Building a Better World Through Technical Textiles

Groundbreaking textile research by Professor Seshadri Ramkumar and colleagues is impacting a variety of areas from the medical industry and the military to environmental cleanup.

by Toni Salama

The field of technical textiles is still in its infancy. Yet already its influence is far-reaching, quietly covering uses in a dozen sectors.

You probably diaper your baby and wipe it dry with technical textiles. You might tote your groceries home in an eco-friendly bag made of the stuff. Buy a new car, and you likely are enveloped by some of these versatile materials, even as you motor over a roadway with technical textiles embedded in the street's substructure.

At the forefront of this technology stands Texas Tech Professor Seshadri Ramkumar, of the Department of Environmental Toxicology's Institute of Environmental & Human Health (TIEHH). He and his team of researchers in the Nonwovens & Advanced Materials Laboratory are testing, developing and producing new substances that may make the world a cleaner, safer and more comfortable place to live. Ph.D. candidate Sudheer Jinka is conducting atmospheric plasma research, and Ph.D. candidate Vinikumar Singh is conducting research on cotton sorption for oil spills.

Making it to Market

The Advanced Materials research team's biggest success story, so far, is a chemical decontamination wipe called Fibertect. It's one of Texas Tech's first products to be commercialized. With its layer of activated carbon sandwiched between top and bottom layers of nonwoven material, Fibertect has tested highly effective in cleaning up certain chemical warfare agents, toxic industrial chemicals and pesticides. Fibertect is manufactured by Waco-based Hobbs Bonded Fibers; and Chantilly, Va.-based First Line Technology is marketing the final product to defense and homeland security sectors.

Another recent breakthrough: The advanced materials research team found that when spunbond polypropylene nonwoven fabrics are pretreated with atmospheric plasma, the number and size of the fabric pores are increased without compromising the fabric's barrier properties, as published in the Journal of Industrial Textiles. The practical application is that this fabric technology could find its way into the development of medical clothing—surgical masks, gowns and drapes, for instance—that is more comfortable, more breathable and, at the same time, more resistant to blood and microbial penetration. Ramkumar adds that this technology would deliver those qualities at a cheaper price than items currently on the market and in an eco-friendly way.

The Wide World of Nonwovens

Technical textiles are considered fabric, but most are not of the spinning-and-weaving variety.

“Conventional fabrics are designed mainly for the apparel and home-furnishing industries. They’re valued for their aesthetics, feel and comfort,” Ramkumar said. “Technical textiles are created for performance and protection.”

The production process of nonwovens is much like that of making paper or felt, Ramkumar explained. “In nonwovens technology, we skip many processes, which the conventional textile industry uses. This way we develop products such as wipes at high speed and reduced cost.”

However, the resulting web-like material is weak and must be bonded to provide strength, he adds. Depending on the type of web formation and subsequent bonding, Ramkumar said, nonwovens can be classified and used in the following ways:

- **Wetlaid**: tea filter bags are a good example
- **Spunbond**: most often used in packaging
- **Needlepunch**: found in automotive textiles
- **Spunlace**: for hygiene applications
- **Meltblowing**: used in filtration
- **Airlaid**: pulp fabrics

The automotive industry, especially, has taken interest in fiber-based nonwovens because the use of these materials can reduce the overall weight of a vehicle. The United Kingdom-based market research firm Textiles Intelligence predicts that by 2020 each automobile will contain about 35 kilograms, or 77 pounds, of textiles. The US based Association of the Nonwoven Fabrics Industry (INDA) trade group estimates nonwoven substrates may be used in some 40 applications within a single automobile, ranging from headliners to carpets, air filters to acoustic insulation.

Considering that market, Ramkumar said the advanced materials research group is exploring natural fiber-based nonwovens for sound absorption in cars.

Technical textiles can be engineered to protect more than tender eardrums. Fabrics with antiballistic properties can be made into soft body armor; others may be worn to protect against chemical or biological hazards. In this area, as well, Texas Tech’s researchers are on the job.

“We have patented a multilayer soft armor, predominantly used for law-enforcement personnel,” Ramkumar said. “It has a next-to-skin nonwoven layer, followed by multiple layers of antiballistic material. These antiballistic materials may be made from Kevlar, Spectra and Twaron.”

The Cotton Connection

The term “technical textiles” may create the impression that all such substances are synthetic. But the advanced materials group is conducting studies on low-grade cotton for its potential in cleaning up oil spills—research that is considered breakthrough work by the American Chemical Society. In recent months, this work has attracted coverage in international publications such as The Economist and The Guardian.

Raw cotton’s high crude-oil sorption capacity and positive environmental footprint make it an ecologically friendly sorbent for oil-spill cleanups, Ramkumar said.

“About 10 percent of the cotton grown in West Texas is low-micronaire/low-grade cotton,” Ramkumar explained. “It doesn’t take up a dye well, so it gets discounted. Our research shows low-micronaire cotton is less mature, it collapses, and more fibers can be packed into a given area. More importantly, the strength here is that the low-micronaire cotton absorbs the most crude oil. The oil not only sticks to the surface, the oil gets absorbed into the fiber.”

What the Future Holds

The Industrial Revolution of the 18th century took spinning and weaving out of the home and into the factory, bringing sweeping social and economic advances. In the 20th century, items made of plastic proliferated to such a degree that modern existence would be inconceivable without them. In the same way, continued discoveries and developments in technical textiles carry the potential to once again revolutionize everyday life.

At Texas Tech, the future is clearly a matter of continued research, hand-in-hand with education. The advanced materials group is focusing its attention on developing flexible materials for environmental remediation, human life protection and health enhancements.

“I feel research is constant education and always looking forward,” Ramkumar said. “With the help of good students, professors learn every day. This has been my story so far. As long as professors are enthusiastic about their research and are forward-looking, new inventions can come, and one day they will be put to good use.”

The Institute of Environmental and Human Health (TIEHH)

The Institute of Environmental and Human Health (TIEHH) develops environmental and health sciences research and education at Texas Tech and Texas Tech University Health Sciences Center.

The institute's goal is to position Texas Tech as an internationally recognized force in the integration of environmental impact assessment of toxic chemicals with human health consequences, framed in the context of science-based risk assessment to support sound environmental policy and law.

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