Step by step, major fibre producers, including Invista and Toray, are investing in new technologies that trade petroleum for renewable resources in the production of synthetic yarns. This signals a possible shift from niche to mainstream for bio-based materials.

New shades of green in biosynthetics

The production of synthetics from renewable resources has long been low on the textile radar. With the launch of a bio-derived Lycra yarn, which appears to be one of many projects at Invista, and the development of cheaper 'drop-in' biotech alternatives to petrol, the market for bio-based synthetics could be at a tipping point. In addition to Invista's flagship spandex yarn, Toray is also close to finalising a fully plant-based polyester under its EcoDear umbrella brand. Major investments are being channelled into the development of bio-sourced materials in Europe as well. The European Commission and a Bio-based Industries (BBI) Consortium have pledged to invest €3.7 billion over the next ten years to find uses for untapped biomass and wastes as feedstock to make sustainable, fossil-free chemicals, materials and fuels.

Launched this May, the new greener Lycra had been in development for two years. As one of the components that make up spandex, Invista now produces a bio-based glycol, which is said to make up 70% of the finished yarn. "The glycol we use is obtained via the fermentation of corn dextrose," says Arnaud Tandonnet, Invista's global sustainability director for apparel. The remaining 30% (MDI) is not bio-sourced. The company currently offers two yarns, in 44 and 78 dtex, and says these bio-derived versions have the same properties as conventional elastane. "There are no restrictions as to the possibilities. We should be able to produce all types of Lycra," says Mr Tandonnet. Production of the bio-sourced spandex was to start this autumn in Singapore, and some 300 to 400 tonnes made this year.

Originating from a conglomerate whose core business is refining and distributing petroleum, the launch of a bio-derived Lycra by Koch Industry-owned Invista could come as a surprise. Though Mr Tandonnet points out that this development is part of the company's Planet Agenda, a programme covering product sustainability, corporate responsibility and



Spanish company Equilicua makes simple everyday products, like rain ponchos, in a biodegradable bioplastic derived from potato, thus the name Spud poncho.

Equilicua

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manufacturing excellence. In recent years, Invista has formed a number of partnerships with biotech companies. The announcement this May concerned the development of a gas-fermentation biotechnology process with fermentation specialist LanzaTech. It follows partnerships formed to develop bio-derived chemicals with UK biotechnology firm Ingenza last year in October and bio-butadiene, a chemical used in the manufacture of nylon 6,6, with Portuguese bioprocess specialist SilicoLife in August 2013. These tend to confirm the company's intention of stepping up its bio-derived product range in the coming years. Furthermore, when Invista acquired Advansa in September 2013, it also gained access to a bio-sourced version of Coolmax made with a PTT fibre derived from corn and called Biophyl by Advansa (the bio-PTT most probably comes from Sorona).

Still in development, Ecolastane is another bio-based elastic yarn in the works. It is the focus of a pan-European research programme involving three laboratories, three innovation clusters and three private companies, including French trail running sportswear brand Raidlight. "We are at the midpoint of a three-year project to achieve a semi-industrial plant producing elastane and polyester from renewable resources," says Bruno Mougin, project manager at Techtera, a research cluster of technical textiles manufacturers—based in the Rhône-Alpes region of France—and part of Ecolastane.

The technology behind the process is a class of furanic monomers derived from lignocellulosic biomass. This biomass includes wood and various crop residues that have no other use besides burning, says Mr Mougin. It is to be used to produce bio-derived chemicals known as furfural, HMF, THF and FDCA, an oxidised furan derivitive, first obtained in 1876 but now identified for use in green chemistry. THF, or tetrahydrofuran, is a precursor to polymer production accounting for approximately 70% of the mass of an elastane filament. HMF (or hydroxymethylfurfural) will be used in the production of a 100% bio-sourced polyester. "Both bio-based fibres will have the same molecular structure as conventional petrochemical elastane and polyester," says Mr Mougin. "In theory we should be able to achieve the same fineness as conventional filaments, but we have yet to test them." The project still has two years to go, and Mr Mougin believes the fibres could be market ready, "if all goes well," in five years time. The companies involved in the project plan to market the fibres at prices similar to those of petrochemical synthetics. "There are few fibre producers remaining in Europe and our intention is to bring production back with high value-added products, such as elastane," he points out, while recognising that it will only be successful if the price is right.



