Reduced environmental impact fibres

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MATERIALLY

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Introduction

Determined by the increased speed with which nowadays it is possible to manufacture garments and accessories, and consequently fashion is delivered to consumers, paralleled by a significant fall in prices, in only a few decades a rise of 40% of the amount of clothes bought per person in the EU has been registered[1], causing fashion clothing purchasing habits to shift to clothing consumption habits. All processes involved - raw materials production, fiber spinning, textiles weaving, dyeing and finishing - require enormous amounts of water and chemicals, as well as energy, with the majority of clothes production taking place abroad.

In order to reduce the textile industry's environmental impact, a variety of aspects has to be carefully considered and efforts should be aimed at implementing or increasing recycled contents and/or biobased contents from easily and sustainably renewable resources, implementing or improving sorting and recycling technologies and processes, as well as wastewater-related good practices, reducing the use of toxic substances and processes and enabling virtuous EOL (end of life) options.

1. Environmental impact of the textile and clothing industry - Nikolina Šajn, EPRS | European Parliamentary Research Service [2019]

Introduction

The textiles industry plays a crucial role in the global economy and. Reducing its overall environmental impact also means safer and healthier working environments for hundreds of millions[2] to which this significant sector provides employment on a global basis.

Keywords

Reduced environmental impact textiles, sustainable textile products, sustainable textile manufacturing, textile life cycle, reduced environmental impact fibres, yarns and textile products, reduced environmental impact dyes and dyeing processes, reduced environmental impact finishes, reduced environmental impact end-of-life options

2. A new textiles economy: redesigning fashion's future - Ellen MacArthur Foundation [2017]

Goals

In order to illustrate how the ecological footprint of textile manufacturing can be achieved, a selection of case studies of commercially available products and processes has been evaluated.

Structure of the OER

1. Reduced environmental impact: fibers, yarns and textile products
2. Reduced environmental impact: dyes and dyeing processes
3. Reduced environmental impact: finishes
4. Reduced environmental impact: end-of-life options

1. Fibres, yarns and textile products

While the global market is offering a growing variety of fibers, yarns, and woven and knit textile products featuring post-industrial and post-consumer recycled contents, choosing recycled raw materials - biological or technical nutrients - does not represent the only way to reduce a fabric's environmental impact. In addition to the adoption of recycled and easily recylable fibres, options include fibers and yarns manufactured with high-performance biopolymeric yarns from easily renewable resources which are non-food crops.

