From the earliest days of the industry, producers of performance and sports textiles have had to contend with the problem of odour-control. The heat and moisture we generate during exercise offer bacteria the ideal conditions to multiply, and our clothes and shoes can make excellent breeding grounds. Silver has long been touted as a natural antidote, with a wide range of products on the market offering silver-based, anti-microbial properties as an important value-add. But doubts have begun to emerge about the long-term effects the metal could have on the human skin and on the environment

Silver lining loses its shine



Clothes that stay fresh and fragrant during exercise have an obvious appeal, as anyone who has had to load a kit-bag full of sweat-sodden socks into a washing-machine will testify. Manufacturers and brands offer a wide range of odour-control treatments, some of which seem unable to cope with serious smells, with others proving effective for a time, but losing their power after a few washes.

The odour comes from the breakdown of bacteria and other microbes on our skin that thrive in the warm, humid atmosphere of a sweaty armpit, wet running shoe or football boot. To combat the odour, you have to fight the microbes, and among the more successful methods for achieving this is to bring them into contact with silver. But this is the key question: do the microbes move towards the silver, or does the silver take the initiative and attack the tiny creatures? In other words, are silver-based anti-microbial treatments migratory or non-migratory? Big brands and retailers want to know.

The micro-organisms that textile manufacturers want to combat include fungi and yeasts as well as bacteria. And the problems they can cause go beyond bad odours; they can stain and discolour cloth and clothing. What these groups of organisms



The heat and moisture we generate during exercise create an excellent breeding ground for microbes.

Torben Laurberg

have in common is that they all need nourishment, moisture, warmth and a surface to call home. Provide these conditions and they will propagate wildly—there have been instances of entire container loads of garments going to waste because micro-organisms took over in transit.

In bed with biocides

It stands to reason then that, in talking about anti-microbial treatments in apparel or in other popular applications such as mattress protection, we're really talking about killing because the agents textile producers employ, including silver, act as biocides. "This throws up a series of important questions," says Alain Langerock, business development manager of Devan Chemicals. "If we're using biocides, we have to think about the safety of the people producing the textiles and of those wearing them. We have to think about cost, and also about the durability and effectiveness of the solutions we make. We also have to consider the environment."

Devan, a Belgian company, has the exclusive distribution rights in Europe of the anti-microbial systems of US-based Aegis Environment. Mr. Langerock talks enthusiastically about the Aegis commitment to non-migratory solutions. "The most common way of tackling micro-organisms is to use migrating anti-microbials that flow out of the textiles and move around to tackle them directly," he explains. "That means leaching out biocides. Do we want that on our skin? Do we want to sleep on that?"

Instead of going out to hunt them down, the system Aegis uses attracts the offending micro-organisms to silane-based anti-microbial agents that remain bonded to a nano-coating on the textile surface. As a result, the surface of the fibre has a negative charge, which draws the positively charged mirco-organisms to it and eliminates them. And, because there is no leaching, Aegis's claim is that the system will remain intact as long as the surface of the fabric does.

The company recently announced a string of new products, all with this surface-changing functionality. They include applications for mattress protection, enhanced stretchability, and improved odour control and moisture management. The two themes they all support are 'active hygiene' and 'active freshness'. "They are all reactive monomers," Langerock emphasises. "There is no release into the environment or onto the skin. We have no need and no intention to combine the technology with silver or any other migrating anti-microbial. Killing microbes is easy, but you release the metal [silver is far from the worst of them: another common agent in anti-microbial treatments is the metalloid arsenic] onto the skin and there is a trend among companies offering these solutions to overload fibres with silver ions to make the effect longer-lasting."

Ion the main chance

At the end of March, Huntsman's Textile Effects division entered into a joint marketing agreement with Toronto-based Thomson Research Associates (TRA) for Silpure, a silver-based anti-bacterial system that the Canadian company launched onto the market towards the end of 2005 as part of a range it calls Ultra-Fresh.

