

By PAUL ENG



Researchers Put Bullet-Proof Glass on a Diet

Material Allows for Tougher, Lighter Shields



A chemical compound of oxygen and aluminum, called alumina, makes a strong shield. (Air Force Research Labs)

Oct. 25, 2005 — Banks and late-night convenience stores everywhere routinely feature imposing slabs of bullet-proof glass. Researchers are now hoping to put those thick, bulky panels on a high-tech diet.

Engineers at Air Force Research Laboratory at Wright-Patterson Air Force Base in Ohio and Surmet Corporation in Burlington, Mass., believe they have perfected an ideal material for light, transparent shields: a chemical compound of oxygen and aluminum, called alumina.

Sturdy, Like Sapphire

The scientists at Surmet, a company that develops new high-tech materials, have created a special variant of alumina called ALON, or aluminum oxynitride. A white chalk-like powder is heated to thousands of degrees in a furnace and treated with nitrogen in a proprietary process, the company says. That allows the ALON to turn into a transparent material which — similar to other ceramics — has a rigid crystalline structure that gives it strength.

When polished to remove tiny surface defects, the ALON material resembles sapphire — a gem prized for its hardness and resistance to scratches.

According to First Lt. Joseph La Monica, a researcher working on transparent armor at the Air Force Lab, ALON has proven to be a remarkable bullet-resilient material. In tests, a "sandwich" of transparent ALON, glass and a polymer laminate survived multiple hits from .30-caliber armor-piercing rounds.

The difference: "The ALON laminate provides the same antiballistic performance at half the weight," says La Monica, comparing the material to traditional bulletproof glass.

Air Force researchers are still testing the material against other, larger threats — .50-caliber armor-piercing bullets, and even improvised explosives. If the tests prove successful, ALON could become the ideal solution for protecting military ground vehicles as well as aircraft, where weight and performance are major considerations.

"We're trying to get this toward use in aircraft where the weight is really an issue," says La Monica. By using it in, say, the cockpit canopies of jet fighters, "we can put the same amount of ALON there, yet offer a lot more protection for the pilot," he says.

While the military conducts further testing, other researchers are optimistic that ALON and other alumina-based solutions have a bright future — mainly because it has a clear success record.

"The material has been around for decades and used and manufactured in small pieces where you need protective optical transparencies — like a sensor in a missile warhead," says Ron Hoffman, an investigator at the University of Dayton Research Institute in Ohio, who has helped the Air Force test ALON. "Finally, the industry and technology has come along where you can make large sheets of this stuff — like full frontal car windshields and side windows."

Traditional, transparent bulletproof panels — which are made of layers of glass and plastics — offer protection, but are heavy and can affect a vehicle's performance and mobility.

Earlier this year, "up-armored" military Humvees in Iraq were found to have suffered accelerated wear and tear due to the increased weight of the additional panels of metal- and bullet-resistant glass.

Surmet officials say ALON could also have non-security applications.

"There are little products that we carry in our pockets every day — all of them have little windows which can get scratched very easily," says Surmet chief executive officer Suri Sastri. "We make the powder, we can melt it, shape it into large panels or intricate shapes. The potential is great."

Clouded Windows

Still, even the most vocal proponents note that ALON still has several hurdles to overcome.

For one, the process of producing the new transparent armor is still quite costly. The Air Force and Surmet say ALON armor costs about \$10 to \$15 per square inch verses \$3 for traditional bullet-resistant glass.

"We've been making glass for thousands of years," says La Monica. "And to be honest, ALON isn't going to replace it everywhere — just in places where it makes sense ... where weight and durability are issues."

Most of ALON's cost is in the manufacturing process. "There is a huge capital expense to build furnaces to make it in the size and quantity that would be needed in commercial ventures," says Sastri.

The company says it is also working with an undisclosed set of customers to test the use of ALON in non-security related applications. And if it can prove successful in commercial applications — say, as a tougher, scratch-resistant "glass" for bar code scanners at supermarket check-out stands — mass production of ALON could also help lower costs.

Until then, Surmet's tough transparency offers just a tempting window into the future.