The elimination of PFC-based DWRs is proving to be a long, step-by-step, fabric-by-fabric process. While the initial 2020 deadline set by some brands is being pushed back to 2023, this leaves extra time for R&D programmes that may yet yield new solutions.

# DWRs at a tipping point

by Sophie Bramel

First came the shock of "Chemistry for any weather" a report released by Greenpeace in October 2012, which called out sports brands' reliance on perfluorinated chemicals or PFCs in their durable water repellent (DWR) finishes. The pressure group followed this with new reports in 2013, 2016 and 2017 and its campaign now resides on a permanent website (detox-outdoor.org) where consumers are invited to contact their "their favourite brands" and urge them to stop using a chemistry that it claims is toxic and unnecessary. The well-orchestrated campaign has been instrumental in raising awareness and mobilising the industry to action. Though data is lacking on the specific impact of PFC-treated textiles in consumer apparel on the environment, the industry cannot pretend not to know about these persistent, bio-accumulative and endocrine-disrupting chemicals.

Many brands have heeded the call and announced their intention to phase out PFC-based DWRs by 2020. A few, Paramo in the UK, Vaude in Germany and Houdini in Sweden, have successfully made the switch. Gore Fabrics declared that it would be investing $15 million into research to find a suitable replacement.

The elimination of PFC-based DWRs has proved to be a slow process. The fact that alternatives so far do not present the same set of properties or the extended durability of PFC-based finishes means that brands need to settle for lower standards. For many performance brands, the only acceptable solution has been to replace long-chain C8 formulations with short-chain C6s that are said to be less harmful.

There is, however, mounting evidence that all perfluorinated formulations are toxic. In August 2018 the Zurich Statement on Future Actions on Per- and Polyfluoroalkyl Substances (PFASs), which cover C8, C6 and C4 DWRs, called for regulations and restrictions in the EU and other regions. The German Environmental Agency (UBA) has requested that ECHA include PFHxA (and its ammonium salt) to the REACH Candidate List of Substances of Very High Concern (SVHC); this targets C6 telomer chemistry. The EU also decided to include the cyclic siloxanes D4, D5 and D6 into the Candidate list in June 2018 making these key precursors for the silicon industry now SVHC, information that Stefan Posner, senior researcher at Research Institutes of Sweden (RISE, formerly Swerea) has shared with *WSA*. Philippa Hill, a PhD student at Leeds University in the UK and also a recognised expert on the topic said that compounds used in C6 have been found to be bio-accumulative.



*On its timeline to eliminate PFCs from its product offering, German brand Vaude presented its first PFC-free apparel collection for S/S2018 and aims to have phased out the chemistry for its backpacks and shoes by 2020.*

Vaude

## The need for boosters

If C6 becomes off-limits, the industry will have to face the facts and accept that the DWRs it can safely use will not offer the same level of performance with regards to durability and oil repellency. This setback can, however, be offset by adding a "booster" to improve overall repellency. These create a rough surface structure, similar to that of the lotus leaf.

Another problem brands and suppliers face is that alternative finishes, be they hydrocarbon-, polyurethane- or silicone-based, need to be adapted to each fabric. It is now common to develop a specific recipe for each type of fabric to be treated.

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*Gore Fabrics has announced it will be eliminating PFCs of Environmental Concern (PFCEC) from its laminates by 2023 and might have a solution for the future. Its highlight for A/W2019 is the introduction of a solution-dyed recycled polyester yarn in the backer fabric of its 3-layer laminates.*

*W.L.Gore*

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German textile chemicals company Rudolf Group began offering non-PFC DWRs 15 years ago under its Bionic Finish Eco label. This dendrimer-structured solution covers different chemistries depending on the material treated and functions desired. It is also sometimes used in combination with a booster, according to sales manager Sabine Beier.

The PFC-free DWR portfolio of Swiss chemicals supplier HeiQ includes 20 different variations and "building blocks" to adapt to each fabric, what the fabric will be used for and the customer's desired price point, says CEO and co-founder, Carlo Centonze. The company will be introducing a new PFC-free range shortly that it claims will meet the performance levels of a C6.

Singapore-based Archroma has introduced what it claims is a "universal" formulation for all types of fibres within its Smartrepel Hydro range of PFC-free DWRs. This silicone-based finish is also said to give fabrics a soft hand feel.

## Stain release properties

DWRs repel rain by modifying the surface tension of a textile, and is, one could say, their core competency. What non-PFC finishes lack is the ability to repel oily substances. In addition to boosters that prolong durability and heighten repellency, chemicals companies are also seeking to make their solutions release stains. US-based Chemours is working on adding an oil release function to Zelan, the non-PFC formulation of the brand Teflon, says European marketing manager Joscha Teubert, suggesting that a solution may be reached soon.

Green Theme Technologies (GTT), a company founded in 2011 and based in Albuquerque, New Mexico, has developed a new method for applying chemical finishes to textiles, including DWRs that it has trademarked Clean Chemistry. Its hydrocarbon-based fluorine-free HDF (High Definition Finish) DWR outperforms C8 and C6 finishes on a Bundesmann water repellency tester, says international sales manager, Mike Costa, and it will also release oily stains: "An oil stain will not stick to the fibre and will come out in the wash." GTT's waterless textile finishing process uses pressure (30 bar), heat (100°C) and a catalyst to "drive chemicals into the fibre," says Mr Costa via "a polymerisation process". The equipment is installed in a facility in Taiwan and Mr Costa says the company has already shipped a half a million yards of fabric. It is currently working on expanding its platform to include dyeing and a membrane-free waterproofing solution that could be ready for market this year.