In launching the latest version of Silpure at Techtextil in Frankfurt in

A funnel-neck jacket from the Marks & Spencer Blue Harbour golf collection. The UK-based retailer is incorporating the Silpure anti-microbial treatment from Thomson Research Associates into the collection.

Marks & Spencer



June, Huntsman's Eberhard Agster said his company was excited about the possibilities for Silpure, particularly in protective wear and nonwoven clothing. He added: "You cannot see or smell the product; it's just on the fibre and it works. It gives the user a feeling of freshness, it's safe for the environment and safe for the end-user."

This last comment, given the views of Mr. Langerock, prompts the obvious question about the safety of a solution using silver if silver is migratory, but TRA's sales manager for Europe, Paul Milner, takes it in his stride. "It's true that retailers are keen on offering the added value of anti-microbial functionality, but they are insistent that they will not go with migratory products. I can tell you that the Silpure system is completely non-migratory."

His explanation is that the basis for the Silpure system is a silver salt—in this case silver chloride—that stays bonded to the fabric, while silver ions come to the surface to attack offensive microbes. "We have been able to demonstrate that the silver does not migrate; it's fully bonded in," says Mr. Milner.

Silpure has already attracted the attention of important retailers. Marks & Spencer, for example, has incorporated the technology into its Blue Harbour golf collection, comprising zip-neck jumpers and jackets, polo shirts and waterproof trousers in polyester, wool and elastane. [See panel for other sports developments involving silver that have come to light in recent weeks].

Paul Milner insists that Silpure works in a different way from earlier silver-based anti-microbial textile treatments and claims that the proof lies amid the Petri dishes and agar gels of the AATCC 147 test. This test uses the gel as a nutrient for bacteria and consists of seeing if anti-bacterial agents migrate into the gel to produce what Mr. Milner calls "a growth-free zone" around a textile sample. "Retailers now would regard anything that develops such a bacteria-free zone during the test as migrating," he explains, "and definitely not suitable for use with apparel."

On hand

The 'migratory' question usually refers to a product's solubility. If something is soluble, it will move or migrate into sweat, water or any other fluid surrounding it. If the product is a biocide, the possible consequences for the skin or the environment are obvious. Triclosan, a traditional anti-bacterial agent in textiles (as well as in soaps and personal care products, including toothpaste), often crops up as an example of a migratory product. It is no longer acceptable as an anti-microbial to apparel retailers in the European Union because it exhibits migratory activity in the AATCC 147 test.

This is not to say that Triclosan's owners at Ciba (from where, ironically, Huntsman acquired the Textile Effects business in July 2006) no longer make or sell the product. On the contrary, precisely because it stays on the skin, hospitals are finding it to be a good weapon to use in their fight against methicillin-resistant

Sporting chance

The nonwovens business unit of Freudenberg is heading up a consortium of companies, including Philips, to develop clothing as part of the European Commission's STELLA (Stretchable Electronics for Large Area Applications) project. The idea is to use silver-based conductive ink on stretchable fabric to remove the need for wires and make it safer for consumers to wear electronic devices next to the skin. One application Freudenberg and its partners have in mind is for gym wear. The conductive ink would allow connectivity to equipment that would monitor the user's heart-rate and breathing-rate. This is where Philips' interest comes in. Odour-control in the gym-wear is a possible spin-off.

Under its Novonic brand, Zimmermann of Germany has recently introduced a fencing jacket which has a silver polyamide woven into it. The company describes the product as being "super-light", while also offering—through the silver content—enough conductivity to enable electronic point-scoring systems, as well as anti-microbial qualities.



Test bed

The American Association of Textile Chemists and Colorists (AATCC) developed the 147 test method in 1976. An earlier method, AATCC 100, had proved effective in "determining antibacterial activity of diffusible antimicrobial agents on treated textile materials", but was also cumbersome and time-consuming. Method 147 offers an easier and quicker way to test textiles and coatings for bacteriostatic activity.