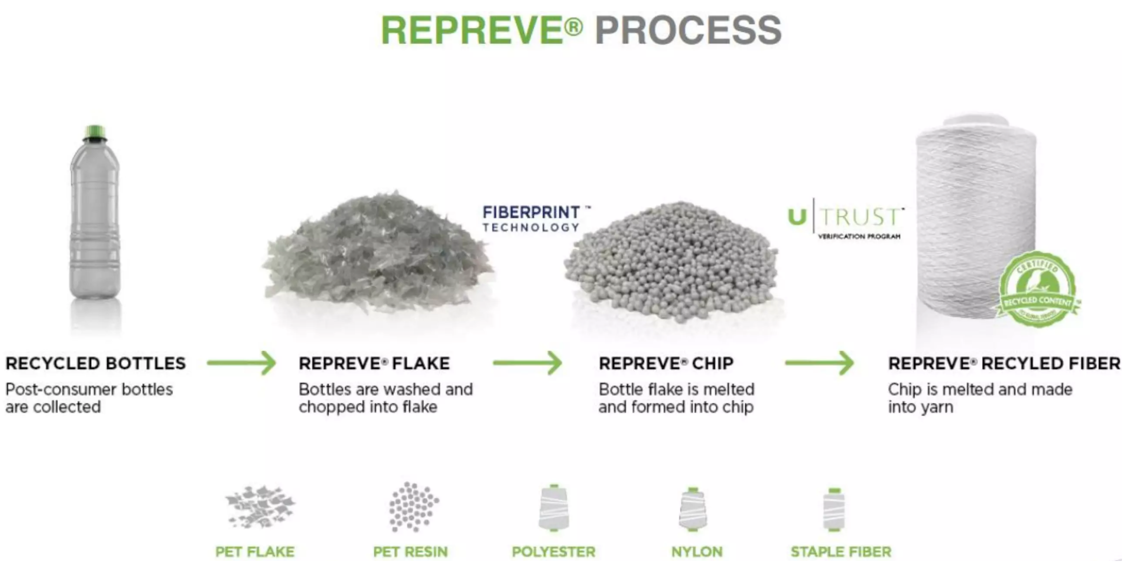
case study: Repreve®

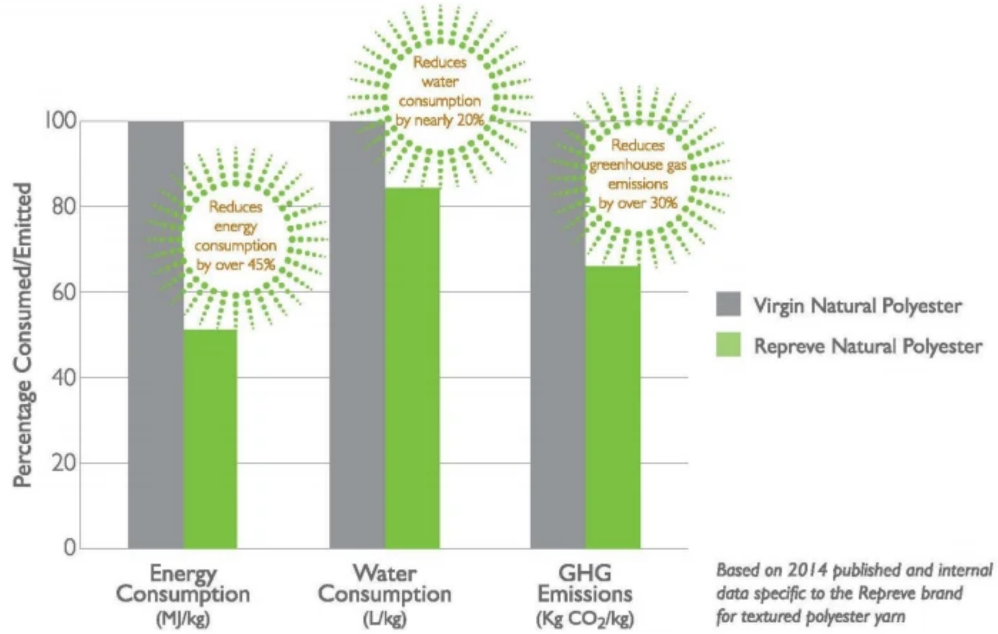
Repreve® by Unifi, Inc. is a recycled performance polyester fiber manufactured with PET (polyester) from recycled materials, including post-consumer drink bottles. The filaments produced are comparable in everyway to virgin polyester; including physical strength, processing techniques and visual quality. To create the fiber, bottles collected from recycling centers are chopped into bottle flake, which is washed to remove residue. The flake is ground fine and melted into pellet form. The PET pellets are then processed into continuous fibers by melting and extruding them through spinnerets, creating thin streams of soft PET, which cools into long fibers.

Unifi, Inc.
https://repreve.com/

case study: Repreve®

These fibers can be woven, knit, or used in nonwoven processes, to make all types of textiles. Fibers are offered as either continuous filament, staple fibers of 1 to 1.5 in. (25.4 to 38.1 mm), or spools of yarn. All fibers are colorless and can be dyed with either solution dying, or package dying techniques. Fiber length and yarn denier are both customizable, performance attributes and coatings can also be added to the fibers including, flame retardant, moisture wicking, UV protection, and stretch. Applications include clothing, sportswear, outerwear, accessories, automotive textiles, and upholstery.





Unifi, Inc.

