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HAVING A BLAST WITH POLYUREA COATINGS

PHOTOS COURTESY OF SPECIALTY PRODUCTS, INC

BY MICHELLE GARDNER

How does a seemingly innocuous non-skid coating become a life-saving shield? Specialty Products, Inc. (SPI) of Lakewood, Washington was asked, and then tasked, by the U.S. military to develop an armor-like coating based on a commercial off-the-shelf (COTS) SPI product that could potentially save lives from fragmentation caused by explosive blasts.

SPI was somewhat surprised by the request because they had never envisioned their product becoming one that was used for blast mitigation. But how do you say no to a customer, especially when it's your country's armed forces?

'IT'S THE GOVERNMENT, LINE 1'

"I told my boss that I got a call from the Navy," says Shere Bush, SPI's vice president of government relations. "At first, I had no idea how to execute a government contract or participate in research and development with the Department of Defense, but I had some really wonderful people helping me," Bush says.

Bush credits relationships with coworkers and government contacts for helping get this product through the process.

"As a small company, we are more like family," Bush says. "Eventually, we find a way to solve problems. We can respond very quickly. We have an excellent team that makes these accomplishments possible."

SPI President Dan Helton concurs, and likes to use an analogy to describe his company's nimbleness. "Mice can dance faster than elephants," he says. "We have 50 employees and we have three lab people. Our people love the constant challenges to develop products that keep raising the bar."

ENTER THE DRAGON(SHIELD)

For Mike Cork, long-term chemist with SPI, initial challenges included determining what exactly was required by the customer.

"The important thing is you have to start asking the right questions," Cork says. "You need a working mental image of what needs to happen. You have to think in terms of [blasts] occurring in fractions of seconds. Acceleration is amazing, and that's what makes it dangerous. Fragments flying around are what are so deadly."

The next challenge was to create a product that would achieve the desired results. The trick was to find the maximum achievable strength and still have the product sprayable, says Cork.

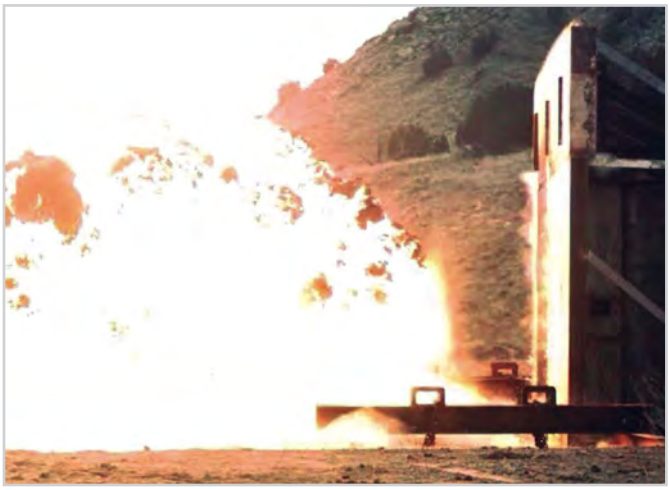
"There are a lot of materials to choose from, but they don't lend themselves to being sprayable," Cork says. "I used materials found in the casting business. I had to make it into a sprayable material."

Cork admittedly has strong feelings about hybrids of polyureas and polyurethanes. He claims they are mediocre in strength and can fracture.

"If I had to walk into a building that might be in harm's way, I want a greater 'catcher's mitt capacity,' a combination of high tensile strength and elongation," says Cork. "I was looking at different morphologies used in polymers and we developed a very respectable modulus. The important thing is that you really want to build a polymer that — whatever your final elongation — you want to build toward rapidly approaching maximum tensile strength faster than reaching a limit in elongation."

The result of Cork and his team's approach to achieving this balance was the Dragonshield-BC™ (DSBC), a 100-percent solids, no solvents, no VOC, ultra high-strength polymer that offers high-build and fast-set properties and is hydrophobic and stable at high temperatures.

"We enhanced its adhesive qualities to withstand the punishment it would take on metal substrates," says Helton. "Since 1989 we've developed over 7,000 formulations of mainly polyureas. We are still at the tip of the iceberg with respect to polyureas. With Dragonshield, a serendipitous byproduct is that polyureas are amorphous, which was beneficial to what our customer required."



ABOVE ▲ High-speed cameras capture split-second images of blasts, useful in analyzing shock waves that create fragmentation, which causes seventy percent of war zone deaths according to Specialty Products, Inc. of Lakewood, Washington.

