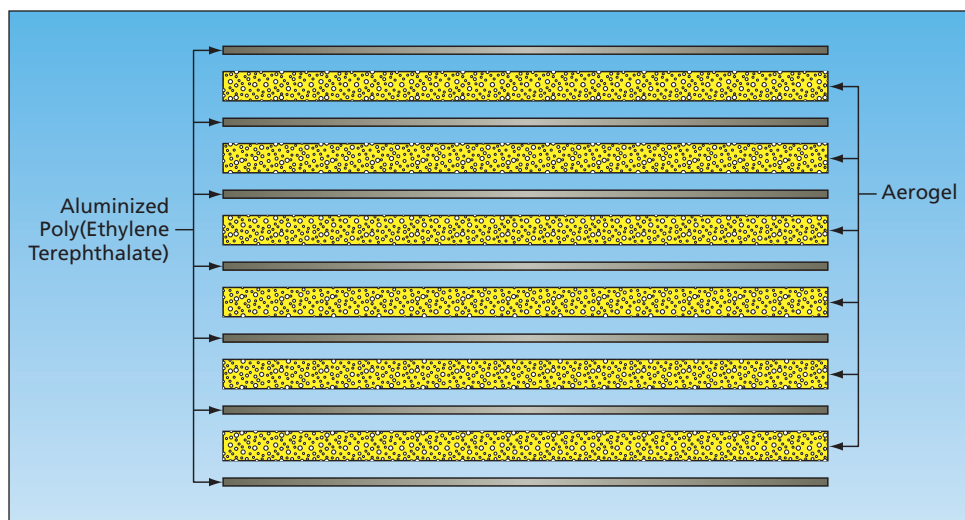
Multilayer structures offer reduced effective thermal conductivity.

Lyndon B. Johnson Space Center, Houston, Texas

An improved design concept for aerogel vacuum thermal-insulation panels calls for multiple layers of aerogel sandwiched between layers of aluminized Mylar (or equivalent) poly(ethylene terephthalate), as depicted in the figure. This concept is applicable to both the rigid (brick) form and the flexible (blanket) form of aerogel vacuum thermal-insulation panels.

Heretofore, the fabrication of a typical aerogel vacuum insulating panel has involved encapsulation of a single layer of aerogel in poly(ethylene terephthalate) and pumping of gases out of the aerogel-filled volume. A multilayer panel according to the improved design concept is fabricated in basically the same way: Multiple alternating layers of aerogel and aluminized poly(ethylene terephthalate) are assembled, then encapsulated in an outer layer of poly(ethylene terephthalate), and then the volume containing the multilayer structure is evacuated as in the single-layer case.

The multilayer concept makes it possible to reduce effective thermal conductivity of a panel below that of a compar-



An **Improved Aerogel Vacuum Insulation Panel** contains multiple layers of aerogel interspersed with layers of aluminized poly(ethylene terephthalate). The panel is shown here in the uncompressed form at an intermediate stage of fabrication. Once the interior of the panel is evacuated, exterior atmospheric pressure squeezes the layers together.

able single-layer panel, without adding weight or incurring other performance penalties. Implementation of the multilayer concept is simple and relatively inexpensive, involving only a few additional fabrication steps to assemble the multiple layers prior to evacuation. For a

panel of the blanket type, the multilayer concept, affords the additional advantage of reduced stiffness.

This work was done by Warren P. Ruemele and Grant C. Bue of Johnson Space Center. Further information is contained in a TSP (see page 1). MSC-24351-1

Fluoroester Co-Solvents for Low-Temperature Li⁺ Cells

Both low-temperature performance and high-temperature resilience are improved.

NASA's Jet Propulsion Laboratory, Pasadena, California

Electrolytes comprising LiPF₆ dissolved in alkyl carbonate/fluoroester mixtures have been found to afford improved low-temperature performance and greater high-temperature resilience in rechargeable lithium-ion electrochemical cells. These and other electrolytes comprising lithium salts dissolved mixtures of esters have been studied in continuing research directed toward extending the lower limit of operating temperatures of such cells. This research at earlier stages, and the un-

derlying physical and chemical principles, were reported in numerous previous *NASA Tech Briefs* articles.

The purpose of the present focus on high-temperature resilience in addition to low-temperature performance is to address issues posed by the flammability of the esters and, at temperatures near the upper end (about 55 °C) of their intended operating temperature range, by their high chemical reactivity. As used here, "high-temperature resilience" signifies, loosely, a desired combination of

low flammability of an electrolyte mixture and the ability of a cell that contains the mixture to sustain a relatively small loss of reversible charge/discharge capacity during storage in the fully charged condition at high temperature. The selection of fluoroesters for study as candidate electrolyte solvent components to increase high-temperature resilience was prompted in part by the observation that like other halogenated compounds, fluoroesters have low flammability.