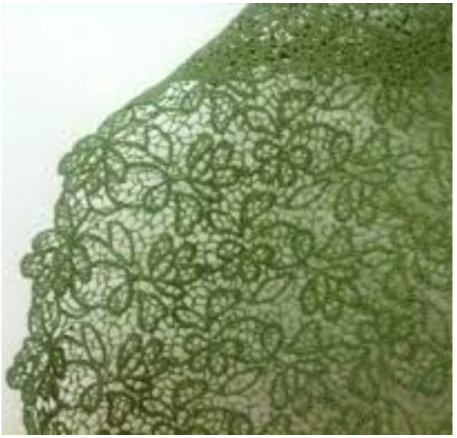
https://repreve.com/

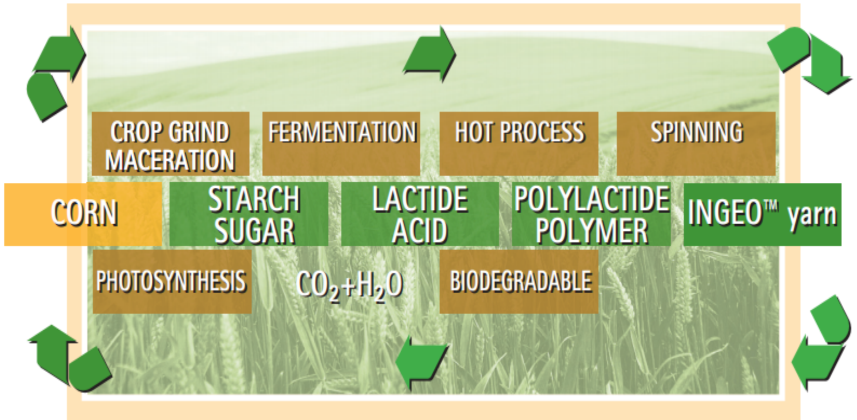
case study: Cornleaf

CornLeaf by Radici Group is a continuous PLA (polylactic acid) filament yarn manufactured with INGEO™, a biopolymer synthetized using plants like corn, cassava, sugar cane or beets to capture and sequester CO2 transforming it into long-chain sugar molecules.

This yarn product is originated from renewable resources. 100% biodegradable and 100% compostable. The highest level of sustainability is achieved by the raw and dope dyed versions. It is very light - its specific weight is lower than that of natural fibers - and features a tenacity comparable to synthetic yarns, greater hygroscopicity than synthetic yarns and faster drying capacity compared to natural fibres.

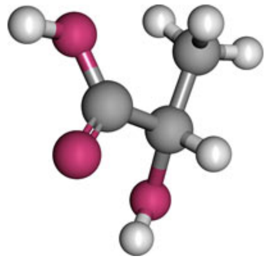
Its elastic recovery exceedes 90% at 5% strain, its UV resistance is excellent, since it dissipates UV radiation. Its is a safe product, with low flammability (LOI>26%) and no release of toxic fumes. It is also available with antibacterial properties (bacteriostatic effect) imparted by HeiQ's additive.





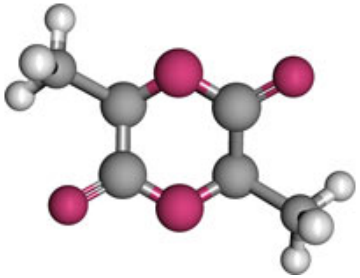
Radici Group
www.radicigroup.com

case study: Cornleaf



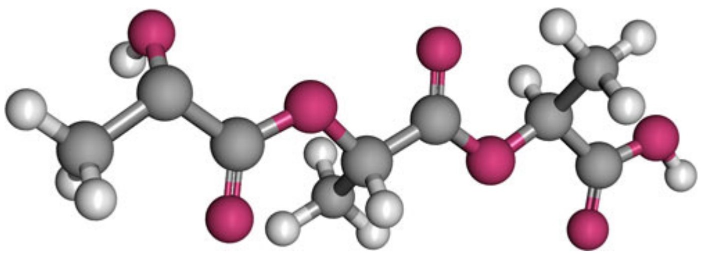
Creation of lactic acid, the building block of Ingeo

The plants are put through a milling process extracting the starch (glucose). Enzymes are added to convert the glucose to dextrose via a process called hydrolysis. Microorganisms then ferment this dextrose into lactic acid.



Transforming lactic acid to lactide

A proprietary two-step process transforms lactic acid molecules into rings of lactide, which is a valuable chemical on its own and the core of the manufacturing company's customizable platform of chemical intermediates.