ABOVE ▲ High-speed cameras aren't needed to see the difference between masonry walls protected and unprotected by Specialty Products' (SPI) Dragonshield, a spray applied blast-mitigation/energy-absorption product designed for field use by U.S. military forces.

BEND, BUT DON'T BREAK

The amorphous qualities of Dragonshield Helton mentions are very important in limiting the fragmentation of substrates used by the military. In amorphous coatings, atoms are randomly placed, which helps improve strength.

"Seventy percent of deaths in the war zone are caused by fragmenting," says Bush. She explains that the amorphous nature of the product helps maintain a cohesive strength as it "bends" when exposed to overpressure (pressure caused by a shock wave over and above normal atmospheric pressure), and shock.

Government-sponsored blast testing pitted SPI and competing products against each other in order to find the right solution for our servicemen and women. One test involved a 20-millimeter powder gun that shot a slug through a plate of steel. Velocity measurements determined that the slug travelled 2,370 feet per second (722.4 meters per second). Computer imaging was used to slow down the slug's passing so that evaluators could see how different types of fragments travelled after impact.

"We used multiple applications from ½- to 1/8-inch (1.27 – 0.317 cm) and reduced the blast standoff down to seven inches (17.78 cm). Even with these minimal parameters, our products met or exceeded governmental standards," says Bush.

Cork adds, "The results from the blast tests of ours and others, and how they performed, gave me some ideas as to how to optimize in the future. Once you submit a formula, you can't make a lot of changes. You can offer off-sets; the K-5 is a sister product to the Dragonshield and it is put on the bottom of jet boats."

BIG GUNS AND LITTLE GUNS

"Dragonshield has to be spray applied – using high volume Graco/Gusmer applicators," says Helton. SPI also distributes Graco. A fun fact is that Helton owns one of the first Gusmer H2 guns produced.

"Bought my first H2 in 1973," Helton says. "I had it on order all winter before they came out."

Bush says that after the DSBC project was approved, SPI sold the government 20 Gusmer H-20/35 machines for the application of Dragonshield.

"The government kept three systems in reserve to perform additional testing, and 17 were deployed," Bush recalls. "Subsequent to shipment, it was realized that the generators and compressors required for application were neither quiet nor stealthy. Smaller machines were required."

Responding to a Broad Agency Announcement (BAA) from the government, SPI received money to develop a new machine for use in the field. It was a fresh challenge, but SPI rose to the occasion.

"It took us 18 months to design and build," says Bush. "We call it the LPG – Low Pressure Gear. The compressor on the LPG is very small, about the size of a fist. You can put it on your back and jump out of a helicopter with it."

The challenge was made tougher by the fact that the government expected the machine to be easy to operate and to require minimal maintenance. "We had an MIT engineer who helped design the guts of the LPG," says Cork. "With the LPG, we have low-pressure, modest output to apply in remote locations."

Phase two of the challenge was to develop a polymer that could be applied with the LPG. SPI did, and the end result became their WS29 polymer coating, which was certified for blast resistance and released for mobile deployment with the LPG.

"You give up a lot when you can't maximize mixing at low pressure," Cork concedes. "Static mixers give very useable strengths. They are better than hybrids, but not as good as a plural component, high-pressure coatings. When we spray the WS29 at high pressure,

Disbelief was on the minds of many who watched Dragonshield survive blast testing, and disbelief almost stopped the product from ever being developed.

we get very good strength. We had to reduce viscosity as well as allow a maximum of 5 gallons of Part A and 5 gallons of Part B to keep it mobile for use in the field."

DON'T STOP BELIEVING

Disbelief was on the minds of many who watched Dragonshield survive blast testing, and disbelief almost stopped the product from ever being developed.

"There were so many naysayers that said it couldn't be done," Bush says. But now that Dragonshield is a reality, Bush is extremely pleased about this project.

"Knowing that we helped to save lives is the project's crowning achievement," Bush says. "I don't know anything that could be better than that."

Cork says nothing really surprised him during the development of Dragonshield.

"I worked on it so long, I kind of knew where I wanted to go," Cork says. "It's the application of science. You test, you make changes. A couple things we did were a bit of a jump, but it still fell within the boundaries of what polyureas can do."

Cork found the project's challenges personally rewarding. "Going to a different morphology brought a new collection of properties that conventional polyureas have difficulty in delivering. I got a charge out of that. It's the last coating you'll ever need!"

