agy

S-2 Glass®
Composite Armor Systems

Optimized Solutions for Ballistic and Structural Applications

Composite Vehicle Armor Systems are the solution for the full range of military, commercial and public safety applications.

S-2 Glass Fiber Delivers Unique Balance of Mechanical Properties

S-2 Glass® fiber based laminates are proven in over 30 years of demanding military applications and provide exceptionally high mechanical properties—including tensile, compression, impact, stiffness, fatigue and other beneficial structural characteristics.

The very high tensile properties of the S-2 Glass fiber, when combined with a high strain to failure of 5.6%, provide laminates with exceedingly high impact resistance. High tensile properties are delivered in combination with very high compression properties, enabling this impact resistant material to be a great light weight structural and a great ballistic resistant material in the same laminate system. See diagram below. This balance of properties permits opportunities for light weight systems that other high performance ballistic armor systems cannot match. Numerous innovative developments have been derived from the unique balance of S-2 Glass fiber properties and leveraged in armor in both structural and ballistic optimized systems.

This flexibility to customize laminate system performance facilitates innovative designs that provide game-changing lighter weight protective solutions. Each combination offers specific benefits to meet system requirements.

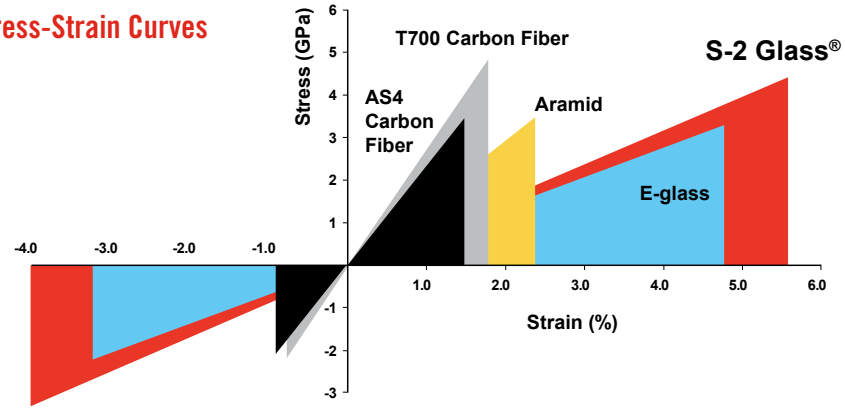
Ballistic Optimized Parasitic Armor Applications

For S-2 Glass armor applications where light weight ballistic performance is critical and load carrying demands less important, systems can be designed that maximize ballistic efficiency. These parasitic systems are typically mounted behind metal structural armor. Baseline S-2 Glass armor systems employ a heavy fabric with polyester, phenolic or vinyl ester resins in very high fiber content laminates. The polyester systems are easier to fabricate and less expensive. Phenolics provide low flammability, low smoke generation and a great balance of superior ballistic resistance while still delivering significant structural capabilities. Vinyl ester systems can improve mechanical properties and weatherability while still providing ease of fabrication and good ballistic performance.

The most widely utilized system is the S-2 Glass fiber reinforced phenolic combination specified in MIL-DTL-64154B Class A. This system is often referred to commercially as HJ1.

All these ballistic optimized systems provide great protection, but unlike other high performance parasitic composite armor systems, the optimized ballistic S-2 Glass systems still possess superior residual structural properties that translate into outstanding mounting ability with fewer attachments. They can also be mounted on vehicle ceilings without sagging, on vehicle floors providing superior wear and moisture resistance, or in exceptionally hot/wet environments such as engine compartments, all with no effect on the laminate or its performance. Finally, the S-2 Glass armor systems are always thinner for the same ballistic protection, providing a lower space requirement than competitive armor systems.

Stress-Strain Curves



PARASITIC ARMOR APPLICATIONS

Spall resistant composite armor systems installed inside vehicles immediately behind the vehicle's structural metal hull.

MRAP Patrol Vehicles
HJ1 spall liner works to structurally support the metal structural hull to mitigate blast, prevent penetration, while still mitigating spall if penetrated.