## Natural chemistry

Innovation in textile finishing, including DWRs, is also on the agenda of Evolved By Nature, formerly known as Silk Inc., a company based near Boston and founded in 2013 by Dr Gregory Altman and Dr Rebecca Lacouture. Having developed cosmetics (Silk Therapeutics), the company is now looking to harness silk's properties for textile applications under a platform it is calling Activated Silk. "Almost all fabrics are coated in some form of chemistry, be it wrinkle-resistant cotton, anti-odour polyester or enhanced wicking for polyamide. Some of those chemicals are very persistent and don't belong on fabrics worn next to the skin," Dr Altman says.

Evolved By Nature has developed a process that extracts the precursor to silk protein by dissolving silkworm cocoons in water and salt, a technology protected by some 75 patents it says. Cocoons unsuitable for the silk fabric industry can be used and the larva can be left alive as well, giving it an eco- and animal-friendly edge.

"The beauty of our technology is that we can use silk to make materials wick water or repel stains," says Dr Altman. Activated Silk is



*2018 was the year Swedish outdoor brand Houdini switched all of its DWR finishes to PFC-free versions. The brand states took it eight years to achieve.*

Houdini

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designed to be a drop-in technology; it does not need a binder as this property is said to be built into the silk protein. "As silk is a natural polymer, the silk proteins seek to bind to everything they find," he says.

Production has already been scaled up and applications on polyamide, polyester and wool fabrics validated (as well as leather). On these materials, "silk forms a film and washing actually pushes the silk into the textile surface," says Dr Altman. The first product to come to market will be athleisure leggings made softer by the Activated Silk finish.

Next up for the company is to make its technology compatible with cotton and to develop a DWR finish. "A portion of the silk protein is hydrophobic and preliminary data indicates that it could be an alternative solution to fluorocarbon chemistry," he says.

Beyond Surface Technologies, based in Pratteln, Switzerland, is another company looking to make performance textile finishes from natural resources. Founded in 2008 by industry veteran Matthias Foessel, and funded in part by Patagonia, the company has developed four bio-based miDori platforms offering wicking, softening or quick-drying functions for cellulosic and synthetic fabrics. The fourth product range the company has yet to finalise is a water-repellent finish. Matthias Foessel is not happy with the company's current product: "The gap between PFC chemistry and alternatives is still too wide. There is room for improvement, and it remains quite challenging," he tells *WSA*.

Beyond Surface Technologies will be launching a new product this year that is derived from micro algae. These have been modified to produce a form of oil that can be used to create a wicking agent. Mr Foessel believes it will "be up to 13 times better than current finishes".

## Sticklers for fluorine

Nano-Care, a company based in Saarwellingen, Germany, has developed a solution for brands that need high-performance repellency. Its "intelligent hybrid" launched in February 2018 is based on a "silica dioxide backbone" that enables the company to reduce the amount of fluorine present in its Nanoflex F-Bond finish. "This process requires only 20 to 30 grammes per litre fluorination compared to current fluorocarbon systems that apply 60 to 80 grammes per litre," Nano-Care CEO, Oliver Sonntag, says. "Its manufacture is safe with regards to undesired side products such as PFOA, PFOS, along with PFHxA and fluorotelomer alcohols (FTOH)."

The company, spun off from the Leibniz Institute for New Materials (INM) in 2000, also offers a PFC-free finish, Nanoflex Repel-Eco Plus, but for high-performance markets, which include workwear, automotive, military and medicine, oil repellency is necessary, the company insists.



***Evolved By Nature, formerly Silk Inc. is developing a series of "activated silk" textile finishes and has plans to introduce a water repellent function.***

*Evolved By Nature*

Behind the chemistry, choice of terms is a key facet of this debate, and Gore Fabrics has convinced Greenpeace to introduce a nuance. The maker of the Gore-Tex PTFE membrane has obtained a new classification within PFCs distinguishing those that are of Environmental Concern, which W.L. Gore proposes to abbreviate PFCEC. "Our goal is to remove PFCs of Environmental Concern from the product itself and from the supply chain by 2023," says Gore Fabric sustainability manager, Bernhard Kiehl. The company says its PFC-free offering now covers 50% of its two-layer laminates and 70% of its WindStopper laminates.

But Gore Fabrics insists that oleophobicity is essential for a DWR to achieve desired efficiency. "A jacket may be exposed to body oils, food or sunscreen, and these may compromise water repellency. For extended use, a DWR with some oleophobicity will contribute to higher water repellency," says Mr Kiehl. One solution the company has been investigating is a new class of fluorine-based compounds that would not pose the same problems as current PFCs. This new research "involves the modification of the chemical class itself. We would be able to keep a great technology while minimising or removing some of its negative impacts," he says. The process is not yet ready for release as "our supply chain partners need to make sure that the compounds of this chemistry don't release any PFCs during manufacturing," and this "justifies a bit of patience," he says. It could conceivably meet the company's stated 2023 deadline.

From biotech solutions to innovation in fluorine chemistry, the race is still on for a solution that will not compromise performance while offering all the necessary guarantees of harmlessness to humans and to nature. The new developments in R&D labs promise yet more twists and turns on the complex and challenging road to cleaner DWR chemistries.

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