Materials

Wider-Opening Dewar Flasks for Cryogenic Storage

Lyndon B. Johnson Space Center, Houston, Texas

Dewar flasks have been proposed as containers for relatively long-term (25 days) storage of perishable scientific samples or other perishable objects at a temperature of –175 °C. The refrigeration would be maintained through slow boiling of liquid nitrogen (LN_2). For the purposes of the application for which these containers were proposed, (1) the neck openings of commercial off-the-shelf (COTS) Dewar flasks are too small for most NASA samples; (2) the round shapes of the COTS containers give rise to unacceptably low efficiency of packing in rectangular cargo compartments; and (3) the COTS containers include metal structures that are too thermally conductive, such that they cannot, without exceeding size and weight limits, hold enough LN_2 for the required long-term-storage.

In comparison with COTS Dewar flasks, the proposed containers would be rectangular, yet would satisfy the long-term storage requirement without exceeding size and weight limits; would have larger neck openings; and would have greater sample volumes, leading to a packing efficiency of about double the sample volume as a fraction of total volume. The proposed containers would be made partly of aerospace-type composite materials and would include vacuum walls, multilayer insulation, and aerogel insulation.

This work was done by Warren P. Ruemmele of Johnson Space Center; John Manry, Kristin Stafford, and Grant Bue of Lockheed Martin Corp.; George R. Rowland, Jr., and John Krejci of Hernandez Engineering; and Bent Evernden of Rothe Joint Venture, L.P. For further information, contact the Johnson Commercial Technology Office at (281) 483-3809. MSC-23761-1

Silicon Oxycarbide Aerogels for High-Temperature Thermal Insulation

Marshall Space Flight Center, Alabama

This work has shown that the use of SOC-A35 leads to aerogel materials containing a significant concentration of carbidic species and limited amorphous free carbon. Substitution of the divalent oxide species in silica with tetravalent carbidic carbon has directly led to materials that exhibit increased network viscosity, reduced sintering, and limited densification. The SiOC aerogels produced in this work have the highest carbide content of any dense or porous SiOC glass reported in the literature at that time, and exhibit tremendous long-term thermal stability.

This work was done by Owen Evans, Wendell Rhine, and Decio Coutinho of Aspen Aerogels, Inc. for Marshall Space Flight Center. For further information, contact Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-32692-1.

Supercapacitor Electrolyte Solvents With Liquid Range Below –80 °C

New formulations extend operation into lower temperatures.

NASA's Jet Propulsion Laboratory, Pasadena, California

A previous NASA Tech Brief ["Low-Temperature Supercapacitors" (NPO-44386) *NASA Tech Briefs*, Vol. 32, No 7 (July 2008), page 32] detailed ongoing efforts to develop non-aqueous supercapacitor electrolytes capable of supporting operation at temperatures below commercially available cells (which are typically limited to charging and discharging at ≥–40 °C). These electrolyte systems may enable energy storage and power delivery for systems operating in extreme environments, such as those encountered in the Polar regions on Earth or in the exploration of space. Supercapacitors using these electrolytes may also offer improved power delivery performance at moderately low temperatures (e.g., –40 to 0 °C) relative to currently available cells, offering improved cold-cranking and cold-weather acceleration capabilities for electrical or hybrid vehicles.

Supercapacitors store charge at the electrochemical double-layer, formed at the interface between a high surface area electrode material and a liquid electrolyte. The current approach to extending the low-temperature limit of the electrolyte focuses on using binary solvent systems comprising a high-dielectric-constant component (such as acetonitrile) in conjunction with a low-melting-point co-solvent (such as organic formates, esters, and ethers) to depress the freezing point of the system, while maintaining sufficient solubility of the salt.

Recent efforts in this area have led to the identification of an electrolyte solvent formulation with a freezing point of –85.7 °C, which is achieved by using a 1:1 by volume ratio of acetonitrile to 1,3-dioxolane