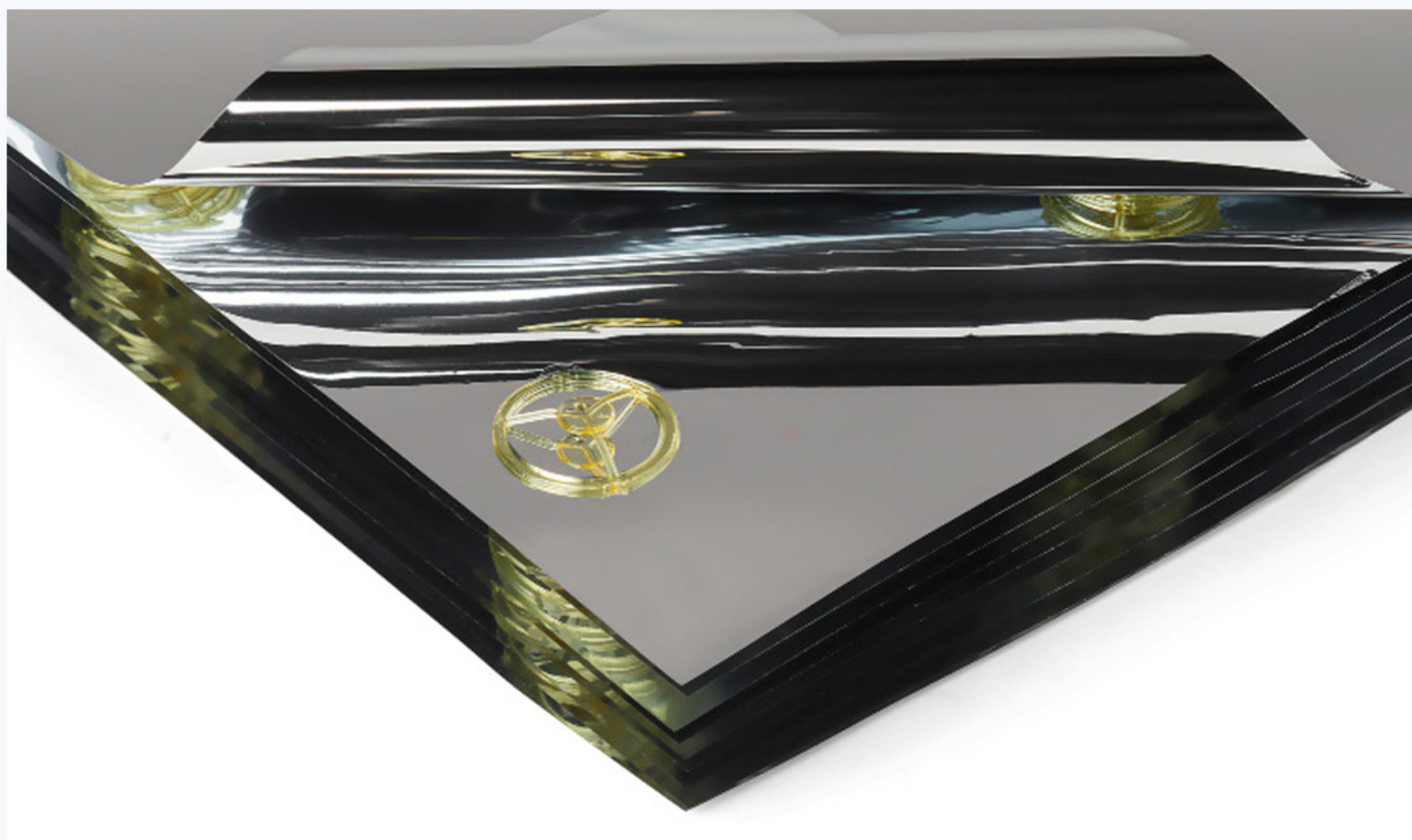


IMLI is an ultra-high performance insulation solution developed by Quest Thermal Group, utilizing proprietary Discrete Spacer Technology[®].

Integrated MultiLayer Insulation (IMLI) is an advanced thermal insulation offering 60% less heat flux per layer than conventional netting-based MLI. IMLI has a robust structure, predictable performance, fewer layers and lower mass than 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 your requirements. Working with your team, Quest provides engineering design, system analysis, 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 shields, external loads or vacuum shells
- IMLI offers you a reliable engineered insulation system with dramatically better thermal performance than netting-MLI



APPLICATIONS

Aerospace

- Long-duration cryogenic propellant storage
- Spacecraft thermal management
- MMOD/Thermal systems
- GEO satellites
- Lunar landers, rovers & science payloads
- Vapor cooled systems
- Space telescopes & science instruments

Commercial

- LH₂-powered aircraft, vehicles & depots
- LH₂/LNG/cryogen storage, transport & infrastructure
- Superconducting equipment
- Vacuum Insulated Pipe
- Quantum computing
- Medical/research cryogenics
- Cold supply chain

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/m ²
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 (LH₂) MODELED PERFORMANCE

No. of layers	Thickness [cm]	Heat Flux [W/m ²]	Mass [kg/m ²]	Emissivity [e*]
5	0.72	2.14	0.22	0.005
10	1.63	1.03	0.46	0.0024
15	2.53	0.68	0.7	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/m ²]	Mass [kg/m ²]	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	0.7	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	Perfed MLI, measured
77 - 295K	77 - 295K	77 - 230K	77 - 230K
0.41 W/m ²	0.41 W/m ²	0.87 W/m ²	0.87 W/m ²
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/m ²	2.4 kg/m ²	0.27 kg/m ²	1.5 kg/m ²

PROGRAMS & MISSIONS

- IMLI has three successful spaceflights, at TRL 9
- IMLI is insulating the Mk1 human rated 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
- IMLI tested for lunar & Mars ISRU liquefaction/storage
- IMLI is insulating LH2 UAV aircraft
- Thermal control for new GEO & hi-V satellite platforms

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

Alan Kopelove, CEO
alan.kopelove@questthermal.com
+01.303.395.3100 x101

Scott Dye, CTO
scott.dye@questthermal.com
+01.303.395.3100 x102

QUEST THERMAL GROUP
6452 Fig St., Unit A, Arvada, CO 80004
+01.303.395.3100 | questthermal.com