The newly released Lycra T162R is partially bio-derived thanks to plant-based butanediol (BDO) obtained via the fermentation of corn dextrose.

Invista

Progress in polyester

Toray has recently improved upon its bio-based polyester with samples of a lab-tested 100% plant-based yarn and presented at the Outdoor Show in Germany this summer. The Japanese producer currently markets a 60% bio-sourced polyester using ethylene glycol derived from cornstarch. The "fully" bio-based polyester will be made using plant-based terephtalic acid (TPA). This new development is the result of progress made by US-based biotech firm Gevo that produces bio-paraxylene (bio-PX) extracted from treacle, or molasses, a by-product of the sugar industry. The two companies have been working together for years, with the first lab-made samples of a biopolyester made in 2011. Toray has since announced that it has secured priority purchasing rights from Gevo. The Japanese fibre producer also provided funding, along with The Coca-Cola Company, for the construction of a bio-PX pilot plant in Texas.

"Ecodear polyester is identical to conventional polyester and it can be recycled," says Steffen Meiler, head of marketing at Toray Europe, who says the company's long-term goal is to shift away from petrochemical to plant-based polymers. The Japanese conglomerate also produces a bio-sourced nylon made from castor bean oil, which is roughly 60% ricinus and 40% petrochemical. They are all a part of a company-wide sustainability programme known as EcoDream. "Since winning the Outdoor Gold Award 2014 for our fully plant-based polyester yarn, we have felt a change in the industry. We are working on several customer projects to implement plant-based polyester or nylon fabrics in the ski and outdoor businesses. We see an upcoming move toward fossil oil-free products and we are excited to have pioneering brands taking this direction with us," he adds.

Bio-based polyesters have previously been developed by Natureworks, that launched Ingeo

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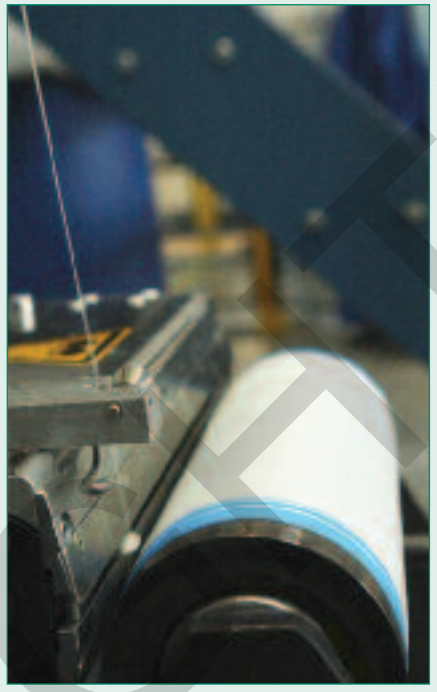
The making of Qmilk



Casein is extracted from dehydrated milk powder.



The milk protein is mixed with water and other natural ingredients, extruded and spun into a yarn.



The smooth, silk-like yarn is then spooled and ready for weaving or knitting.

Qmilk

(PLA), produced by Natureworks, and DuPont's Sorona, a PTT also known as triexta, first became available in 2006. Both are derived from corn, and DuPont says that Sorona contains 37% renewable plant-based ingredients by weight.

Ingeo is currently being used in insulation materials by Lavalan, a division of German company Baur Vliesstoffe. Lavalan adds 10% of Ingeo to the 90% natural fibre content of its insulation materials to improve dimensional stability and washability as well as bring down weight, said Baur Vliesstoffe sales director Matthias Böhme at ispo earlier this year. The yarn's thermo-bonding properties, due to its low melting point, have been said to improve the product value of nonwoven paddings. As for Sorona, an exhibitor at French trade show Expofil in 2013, the DuPont division is focusing on nonwovens and seamless knitting, thanks in part to the air-textured yarn's reported wicking properties.

