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Enhanced Armor

New shields to fend off evolving battlefield threats

By Steven Ashley | Monday, May 15, 2006

It's an all-too-familiar scene from the war in Iraq: A video shows a convoy of combat vehicles patrolling a dusty causeway. Suddenly, a huge detonation erupts next to one, often followed by a determined ambush. Over time, the guerrillas have steadily upgraded the lethality of their roadside bombs, suicide assaults and surprise attacks. This year, however, the U.S. military plans to field several new armor systems that should better defend its vehicles and personnel. "The need to stop multiple, ever evolving threats is a tough problem," states Tony Russell, chief technology officer at Armor Holdings, a security products maker based in Jacksonville, Fla. "The systems we develop must defeat repeated armor-piercing bullet hits as well as the fragments and blast overpressures from explosives. And no one material--metal, composite, ceramic--is best at stopping every threat." Moreover, the armor has to be as light as possible. Successful solutions often mix several different substances to achieve the best result, Russell notes.

One of the least apparent recent improvements in armor has been the development of new, ultrahigh-hardness (UHH) steels. Such alloys are as much as 20 percent harder than the hardest off-the-shelf high-carbon steels, but they tend to be brittle and can crack when hit. Russell says that Armor Holdings has introduced an optimized version called UH56 steel, which is "hard enough to fracture armor-piercing ammo but tough enough not to crack with many impacts." UH56 is also easier to shape than many of its UHH cousins. The enhanced steels are being installed on many U.S. light-armored vehicles.

Researchers are also working on better transparent materials for windows, which are typically made from multiple laminations of bonded glass. As new threats loom, "the reaction is to add another layer of glass," explains Ron Hoffman of the University of Dayton Research Institute. But extra glass can make vehicles top-heavy, fuel-thirsty and sluggish.

One promising solution is to replace the glass with significantly cheaper and more effective aluminum oxynitride (ALON), a hard, sapphirelike material developed by industry, the U.S. Army and the U.S. Air Force. ALON offers better protection against armor-piercing projectiles at roughly half the weight and half the thickness of traditional glass-based transparent armor, Hoffman reports.

ALON has been around for years, but it has always been too expensive and too limited in size for vehicle windows. Engineers at Surmet, a ceramics maker in Burlington, Mass., have improved manufacturing processes involving the heating and compressing of ALON powders to make larger pieces of the material and to lower production costs significantly. Still, at around \$10 to \$15 per square inch, the optical ceramic costs more than military-grade glass (\$3 per square inch). Armor Holdings is expected to start installing the lightweight windows this year.

Body armor will soon be in for some significant enhancements as well. Standard--issue ballistic vests, which are reinforced by hard ceramic plate inserts, are massive and bulky but more protective than today's lighter-weight, multilayer fabric alternatives made of

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SHEAR-THICKENING FLUID stiffens instantly when an object is dragged through it, enabling a vial of the liquid to be lifted. It can improve Kevlar's bullet-stopping power.

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woven Kevlar and other high-strength fibers. A new technology called liquid armor may change that, however.

Liquid armor refers to "ballistic fabric infused with a shear-thickening fluid," a substance that stiffens temporarily less than a millisecond after impact, says Norman Wagner, a chemical engineer at the University of Delaware. Co-developed by Wagner's research group and a team led by Eric Wetzel at the U.S. Army Research Lab in Aberdeen, Md., shear-thickening fluid is a mixture of hard nano-particles (often silica or sand) suspended in a nonevaporating liquid such as polyethylene glycol. Although the fluid adds only about 20 percent to the weight of the fabric, it greatly augments its resistance to puncture by high-speed projectiles. It also reduces the effect of blunt trauma by helping to transmit the impact energy to a larger portion of the ballistic fabric, Wagner explains. Certainly, in today's Iraq, allied forces need all the protection they can get.

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