SPACE ARMOR™

IMPACT SHIELDING TILES

A SAFER WAY FORWARD

The majority of space debris remains untrackable, posing a significant threat to all spacecraft. Legacy shielding solutions exacerbate the problem by expelling secondary debris upon impact. Space Armor™ shielding tiles are advanced composite structures engineered to absorb hypervelocity impacts while minimizing the secondary debris emission. Designed for ease of integration, these tiles optimize safeguarding of critical spacecraft components and high-value assets. Space Armor™ increases mission assurance in the face of threats from debris enhanced environments.

Front, side, and back views of the Space Armor™ Lite panel (30cm x 30cm x 2cm), tested with a 3mm projectile traveling at 7.2 km/s, showing minimum deformation on the back side.

FEATURES

- All-composite structure
- Custom sizing upon request
- Durable against atomic oxygen (AO) and vacuum ultraviolet (VUV) exposure
- Space Armor™ Lite shields against hypervelocity impacts of particles up to 3mm in diameter
- Space Armor™ Max shields against hypervelocity impacts of particles up to 12.5mm in diameter
- Shield tested at 7.2 km/s projectile impact for Micrometeoroid and Orbital Debris (MMOD)

BENEFITS

- Protects against all untrackable debris (≤3mm)
- Protects against >90% of debris in LEO
- Minimizes secondary debris creation
- No back side deformation, outperforming state-of-the-art shields
- Tile approach simplifies integration and design

Comparison of Aluminum vs. Atomic-6 Space Armor™ shot with 3mm projectile at 7.2 km/s. Traditional aluminum produces secondary debris (ejecta) after impact, whereas Space Armor tiles produce a mist of fine particles and gases with a low chance of causing future damage.

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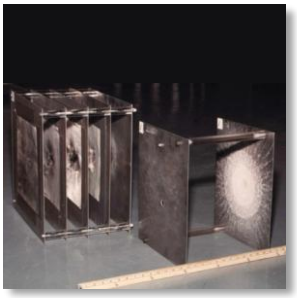
ATOMIC-6

THE WORLD'S FINEST COMPOSITES

SPACE ARMOR™ IMPACT SHIELDING TILES

CURRENT STANDARD

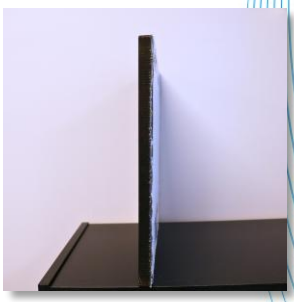


Whipple Shield
Deformed After Impact
Credit: NASA[1]

Solid Aluminum
Deformed After Impact
Credit: ESA[2]

ATOMIC-6 SPACE ARMOR™

Space Armor™ Max Tile



Space Armor™ Lite Tile
Side View Pre-Impact Test

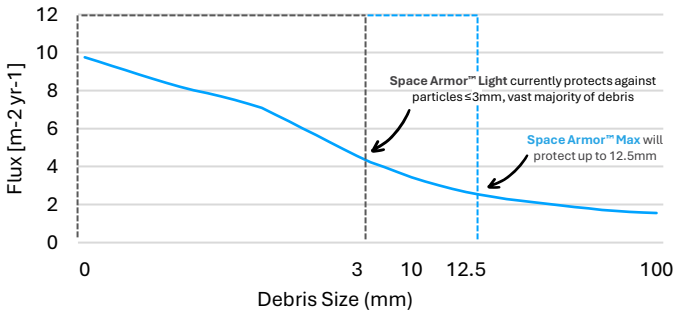
DISADVANTAGES

- **SPATIAL CONSTRAINTS** — Traditional Whipple shields are not volume optimized for 3mm particle protection
- **DEFORMATION UPON IMPACT** — After a hypervelocity impact, traditional shields deform significantly, compromising their ability to protect from subsequent impacts.
- **THERMAL LIMITATIONS** — Traditional shields are limited in their ability to accommodate thermal control.
- **REDUCED ADAPTIBILITY** — Traditional Whipple shields must be custom designed for each spacecraft and lack modularity and adaptability to varied mission requirements and threat environments.
- **LAUNCH VIBRATIONS** — Launch vibration causes substantial ringing and deflection of traditional shields.
- **MAINTENANCE CHALLENGES** — Traditional shields do not support convenient in-space repair or replacement.

ADVANTAGES

- **COMPACT DESIGN** — Space Armor™ tiles are volume optimized for impacts up to 3mm critical diameter
- **IMPROVED DURABILITY** — Space Armor™ tiles maintain structural integrity after impact, providing continued protection even with repeated adjacent impacts.
- **THERMAL MANAGEMENT** — Space Armor™ tile thermal properties can be tailored to improve thermal management.
- **INCREASED ADAPTABILITY** — Space Armor™ tiles are modular, and off-the-shelf units can be easily applied to any spacecraft design. With Space Armor™ Lite and Max options, multiple threat scenarios can be addressed.
- **MINIMAL VIBRATION** — Space Armor™ tiles are stiffer than traditional shields, reducing deflection during launch.
- **IN-SPACE MAINTENANCE** — Space Armor™ tiles can be removed and replaced in-orbit, enabling servicing options.

NASA Generated Orbital Debris Engineering Model (ORDEM) for example LEO orbit



[1]Orbital Debris and Risk Mitigation

[2]License: https://creativecommons.org/licenses/by-sa/3.0/igo/

Space Debris Solutions, Weight per Unit Area

Solution	Max Projectile (mm)	Weight (kg/m²)
Space Armor™ Lite	**3**	**14.0**
1cm Solid Aluminum	3	28.8
Space Armor™ Max	**12.5**	**TBD[3]**
ISS Baseline (Whipple Shield)[4]	12.5	27.5

[3]Space Armor™ Max is currently in development
[4]https://ntrs.nasa.gov/citations/20060026214

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