In addition to limiting the effects of blasts, Dragonshield self-seals and has been put to use in non-military applications. It may be sprayed onto the outside of fuel tanks to limit leakage in the event of a penetration. It could be used on railroad tankers to help protect the cargo, and the environment, in a derailment situation.

ON THE HORIZON

"I am still amazed at what could be done with elastomeric polymers primarily, and certainly the nanotechnology is gaining," says Helton. "Within five years, I believe there are going to be stronger strengths – not necessarily just tensile strengths – but fire retar-

ABOVE ▲ Since 1989 SPI has developed more than 7,000 formulations states president Dan Helton. Yet, "We are still at the tip of the iceberg with respect to polyureas," Helton says.

JOB AT A GLANCE

PROJECT:

Develop, deliver, and deploy blast-mitigation/energy-absorption products and build spray applicator for use in field for the U.S. military

COATINGS SUPPLIER:

Specialty Products, Inc.
2410 104th Street
Court South, Suite D
Lakewood, WA 98499
(800) 627-0773
www.specialty-products.com

PRIME CLIENT:

Various branches of United States armed forces

SUBSTRATES:

Concrete, steel, alloys, and other substrates

DURATION:

Eight to nine months to develop coating system and 18 months to design and develop LPG spray applicator for use in field

UNUSUAL FACTORS:

- Customer is U.S. military
- Some spray applications take place on or near battlegrounds
- Develop a spray unit that is mobile and easy to use
- Develop a lower viscosity product for use with mobile spray unit

MATERIALS/PROCESS:

- Develop an ultra-high-strength polymer with armor-like qualities
- Develop a less viscous polymer for use with mobile equipment
- Blast test polymers to successful result
- Design and build low pressure applicator and polymers for field use
- Package applicators and polymers for deployment in the field

SAFETY CONSIDERATIONS:

- Recommended that worker wear includes chemical safety goggles; hearing protection; full-faced shields if potential exists for splashing; and chemical-resistant, impervious gloves such as neoprene or rubber.
- When spraying in areas with inadequate ventilation, positive-pressure, supplied-air respirators are required.
- Blast testing performed by qualified experts.

SPI Advanced Applicator Training Available

"Heated plural impingement coating IS rocket science," says SPI President Dan Helton, who believes applicators should always be in the learning mode when it comes to using and applying these coatings.

"You cannot just hand someone a gun and product," Helton says. "We have a minimum of four training sessions a year, five to six days each, at our facilities in Dallas, TX; Anchorage, AK; and at our headquarters in Lakewood, WA. We typically try to limit each session to 18 students with a cut off of 24 people."

Classroom instructors are NACE Certified Level III Coating Inspectors, and the program includes audio/visual presentations, demonstrations, equipment operating procedures, troubleshooting, and extensive hands-on experience with spray guns, including a competition spray-off.

All classroom-related materials are furnished. Disposable, protective clothing is provided, but attendees are invited to bring their own protective gear. Participants are required to bring their own air-purifying respirators equipped with organic vapor cartridges and HEPA (P100) particulate filters. Fusion, GX7-Series, and D-7 guns are supplied, but trainees are welcome to bring their own spray guns for instruction on a more individual basis during the appropriate instruction period.

For further details, and to check out a cool Dragonshield blast test video, visit www.specialty-products.com or call (800) 627-0773.

dancy and coatings longevity. There will be a lot tougher materials. We are trying to develop an elastomeric polymer that will be truly fire-retardant and we've been working on it for seven years."

Cork adds, "We may go to the E84 test (ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials) pretty shortly. Polyureas don't lend themselves to fire

ABOVE ▲ To help apply Dragonshield at forward outposts where larger machines often dare not tread, SPI designed a fist-sized mobile spray applicator that, "You can put on your back and jump out of a helicopter with." A new polymer was developed to work with the mini-spray unit.

ABOVE ▲ SPI offers extensive hands-on training including a competition spray-off during their five- to six-day courses. Classroom instructors are NACE Certified Level III Coatings Inspectors.

retardancy. It's their Achilles heel. There are still many areas where we can go to learn the boundaries of where polyureas can go."

As one who has spent 20 years in epoxies and knows his chemistry well, Cork advises others in the industry to give polyureas a serious look and remember that the coating's precise limitations are as of yet unknown.

"Remember that these are organic materials – there is no such thing as a perfect coating," Cork advises coatings professionals. "They will have strengths and weaknesses. You have to have a working knowledge of what the coating can and cannot do. You have to have a firm idea of the environment it will need to perform in. Then you can choose the coating to achieve probably 99 percent of what you need it to do." CP

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