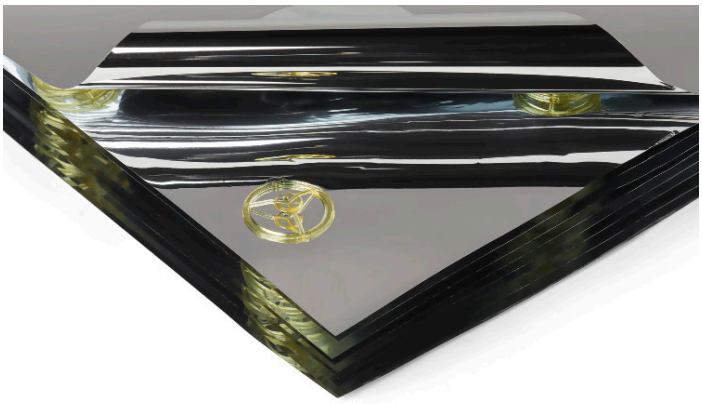
Integrated MLI (IMLI)
PRODUCT SHEET

IMLI is an ultra-high performance insulation solution developed by Quest Thermal Group, utilizing proprietary Discrete Spacer Technology™

Integrated MultiLayer Insulation (IMLI) is an advanced thermal insulation offering 60% less heat flux per layer then conventional netting-based MLI. IMLI has a robust structure, predictable performance, fewer layers and lower mass then netting MLI, and provides unique structural capabilities. Originally developed for NASA, IMLI's engineered structure can be designed for specific heat flux and structural loads to meet the requirements of your next mission. Working with your team, Quest provides engineering design, system analysis, and the fabrication and installation of our highly-modular IMLI systems.



DIFFERENTIATORS

- Discrete Spacer Technology™ solutions provide superior thermal performance and structural capabilities
- Discrete spacers and IMLI are the first real advance in multilayer Insulation in over 50 years
- 60% less heat flux per layer compared to netting MLI
- Passive or Active Cooled Shields paired with IMLI reduces heat flux by additional 50 – 70%, can help achieve ZBO operation for cryopropellants
- Highly accurate modeling and predictable heat flux
- Robust structure unaffected by gravity and compression
- Repeatable install & removal with no performance penalties
- Modular IMLI supports MMOD ballistic layers, Broad Area Cooled shield, external loads or vacuum shells

APPLICATIONS

Aerospace

- Long-duration cryopropellant storage
- Spacecraft thermal management
- Lunar surface missions
- Vapor cooled systems
- Space telescopes & science instruments

Commercial

- H_2-powered aircraft, vehicles & depots
- LH_2/LNG/cryogen storage, transport & infrastructure
- Quantum computing
- Medical/research cryogenics
- Cold supply chain

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THERMAL PERFORMANCE

TYPICAL IMLI CONFIGURATIONS

IMLI thermal performance has been extensively tested via boil-off calorimetry at Quest Thermal Group, Ball Aerospace, NASA Kennedy Cryogenics Test Lab, Glenn Research Center, and Marshall Space Flight Center. The Tables below provide predicted performance at different boundary temperatures and highlight the benefits of IMLI compared with traditional MLI.

IMLI Measured Thermal Performance

LAYERS OF IMLI INSULATION	COLD BOUNDARY TEMPERATURE	WARM BOUNDARY TEMPERATURE	HEAT FLUX W/m²
5	77K	295K	2.00
10	77K	295K	0.95
20	77K	295K	0.45
10	20K	295K	1.03
20	20K	295K	0.52
5	20K	90K	0.36
10	20K	90K	0.18
20	20K	90K	0.08

20K - 295K (LIQUID HYDROGEN) MODELED PERFORMANCE

NO. OF LAYERS	THICKNESS [cm]	HEAT FLUX [W/m²]	MASS [kg/m²]	Emissivity [e*]
5	0.72	2.14	0.22	0.0050
10	1.63	1.03	0.46	0.0024
15	2.53	0.68	0.70	0.0016
20	3.43	0.51	0.93	0.0012
30	5.23	0.34	1.41	0.0008
40	7.04	0.25	1.88	0.0006

77K - 295K MODELED PERFORMANCE

NO. OF LAYERS	THICKNESS [cm]	HEAT FLUX [W/m²]	MASS [kg/m²]	Emissivity [e*]
5	0.72	2.06	0.22	0.0048
10	1.63	1.00	0.46	0.0023
15	2.53	0.66	0.70	0.0015
20	3.43	0.49	0.93	0.0011
30	5.23	0.32	1.41	0.0007
40	7.04	0.24	1.88	0.0006

IMLI PERFORMANCE COMPARED TO CONVENTIONAL NETTING-MLI

IMLI, MEASURED	Low Density MLI, MEASURED	IMLI, MODELED	PERFORATED MLI, MEASURED
77 - 295K	77 - 295K	77 - 230K	77 - 230K
0.41 W/m²	0.41 W/m²	0.87 W/m²	0.87 W/m²
e* 0.00095	e* 0.0010	e* 0.0055	e* 0.0055
20 LAYERS	49 LAYERS	6 LAYERS	30 LAYERS
0.48 - 0.93 kg/m²	2.4 kg/m²	0.27 kg/m²	1.5 kg/m²

PROGRAMS & MISSIONS

- IMLI has three successful spaceflights, at TRL 9
- IMLI is insulating the Mk1 lunar lander
- IMLI is insulating the LEMS lunar surface science payload
- IMLI is insulating the Roman and NEOS space telescopes
- IMLI is in design for lunar rovers
- ISRU surface liquefaction & storage for lunar and Mars
- LH_2 UAV & aircraft tank insulation systems
- Thermal control for new satellite platforms

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

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