For and against

Opinion on the impact of silver and silver ions on the environment, on us and on our clothes is divided.

At the start of 2006, Samsung introduced a washing machine with technology it has trade-marked as SilverCare to the US market. In the United States, the company explained at the time, most laundry cycles use cold or warm water, and no bleach. "Prominent" scientists (according to Samsung) have shown that this often leaves laundry with "significant microbial contamination". In an attempt to make this contamination a mere mouldy memory, the manufacturer came up with the idea of adding "a grapefruit-sized device" to an otherwise ordinary looking front-loader. The "grapefruit" uses electrical currents to shave tiny particles from two silver plates "the size of large chewing-gum sticks". The result is that the washing-machine injects silver ions into each wash and, during tests, Samsung claims that the silver killed 99.9% of bacteria. "Our SilverCare technology has superb microbe-killing capabilities," said senior marketing manager Jeffrey Armstrong at a New York launch event.

On the other side of the country, however, a Californian water treatment expert, Chuck Weir, was at that moment lobbying public health officials, asking them to impose registration procedures on the new Samsung appliance. In a letter that *WSA* has seen, he said: "Silver is a toxic element that cannot degrade in the environment, and is registered as a pesticide in numerous products. To allow the unrestricted usage of a product that intentionally releases silver into the environment would be an irresponsible neglect of the principles of environmental sustainability."



Samsung's Zeus washing machine featuring SilverCare Technology.
Samsung

By the end of November 2006, the US Environmental Protection Agency (EPA) had decided to take action. It said that any company aiming to sell a product that it claims will kill germs by the release of silver will first have to provide scientific evidence that the product does not pose an environmental risk. In a frank admission, the EPA's director of pesticide programmes, Jim Jones, told the Washington Post that his office had previously made a distinction between pesticidal chemicals, which companies had to prove were safe for the environment before they could sell them, and pesticidal devices (including devices that release silver ions), which did not come under the same scrutiny. Mr. Jones told the newspaper: "We took a second look at the release of silver ions, and it was very clear that this is a pesticide and not a device. Our original determination proved not to be a correct one."

Soon afterwards, the EPA wrote to Samsung to say that the new washing machine now required registration under pesticide laws. Samsung says it is working closely with the EPA on this matter and, while at the time of writing it seems almost to have stopped marketing the SilverCare washing-machine, the model is still for sale in the USA.

Staphylococcus aureus (MRSA). Ciba has consistently argued that the product causes no harm to humans or the environment, even if clothes manufacturers and retailers seem unwilling to take a chance on it.

Paul Milner is adamant that Silpure poses no such risk. "It is based on silver chloride," he explains, "and is virtually insoluble. It is bonded to the treated textile and does not migrate. It works through surface ionisation, which means that in the presence of moisture, one of the conditions necessary for bacterial growth, the Silpure particles will produce a surface ion that neutralises the bacteria and is itself neutralised in the process. For this reason, it shows no migration in the AATCC 147 test." He argues that clients such as Marks & Spencer would refuse to work with TRA, and now Huntsman Textile Effects, unless this were true.

War of words

Back at Devan, Alain Langerock is the first to admit that it's only natural for rival companies to engage in a war of words from time to time, but he holds onto his conviction that Aegis's silane-based products are better.

"We have a lot of test data that shows silver is a migrating system, and it is really not difficult," he says. "If you shake a silver-treated fabric for some time in water, and you remove the fabric and analyse the water you will find silver ions. If you put bacteria into that water you will see that they will not survive. Companies offering silver technology have been arguing for some time that silver ions are the key. But they work because the ions enter into the micro-organisms and interfere with their DNA material and their metabolism. Fine, but how do the silver ions get inside the micro-organisms if the system is non-migrating?"

He believes some anti-bacterial products, including a number that are in use in the textile and apparel industries, are being "mis-branded" and urges retailers to think carefully before following the silver route—especially as alternatives are available.