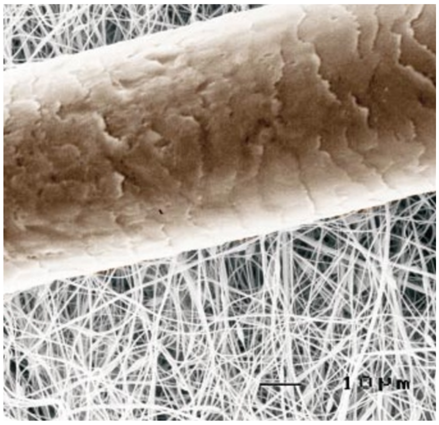
A fine set of threads

Ultra-thin fibres spun from polymers could be used to protect against chemical weapons, dress wounds and make brakes for aircraft. David Adam tells a gripping yarn.



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JEFF BRASWELL/ESPIN TECHNOLOGIES

Mighty mesh: built from fibres that make a human hair look bulky (left), the fabric (above) withstood liquid versions of nerve gas in tests.

The best-dressed soldiers of the future may not be wearing standard camouflaged battle fatigues, but a daring little number that Heidi Schreuder-Gibson likes to call "a head-to-toe odour-eater". By reviving a 70-year-old process called electrospinning, Schreuder-Gibson hopes to create a breathable fabric that can trap and deactivate lethal nerve gases.

Current chemical-weapons suits are relatively crude ensembles consisting of little more than Wellington boots and rubberized trousers and tunics. Such barrier protection keeps gases out, but also retains body heat — Gulf War troops found the suits stiflingly hot. Schreuder-Gibson and her colleagues at the Natick Soldier Center in Massachusetts may have the solution. Their fabrics are made from threads just a few nanometres wide that are 'spun' from drops of liquid polymer. Speaking to a packed session at the American Chemical Society's meeting in San Diego last month, Schreuder-Gibson described how she mixed catalysts capable of breaking down nerve gases into the drops of polymer. Fabrics made from the resulting fibres blocked liquid versions of nerve agents such as mustard gas and sarin.

Electrospinning's potential does not end there. Mix a substance that protects against infection into the polymer drop and the fibres could be used to create materials for wound dressings. Other researchers want to mix in compounds that release drugs over periods of time.

The technique dates from the 1930s. "The big textile companies had a look at it, decided it didn't offer anything new and put it aside," says Darrell Reneker, a polymer scientist at the University of Akron in Ohio. But the rise of nanotechnology persuaded Reneker and others to take another look. "We realized that what this technology offered was access to nanoscale diameters," he says.

By applying tens of thousands of volts, it is possible to overcome the surface tension that holds liquid drops together. The voltage pulls charge from inside the drop onto the surface, where it causes surface molecules to repel each other. These push away from each other, allowing new molecules to come to the surface. This makes the drop very unstable. Controlling the process is tricky, but, under the right conditions, the drop can become a rapidly growing polymer jet that follows a tightly looping spiral path. The jet's width shrinks to as little as three nanometres as its length increases.

Synthetic skins

Mats of polymer nanofibres can then be built up by collecting the rapidly solidifying jets on a surface. The technique works with over 30 different organic polymers, as well as some non-polymeric materials including carbon and certain ceramics. Electrospun fibres can cost up to 30 times as much as nanofibres produced by drawing out strings of polymer from solidifying polymer solutions. But this has not stopped eSpin Technologies, the world's only electrospinning company, based in Chattanooga, Tennessee, from shipping fabrics to researchers investigating their potential as synthetic skins, scaffolds for artificial organs and brake pads for aircraft. Customers are prepared to pay because electrospun fibres can be made one-tenth the thickness of conventional nanofibres. Researchers also like the ability to tweak the chemistry of the fibres and to control their diameter accurately, says eSpin founder Jayesh Doshi.

For Schreuder-Gibson, this difference in fibre width is critical. The thinner the fibre, the finer the mesh of fibres in the fabric, and the greater the chance of catching and breaking down an incoming molecule of nerve gas.

Ultimately, she hopes to create whole suits by electrospinning fibres onto mannequins, a process she estimates will take 10 years to develop. She also has one more trick up her sleeve. By blending carbon nanotubes and conductive polymers into the mix, Schreuder-Gibson's team have made fabrics that conduct electricity. Nerve gas sensors woven into the suit could then detect the gas and warn the wearer — making it the first odour-eater to neutralize offending chemicals while complaining about the smell. ■

David Adam is a news and features writer for Nature.

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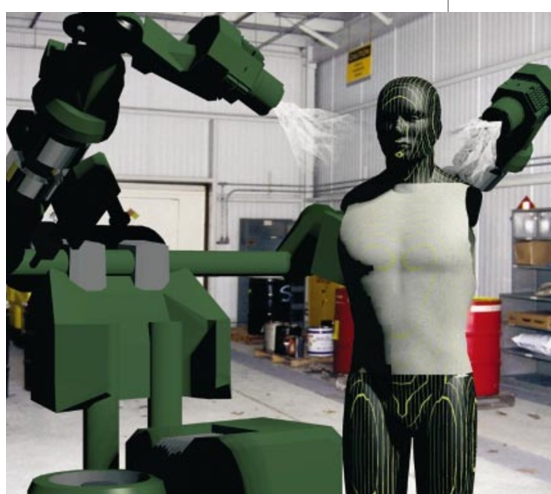

Suits you: ten years from now, garments may be made by spraying fibres on to a mannequin.