

Thin Aerogel as a Spacer in Multilayer Insulation

For cryogenic space applications

Cryogenic fluid management is a critical technical area that is needed for future space exploration. A key challenge is the storability of liquid hydrogen (LH₂), liquid methane (LCH₄), and liquid oxygen (LOX) propellants for long-duration missions. The storage tanks must be well-insulated to prevent overpressurization and venting, which can lead to unacceptable propellant losses for long-duration missions to Mars and beyond.

Aspen Aerogels had validated the key process step to enable the fabrication of thin, low-density aerogel materials. The multilayer aerogel insulation (MLAI) system prototypes were prepared using sheets of aerogel materials with superior thermal performance exceeding current state-of-the-art insulation for space applications. The exceptional properties of this system include a new breakthrough in high-vacuum cryogenic thermal insulation, providing a durable material with excellent thermal performance at a reduced cost when compared to longstanding state-of-the-art multilayer insulation systems. During the Phase II project, further refinement and qualification/system-level testing of the MLAI system will be performed for use in cryogenic storage applications.

Aspen has been in discussions with United Launch Alliance, LLC; NASA's Kennedy Space Center; and Yetinspace, Inc., to test the MLAI system on real-world tanks such as Vibro-Acoustic Test Article (VATA) or the Cryogenic Orbital Testbed (CRYOTE).

Applications

NASA

- ▶ Insulation for cryotanks and cryogen transfer pipelines for ground processing
- ▶ Cryogen storage insulation for in-space applications
- ▶ Satellite thermal management
- ▶ Extravehicular activity (EVA) suits
- ▶ Internal insulation on future generations of reusable launch vehicles

Commercial

- ▶ Durable and reliable insulation systems for any cryogenic, high-vacuum, or thin and flexible applications:
 - Appliances
 - Airliner fuselage
 - Liquid natural gas fuel storage tanks and transfer lines
 - Apparel



Phase II Objectives

- ▶ Refine low-density and thin aerogel formulations
- ▶ Optimize thin aerogel scale-up process and MLAI system fabrication
- ▶ Assess MLAI prototype performance:
 - Cryostat 500 (size 8-in diameter) testing
- ▶ Large-scale testing of optimum MLAI system:
 - Cryostat 100 (2 x 4-ft size)
 - System-level testing at Ball Aerospace & Technologies Corp.

Benefits

- ▶ More durable and robust multilayer insulation system that is easy to install
- ▶ Improved process for manufacturing thin, low-density aerogel materials
- ▶ Superior thermal insulation for cryogenic applications

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