Italian fibre producer Radici produces bio-based polyester and polyamide, marketing its PLA under the brand name Cornleaf and its castor oil-derived nylon 11 in the Radilon and Dorix ranges. The company says the nylon biopolymers contain 64% bio-sourced ingredients by weight. "Market awareness of reduced environmental impact yarns in general, and of our Cornleaf products in particular, has been growing and is expected to grow even more in the future, although volumes still remain modest," says Maurizio Vedovati, general manager of Noyfil SpA and sales manager for the RadiciGroup PET yarn business unit. He goes on to recognise that the low-temperature melting point of PLA remains a limitation and has kept the company "from producing the product on a large scale." The Italian producer has made sustainability a core value of its many businesses throughout the world. "Doing business sustainably is our duty," says corporate marketing and communication director, Filippo Servalli. "The path towards sustainable development is a cultural challenge that is not easy, but one that the world cannot avoid. What we need is a concrete approach, action."

These yarns have yet to be widely used in the industry, possibly due to their higher costs. But the situation could be changing here, also with the construction of a biomass-to-glycols biorefinery in the Anhui province of China. The technology used will be that of Danish biotech company Novozymes, which has entered into an agreement with M&G Chemicals and the Guozhen Group. Scheduled to open in 2015, the new plant is said to have a treatment capacity of one million tonnes of biomass per year. It will produce mono-ethylene glycol (MEG), a component of polyethylene terephthalate (PET) used to make polyester filaments.

Research is also being conducted on a furanic PLA process with Avantium. The Dutch biotech firm has developed what it calls YXY chemistry, a multi-step process that turns carbohydrate

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feedstock into mono-ethylene-glycol (MEG) from which a polyester fibre known as polyethylene furanoate, or PEF, can be made.

Biotech start-ups

In addition to major fibre producers and chemicals companies, the bio-sourced textile landscape is also changing thanks to input from smaller businesses looking for renewable alternatives to petroleum. Swedish cleantech company OrganoClick makes a bio-based durable water repellant finish that is attracting new users since Norway banned the use of fluorochemicals. The new brands switching to Organotex include Haglofs and Houdini. In January of 2014, Taiwanese textile manufacturer Chang-Ho formed a partnership with OrganoClick to offer a range of fabrics treated with the non-fluorocarbon chemistry. The finish lasts 20 washes, and has been tested by third-party institutes on both polyester and polyamide grounds, says business manager, Robin Grankvist.

In Germany, young entrepreneur and Qmilch founder Anke Domaske is making progress on a pilot plant to produce a casein fibre, Q-milk, from milk produced in Europe but unfit for human consumption. "It's been an exciting year for us," says Ms Domaske. "Our pilot plant is now set up. It is not yet up to full capacity, but we are working two shifts. Staff has expanded to 20 people, and we're continually adapting and optimising the process." The casein fibre is still in development, but could be ready for market in early 2015. "We have improved its mechanical strength, but we still have variations in the fibre. We need to make it as homogenous as possible to market a high-quality yarn," she says.

Anke Domaske has been busy with two other casein projects, including the launch of a cosmetic cream this past August and continued research on bioplastics for use in food packaging or technical applications. "Under certain conditions it could be possible to remould casein," says Ms Domaske, noting that for the sports industry, the compostable material could be used to make shoe components or garment trimmings such as buttons or zippers.

In Spain, Equilicua, co-founded by Maite Cantón in 2008, manufactures products made in a potato starch-derived bioplastic. The former marketing manager is focusing on items that can be used for outdoor activities, a market seen as more open to ecological materials. The two-person team has just launched an e-commerce website. "We strive to offer basic everyday products at reasonable prices," says Ms Cantón. The goal, she adds, is to achieve big volumes. "This is the only way to have a real impact on the environment." The so-called Spud raincoat is sold for €10 online and in concept stores in Europe, Asia and the United States. The potato-starch plastic is said to be biodegradable; a raincoat will 'disappear' in 180 days if composted. Ms Cantón has kept one of the first rain ponchos, made seven years ago, which is just beginning to break down now.

Though still small-scale, Equilicua is a real-world example of bio-sourced products sold at affordable prices. The biotech materials in the pipeline also intend to conform to rates currently applied to conventional polymers. If the price is right and the technology can drop in, implying no extra cost at production level, then it could be safe to say that these upcoming bio-sourced polymers are potential game-changers.



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