QUEST THERMAL GROUP
Innovative thermal solutions

Load Responsive MLI
PRODUCT SHEET

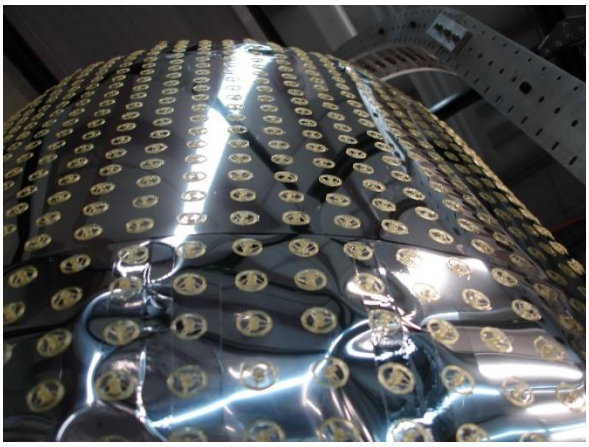
Load Responsive MLI is a dynamic structural insulation for load bearing applications.

- Dynamic load carrying insulation supports lightweight vacuum shells, embedded loads and external loads
- LRMLI offers high in-air thermal performance and outstanding in-space performance

Load Responsive MLI (LRMLI), also called Load Bearing MLI (LBMLI) by NASA, uses our proprietary dynamic Discrete Spacer. The spacer compresses under load, then disconnects when able. LRMLI supports thin lightweight vacuum shells, vapor cooled shields, MMOD ballistic layers, or external loads. LRMLI, with a lightweight metallic or composite vacuum shell, operates both in-air and in-space, and provides high thermal performance for in-space, soft-vacuum and in-air environments.

LRMLI is a SOFI replacement with significantly improved thermal performance. A 3-layer 0.25" thick LRMLI system has an in-air heat flux of 29.3 W/m^2 and 4.8 W/m^2 in-space, compared to approx. 236 W/m^2 for 0.75" SOFI.

The Quest team works closely with our clients to provide highly-customized engineering design, system analysis, fabrication and installation of our modular IMLI, LBMLI and LRMLI systems that will meet your requirements.



DIFFERENTIATORS

- LRMLI supports lightweight vacuum shells, embedded Broad Area Cooled shields, MMOD ballistic layers, and external loads.
- LRMLI supports up to 90 psi load.
- Provides low heat flux both in-air and in-space.
- 24-fold heat leak reduction compared to SOFI in-air.
- 144-fold heat leak reduction compared to SOFI in-space.
- Potential SOFI replacement for launch vehicles and cryo second stages.

APPLICATIONS

Aerospace

- SOFI replacement
- In-air cryopropellant storage
- Orbital fuel depots
- Structural load bearing (lightweight vacuum shells, cooled shields)

Commercial

- LH_2-fueled aircraft
- LH_2 infrastructure
- Cryogen storage and transport
- Superconductor cooling

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LRMLI PERFORMANCE

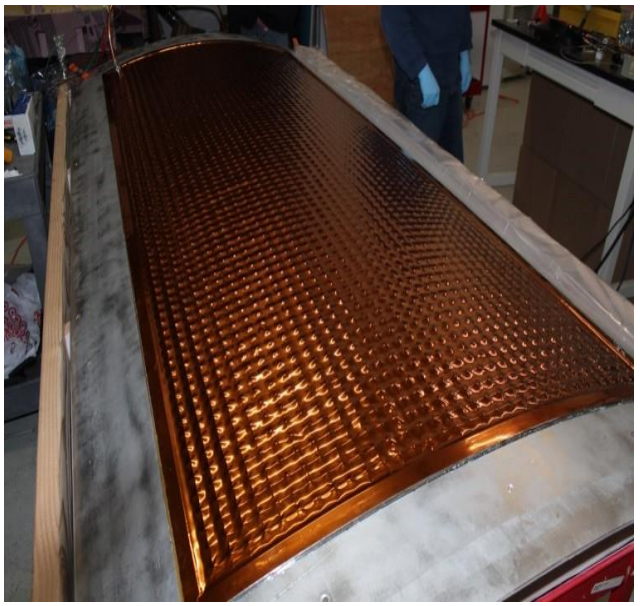
LRMLI provides both high thermal performance in-air, and ultra-high performance on-orbit. LRMLI's 144-fold lower heat flux per thickness than SOFI provides lower propellant boil-off loss for ground hold. LRMLI provides robust blanket structure, low heat leak, and modeling predictability similar to IMLI, but allows pairing with lightweight vacuum shells for in-air and soft-vacuum environments use. Currently at TRL5.

LRMLI vs Spray On Foam Insulation performance			
Insulation	In-space W/m^2	In-air W/m^2	Thickness, cm
LRMLI, 3 layers	4.83	29.3	0.63
LRMLI, 5 layers	3	18	1
SOFI, 0.75"	236	275	1.9
SOFI equal heat flux to 3-layer LR	4.8		49.2
		29.3	11.3
Aerogel equal heat flux to 3-layer LR	4.8		4
		29.3	10.1

LRMLI is an advanced thermal insulation system that uses dynamic beam discrete spacers that provide high thermal performance both in-air and on-orbit. LRMLI systems provide unique properties, including higher in-air performance than competing insulations such as SOFI or aerogels; less thickness and less mass for equal heat leak; and a robust, high strength structure that can self-support thin vacuum shells, MMOD ballistic layers, or vapor cooled shields for advanced zero boil-off cryogenic storage systems.

STRUCTURAL CAPABILITIES

LRMLI spacers possess a unique Y-rib feature to support compressive loads. When unloaded, the Y-ribs dynamically disconnect and the blanket assumes IMLI characteristics. The low thermal conductivity load responsive spacer supports up to 90 psi, and disconnects when unloaded for even lower heat leak. Vapor cooled shields and other modular components are self-supported by IMLI and LRMLI spacers without tank standoffs and parasitic heat leak. Spacer supported vacuum shells are very lightweight, such as 0.010" to 0.032" Aluminum or 0.005" composite shells. IMLI/LRMLI can be designed for optimal heat flux for multiple mission environments, such as 1 atm in-air, stratospheric operation, Mars surface, lunar surface.



For more information about our products, visit our website: questthermal.com

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