NORPLEX MICARTA
High Performance Thermoset Composites

Fiberglass as Armor? Sure!

By Alan Johnson, Contributing Writer

Fiberglass-phenolic laminate armor is being increasingly specified for courtroom, check-cashing, gas station and convenience market applications.

In both military and civilian settings, tough security problems are being solved by new versions of a very old concept: armor. Today, more and more organizations are turning to modern-day armor to protect personnel, vehicles and buildings from a variety of ballistic threats.

Modern armor is made of several different materials, including metals, ceramics and even plastics. While each material can provide adequate protection, some also have serious drawbacks. As a result, effective armor material may be less than ideal for a particular application due to excessive weight, machining difficulties, or toxic emissions when overheated.

These issues and others sparked the development of a new generation of thermoset composite materials. The new fiberglass-based options eliminate many problems associated with other armor materials, while still providing certified threat-level protection in portable-combat and blast-shield applications. As an added bonus, some of the glass fabric based composite options are also much less expensive than many conventional alternatives, thereby saving money as well as lives and property.

Material options

Armor is used to protect a range of civilian and military assets. These include personnel; building components such as walls, doors and counters; and vehicles such as automobiles, trucks, jeeps and aircraft.

The physical characteristics of ballistic materials vary widely. Some of the most important of these characteristics are weight, ease of cutting and drilling, ease of forming into complex shapes, resistance to ricochet, resistance to chemicals and heat, aging characteristics, resistance to fire and flame, ease of manufacture, cost, and availability. These characteristics must be considered when specifying armor against a specific threat level and in a specific environment. For example, weight and flexibility are critical factors in personal body armor systems; ease of cutting and drilling, resistance to fire and flame, and cost are critical to architectural applications; and weight, as well as ease of cutting, drilling and

adhering are critical to vehicle applications.

One commonly used armor material is ballistic steel. While it has proven itself to be an adequate ballistic protection material, ballistic steel is very heavy, making it difficult to handle – and, therefore, less than ideal for body armor. Weight is also a critical factor in vehicle armor. In the design of ground vehicles, the weight of large, heavy ballistic steel armor panels requires the use of stronger suspensions, brakes, and engines than would otherwise be necessary. In addition, ballistic steel armor may compromise handling properties by raising roll centers and centers of gravity.

Weight is also a problem in airborne applications. In some cases, excessive armor weight would result in significant reductions in aircraft performance, range and payload. For example, specifications for the ballistic armor packages for the Comanche helicopter limit their maximum weight to 5.5 to 6.0 lbs per sq. foot. This weight limit would prohibit extensive protection with ballistic steel, which weighs approximately twice that amount.

Nonmetal alternatives

Ceramic armor is lighter than ballistic steel but still provides adequate protection in a number of applications. However, the relatively high cost of ceramic armor makes it unsuitable for large-area protection. In addition, ceramic armor cannot take more than one hit in the same spot or tile without potential penetration of the second hit.

Side-view of fiberglass-phenolic laminate fired upon from close range with .50-caliber bullet.

Contributing to the total cost of a material is the relative ease of manufacturing panels and sheets of the material for OEM or field-rigged installations. Ceramic armor requires heavy manufacturing equipment such as heavy-duty cutting, shaping and drilling machines, as well as heat treating/quenching facilities. Therefore, field modification of ceramic armor plates is generally not possible.

In the category of personal body armor, a high level of protection is provided by a hard armor rifle plate, usually a ceramic material. The rifle plate is inserted into a carrier, which can be constructed of ballistic fabric or conventional garment fabrics such as nylon or cotton. The rifle plate can be removable or permanently sewn into the carrier. But such a garment is complex and heavy, while also restricting the movement of the wearer.

Concealable body armor is usually constructed of multiple layers of ballistic fabric or other ballistic-resistant materials, which are assembled into ballistic panels. Polyester laminates are widely used to make this type of armor. In sheet form, these materials can be drilled and cut with power tools. They can also be made flame retardant, but they may produce toxic gases when they burn.

Another significant downside is the expense of polyester composites, which are made in a complex and costly hand lay-up process. This process involves pouring liquid binder onto fabric layers in a dedicated closed mold with the thickness of the final part engineered to meet a specific threat type.

Fiberglass advantages

A new generation of advanced laminated fiberglass composites can be manufactured in a much simpler lay-up process. In this process, pre-saturated layers of a fiberglass textile are simply stacked in open dies to the required thickness. The laminates are manufactured in a range of thicknesses, depending on the weapon threat.

Used by OEMs and fabricators for vehicle panel armor, these relatively inexpensive fiberglass-phenolic materials are offered as either a fully cured, rigid sheet or compounded with a proprietary catalyst as a partially cured, rigid pre-preg, which melts and cures when the appropriate temperature is applied. The catalyst allows the material to be shaped to contours in standard forming dies by application of moderate heat and pressure for only a few minutes, eliminating the messy, wet, hand lay-up process.

Fiberglass-phenolic laminate armor is being increasingly specified for courtroom, check-cashing, gas station and convenience market armor. These new glass fabric-based materials provide far greater security and protection than polyester based ballistic laminates in walls, doors, counters and other architectural applications. Certified for threat-level protection to the National Institute of Justice standards, these materials provide inherent ricochet resistance. Overall, the performance of the new composites is equivalent to that of conventional S-2 glass laminates that cost considerably more.

Postville, Iowa-based Norplex-Micarta's fiberglass-phenolic composite, part of the company's Ballistic-Resistant Armor Security System, MC504BR (BRASS), is a UL-listed, Class 1-A (ASTM E 84) fire-rated projectile-resistant building materials. Unlike flame-resistant polyester based ballistic laminates, which can produce toxic fumes when charring, glass laminates produce no toxic fumes when burned.

And unlike ballistic steel, glass based phenolic composites can be cut and drilled in the field with ordinary power tools. In addition, glass-based armor weighs less than a third of ballistic steel armor plate, making it much easier for installers to handle. The combination of lightweight and robust threat protection makes these composites well-suited for ground vehicle and airborne applications, where they have far less impact on vehicle performance – including fuel consumption, maneuverability and load capacity – than does armor steel.

Next-generation glass based composites offer armor fabricators and end users the protective performance of steel and the light weight of plastic laminates. The materials also feature low-cost, high-flame retardance, and easy machining in the field. These attributes and others are making these new materials an increasingly popular choice to protect valuable military and civilian assets from ballistic threats.

ADDITIONAL INFORMATION

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