

# SABIC Innovative Plastics helps Armor Holdings strengthen customer confidence in its vehicle protection solutions

Raising the bar in performance and visibility with laminates made from optical quality Lexan<sup>®</sup> Margard<sup>®</sup> sheet

Armor Holdings, Inc., is a leading manufacturer of vehicle armor systems for U.S. and international military forces, government organizations, corporations, high-net-worth individuals and cash-in-transit companies. The company pursues a strategy of continuous improvement to meet escalating threats and changing customer requirements. One key focus area is armored glazing for vehicle windows, which must provide bullet resistance, spall-protection capabilities and optimal visibility. Armor Holdings had been using conventional polycarbonate (PC) in the various glass/plastic glazing laminations it produces to meet different vehicle protection requirements. However, the company needed to improve such properties as light transmission through multiple layers, physical performance and scratch resistance. The result - Armor Holdings worked with SABIC Innovative Plastics to leverage a new family of optical quality PC sheet products.



## Challenge

### Continuously improving protection to meet growing threats

Headquartered in Jacksonville, Fla., Armor Holdings comprises three divisions - Aerospace & Defense, Products and Mobile Security. Among its products are advanced survivability systems for U.S. and international military forces, such as the up-armored UMMWV, and armoring systems for commercial vehicles such as limousines. The company operates 25 facilities in nine countries and had revenues of \$1.6 billion in 2005.

The glazing systems in armored vehicles play a critical role in protection and visibility. Like the rest of the vehicle, windows must be resistant to direct fire, blast and the impact of fragments. They must also be able to withstand rough conditions, such as exposure to sand and ad hoc cleaning methods. And, of course, they must enable the occupants to see outside, even at night or in inclement weather.

As weapons increase in sophistication and power, and as customers raise their requirements, vehicle armor must stay ahead of the curve with new performance enhancements. Following its corporate strategy of continuous improvement, Armor Holdings constantly tests materials used in its products. This strategy led the company to a re-evaluation of the standard PC sheet it had been using in glass/plastic laminations for vehicle glazing.

“We are constantly trying to deliver improvements in armor performance,” said Matt Burke, Ballistics Engineer responsible for Commercial Vehicles & Transparent Armor, Armor Holdings. “We targeted polycarbonate because our existing material needed improvements in three key areas - spall protection, light transmission and scratch resistance. We were looking for a next-generation plastic that could deliver better results in all of these

categories. Plus, we wanted greater material versatility because of the dozens of different laminate configurations we create to meet customer specifications – including some that are up to 137 millimeters thick.”

Still another issue with the conventional PC laminates was a high post-cutting scrap rate of up to 30 percent. To accelerate cycle time and lower material costs, Armor Holdings wanted a plastic grade that could significantly reduce part rejects.

## Solution

### SABIC’s Innovative Plastics optical quality Lexan Margard HLG5 and HLGA3 sheet products with abrasion-resistant coating

To address Armor Holdings’ requirements, SABIC Innovative Plastics identified as material options, its new family of optical quality Lexan Margard sheet products, which are excellent candidates for incorporation into glass/plastic laminations as the inside glazing layer. Lexan Margard HLG5 and HLGA3 sheet grades are comprised of a base of clear, flame-retardant Lexan PC, which is coated on one side with a special abrasion-resistant, low-glare coating that resists fogging.

To produce the window glazing, Armor Holdings follows a complex process that includes cutting, grinding, polishing, curving and pre-laminating a stack incorporating glass, interlayers and Lexan Margard sheet, followed by autoclaving. The company produces approximately 75 different vehicle models, each with about six unique pieces of glazing.

“Vehicle armor is one of the most demanding applications for plastics, but our Lexan Margard sheet grades are tough enough to take the punishment,” said Lisa Marrs, Application Development Specialist – Sheet, SABIC Innovative Plastics. “At the same time,

## Case Study

# Optical quality Lexan\* Margard\* HLG5 and HLG A3 sheet / Armor Holdings

these products have been engineered to provide excellent optical quality so that even in thick laminations and under low-visibility conditions, drivers and passengers can do their jobs effectively. We're proud to supply next-generation plastics that can make a difference for soldiers, police, government officials and anyone else in harm's way."

SABIC Innovative Plastics provided a wide array of value-added services for this project, including material recommendations, superior customer service and product support.

## Benefits

### **Increasing customer confidence with improved protection and performance**

By replacing generic PC with laminates featuring optical quality Lexan Margard sheet, Armor Holdings has been able to improve its vehicle armor glazing in several important ways.

Burke explained, "First, the SABIC Innovative Plastics sheet offers high elongation so it maintains cohesiveness upon impact. In effect, the Lexan Margard sheet layer acts as a spill net, stopping high-velocity glass fragments from entering the interior of the vehicle and causing injury. It also absorbs kinetic energy, contributing to the bullet-resistance of the system."

With its excellent modulus and impact resistance, optical quality Lexan Margard sheet absorbs ballistic impact without penetration. In addition to "catching" glass shards, the sheet itself will not pulverize or spall.

The second critical property is improved light transmission for visibility. "In addition to the challenge of creating multiple-layer laminations, these laminates soak up light at every interface creating a disadvantage for night-vision goggles and other equipment that requires IR light transmissivity," Burke explained. "For Armor Holdings, the SABIC Innovative Plastics materials provide the highest optical quality and clarity, which help deliver optimal visibility for our vehicles." Further, these materials will not spider, crack or white-out on impact, providing visibility even after ballistic or physical attack.

Abrasion resistance is another important advantage of the Lexan Margard sheet. The specialized hard coating on the interior side of the PC sheet protects the laminate from scratches and marring caused by flying sand and debris, or rough cleaning in the field.

Finally, upgrading to the new Lexan Margard sheet materials enabled Armor Holdings to reduce scrap and lower part rejects, resulting in lower costs and faster cycle times.

Burke concluded, "We invest heavily in R&D, and we test materials every day to be sure they are performing according to our stringent requirements. In ballistic tests on glass/plastic laminations, where minute variations in glass/PU/PVB/PC/acrylic combinations can result in drastic performance changes, Lexan Margard sheet performed better overall. By using vehicle glazing that incorporates these products, we can demonstrate the industry-leading performance and protection of our armored vehicles and give customers full confidence in these systems."

## Details at

[armorholdings.com](http://armorholdings.com)

## For further information

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