Tracked Fighting Vehicles
S-2 Glass HJ1 spall liner behind the structural hull works to both prevent penetration and if penetrated, significantly mitigate spall inside vehicle.

Wheeled Fighting Vehicles
HJ1 spall liner can be used to mitigate spall, and in blast resistant floor designs, it is capable of both spall suppression while enhancing blast mitigation.

STRUCTURAL ARMOR APPLICATIONS

S-2 Glass structural armor systems are capable of replacing metal hulls and providing dramatically lower weight vehicle systems.

UK MoD "Snatch" Vehicle
Innovative ballistic and blast resistant vehicle that leverages S-2 Glass structural armor load bearing capability as well as blast and ballistic resistance.

"Snatch" Vehicle S-2 Glass Components
Doors, walls, floor and entire rear enclosure are all structural S-2 Glass composite armor. It provides all structural requirements and penetration resistance.

UK MoD Foxhound Vehicle
S-2 Glass structural armor provides the complete crew pod with integrated blast resistant V-hull to this groundbreaking 4x4 MRAP vehicle.

Non-Spalling High Strength Structural Armor Applications

High performance S-2 Glass armor technology can also provide ability to design lighter weight fully structurally capable composite armor systems to replace heavy metal primary structure. On average, a structural S-2 Glass laminate hull system can permit composite hulled combat vehicles that are half the weight of comparable steel hulled equipment, and 30% lighter than comparable aluminum hulled vehicles.

Utilizing a system approach to address new program requirements, AGY is able to recommend efficient, integrated solutions to complex design challenges. AGY can assist in the optimization of materials, the required manufacturing processes, and skilled contractors able to deliver such composite hull components. Potential customers can leverage our background to their full advantage.

S-2 Glass armor systems optimized for structural load-bearing capability can be used to replace metallic hull and hull substructures for dramatically lighter weight solutions. These systems maximize structural performance and still maintain good ballistic efficiency, while eliminating any requirement for add-on spall liner systems. These composite systems have higher resin content to maximize laminate strengths and typically employ epoxy resins where exceptionally high structural properties are required. Phenolic based systems have also been designed and deployed for structural laminates while certain vinyl ester systems provide near comparable performance to epoxy and phenolic with easier fabrication and storage. These systems have been designed and deployed to replace heavy metal hatches, ramps, turrets, floor, roof and full hull applications. These structural solutions are also well-suited as a thin thickness, weight and space efficient backing for ceramic faced armor systems where mounting requirements and multi-hit capability are critical.

An Evolution of Products for your Evolving Needs

AGY's S-2 Glass fiber has always been employed in the high performance armor systems above using the 463-AA-250 S-2 Glass multi-end roving in a heavy woven fabric. This is the fiber and fabric used in the HJ1 composite armor system of phenolic/S-2 Glass fabric.

New to AGY's ballistic armor portfolio is the S-2 Glass based ZenTron9 fiber. ZenTron9 is a single-end roving yet still maintaining

Lightweight personnel pod for 4x4 vehicle.

AGY S-2 GLASS roving

a 9 micron filament diameter critical to both high strengths and great ballistic resistance. The ZenTron9 S-2 Glass fiber is an excellent candidate for unidirectional armor system development. This fiber form is currently under development in a number of higher performance unidirectional fabric systems to provide even lighter weight ballistic optimized armor systems.

With our weaver supply chain partners, we have also supported development of lighter weight fabric options that permit higher ballistic efficiency with greater ease of fabrication. These lighter weight fabrics can be used with traditional thermoset resins, but also facilitate the use of thermoplastic matrices. AGY is expanding its portfolio of thermoplastic compatible sizings on continuous rovings to support new thermoplastic compatible light weight fabrics for new, lighter weight composite armor system designs.

The resulting portfolio of S-2 Glass fiber and fabric options allows the armor designer an array of solutions for any design challenge. Each combination of fiber, fabric architecture, and resin offers a different cost/weight/structure/performance solution for any lightweight armor requirement.

Call AGY today *for more information including case studies, technical data sheets, and technical papers describing why AGY S-2 Glass based armor systems are your best choice for performance and value.*

For more information, visit us at www.agy.com

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strength in materials

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