



Stronger than a Speeding Bullet

There's plenty of life left in Honeywell's high performing Spectra Shield II body armor. A fourth-generation fiber is lighter, stronger and suitable for a number of new military applications.

By James A. Bacon

On July 2, 2005, PFC Stephen Tschiderer and his unit with the 101st Cav were patrolling the streets of Baghdad. Someone shot at the convoy, so the soldiers initiated a search of the surrounding homes. Tschiderer was providing security around his Humvee when a two-man sniper team -- the men they were looking for -- caught him in their cross-hairs. The sniper, armed with a Draganov rifle, pulled the trigger and hit Tschiderer in the chest with an armor-piercing round.

Tschiderer crumpled to the ground and the insurgents began chanting, "Allahu Ak-hbar" (God is Great). But seconds later, the private scrambled back to his feet, his gun at the ready. Crouching and glancing around for the sniper, he retreated to cover behind the Humvee.

Tschiderer later participated in a chase through the neighborhood and helped net one of the two insurgents. Among the spoils of war: the sniper rifle and the camera that one of the Iraqis had used to record the episode. What the Iraqis hadn't known was that Tschiderer had been wearing a breastplate made with

Spectra Shield. The armor-piercing round, which had struck at an angle, didn't penetrate the plate. Tschiderer walked away from the battle with no more than a bruise on his torso. The episode was big news to Honeywell's Advanced Fibers and Composites operation in the Richmond region, which manu-



Captured video image of Tschiderer seconds before he was shot by an insurgent sniper.

factures the light, high-strength

fiber used in Spectra Shield. In fact, so excited was Honeywell about the vivid, real-world demonstration of its product that it invited Tschiderer and his parents to Virginia to see the plant. Meeting the people whose lives they save spurs the Spectra team to continue refining their product and making it better, says Lori Wagner, Honeywell's industry technology leader for armor.

Since Tschiderer's brush with death two years ago, Honeywell has developed an even stronger, lighter version of its armored plates based upon an upgraded Spectra fiber. S3000, the fourth generation of Spectra fiber, was developed at Honeywell's operations in the Richmond region specifically for use in armor applications to counter ballistic threats.

Honeywell employs its patented gel-spinning technology to align the polymer molecules of an ultra-high weight polyethylene feedstock in the same direction. "If you can imagine a pot of spaghetti and all the noodles are intertwined, if you pick up a blob, you can pull on any of the fibers and there's very little strength," explains Wagner. "If you could take those noodles and elongate the fibers in the same direction, you'd get a lot more strength. That's what you get with gel spinning. We orient those molecular chains along the same direction."

Each successive generation of Spectra has refined the gel-spinning process over the years to improve strength, modulus (stiffness), elongation, denier (thickness) and other characteristics. Honeywell has devised a wide range of applications for the material. With a pound-for-pound strength 15 times that of steel, the fiber is used not only in body armor but marine cables, fishing lines, sailboat canvas and cut-resistant gloves. One recent innovation uses Spectra in flexible, canvas-like panels that homeowners can put

over their windows to protect against hurricanes. Although the material weighs only two-and-a-half ounces per square foot, it meets Florida specifications for wind, rain and wind-born projectiles in hurricanes of 155 miles per hour.

S3000, however, was engineered specifically as a military armor. "It provides 20 percent improvement over our original product," says Wagner. Rather than weaving the fiber into a fabric, which bends and weakens it, Honeywell lays the fibers parallel and embeds them in a resin. Then, these panels are layered in a cross-hatch pattern and fused together. That technique, called Spectra Shield, creates light-weight armor of phenomenal strength.

The United States military wants plates that protect against different types of weapons, up to and including armor-penetrating projectiles fired by sniper rifles. The new Spectra products can meet those specs with less material, which translates into lighter armor plates. If the plates weigh less, soldiers can load up with other gear like high-tech communications equipment -- or water to survive the Iraqi heat. Every pound of weight reduction is precious.

Meanwhile, Wagner is looking for other military applications. One strong possibility is a new helmet for the U.S. Marines, Army and special forces. Current models are designed to stop rounds from a handgun, but senior military officers have set a goal of preventing bullets from the AK47, the most widely used assault rifle in the world, from penetrating the helmet. Kevlar, the fiber widely used today, cannot meet the specifications without adding significantly to the helmet's weight. According to

[Marine Corp Times](#), Kelvar manufacturer DuPont is working on new materials that can make the cut. At the time this article was written, one candidate was M5, its next-generation fiber under development in Richmond.

Wagner also considers Spectra Shield II a likely candidate. "Helmets have not been upgraded to the same level of protection as body armor," she says. "The traditional aramid fibers [such as Kevlar] cannot meet the weight requirements. Spectra Shield II is one of the only materials that can meet the weight requirements and stop a rifle round."



Lori Wagner

Even if Spectra Shield II meets the military's specs, however, there is no guarantee that the helmet market will materialize. One widespread concern is that even if the bullet doesn't penetrate the helmet, it will generate so much force when it strikes that the soldier's neck will snap.

Still, there is no lack of potential new applications. As the nature of military threats evolve -- the introduction of Improvised Explosive Devices (IEDs) into the Iraq conflict, followed by Explosively Formed Penetrators -- the military is scrambling for better vehicle armor.

For a long time, weight was never a significant factor for vehicle armor, Wagner explains. But the experience in Iraq has

shown that excessive armor weight on Humvees and other light vehicles can make them top-heavy and difficult to maneuver. The extra weight is also murder on engines. The military is doing a lot of work on MRAPs (mine-resistant, ambush-protected vehicles) that are light weight but still can protect against insurgent bombs. "The highest-performing materials include Spectra Shield," Wagner asserts.

Another remarkable property of Spectra is transparency to radar. That makes it a suitable armor for communications equipment. Spectra has long been used in commercial aircraft. Now the military sees value in the material. "Many armor solutions interfere with the equipment," Wagner says. "Our materials don't."

Wagner, a Virginia Tech engineering grad who has worked for Honeywell's advanced materials business in the Richmond region her entire 22-year career, says Spectra still has great growth potential. "We foresee continuing to make improvements. We have not nearly reached the theoretical strength" for the fiber. R&D activity will continue at the company's Richmond regional. The S3000 fiber and Spectra Shield are just "one stopping point along the way."

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