Polymerizing lactide into Ingeo PLA

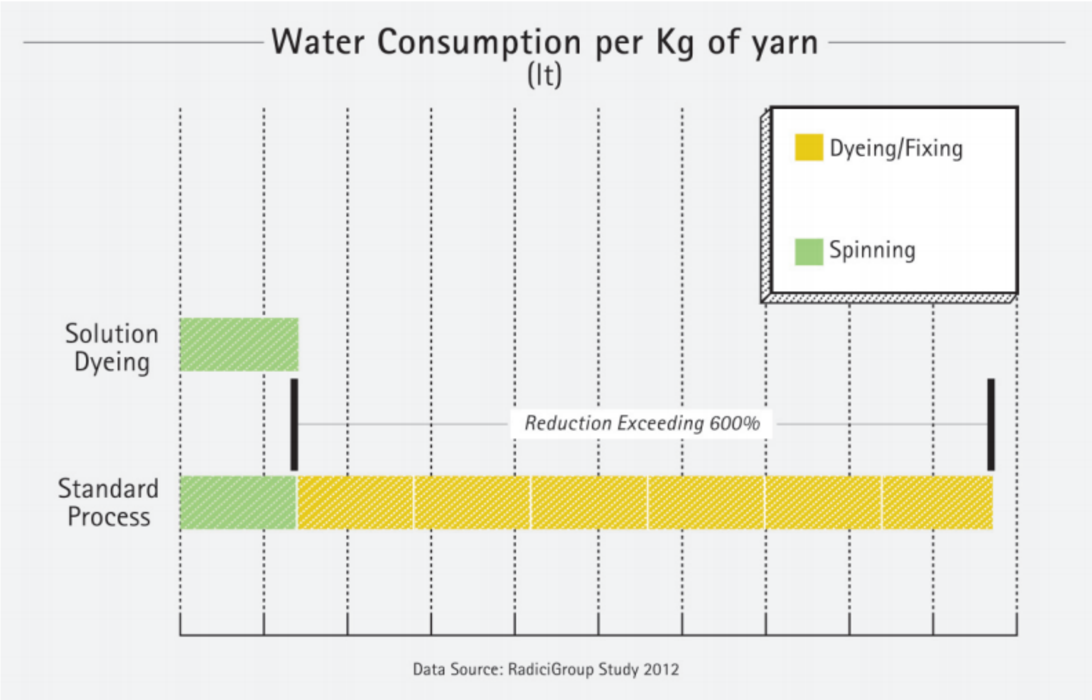
In the process of polymerization, the lactide ring is opened and linked together to form the long chain of Ingeo polylactide polymer. This long chain of Ingeo PLA is formed into pellets suitable for injection moulding or extrusion purposes, or for extrusion into fibres.

Radici Group
www.radicigroup.com

case study: Cornleaf

FIBRE PROPERTIES-COMPARISON

Properties	PA6	PET	VISCOSE	PLA	COTTON	SILK	WOOL
Specific Weight	1.14	1.39	1.52	1.25	1.52	1.34	1.31
Tenacity (cN/dtex)	4.2÷4.8	4.5÷5.5	2.0÷2.5	3.0÷4.0	2.0÷4.0	3.2÷3.8	1.2÷2.0
Moisture Regain (%)	4.0÷4.5	0.2÷0.4	11÷13	0.4÷0.6	7.0÷10.5	10÷12	14÷18
Melting Point (°C)	215	255	-	170	-	-	-
Elastic Recovery (%)	89	65	32	93	52	52	69



Radici Group

www.radicigroup.com

2. Dyes and dyeing processes

In addition to the main constituents of textile products, fibers and yarns, dyes used for different types of fiber and used at different stages of the textile production process may contribute to reduce a textile's environmental impact. Depending on fiber, yarn, textile, construction and garment, as well as fiber, dye lots size and quality requirements the dyed fabric must satisfy, textile materials can be dyed using different processes, typically batch, continuous or semi-continuous.

Colored, organic, surfactant, toxicant and chlorinated compounds and salts represent the primary pollutants in textile effluents[3], to which up to 200,000 tons of dyes are lost every year during dyeing and finishing operations, due to process inefficiency[4].

The textile industry consumes a substantial amount of water in its manufacturing processes: water is primarily used for dyeing, rinsing and finishing operations, or for the application of auxiliary chemicals. Resulting volumes and composition of the generated effluents make the wastewater from textile plants the most polluting of all industrial sectors[5], therefore plant-based dyes and waterless dyeing solutions represent sustainable options.

3. Bioremediation and Detoxification of Synthetic Wastewater Containing Triarylmethane Dyes by Aeromonas hydrophila Isolated from Industrial Effluent - CJ Ogugbue, T. Sawidis, Biotechnology Research International [2011]

4,5. Alteration of in vitro and acute in vivo toxicity of textile dyeing wastewater after chemical and biological remediation - H. Ben Mansour, I. Houas, F. Montassar, K. Ghedira, D. Barillier, R. Mosrati, L. Chekir-Ghedira, Environmental science and pollution research international [2012]

case study: ColorZen®

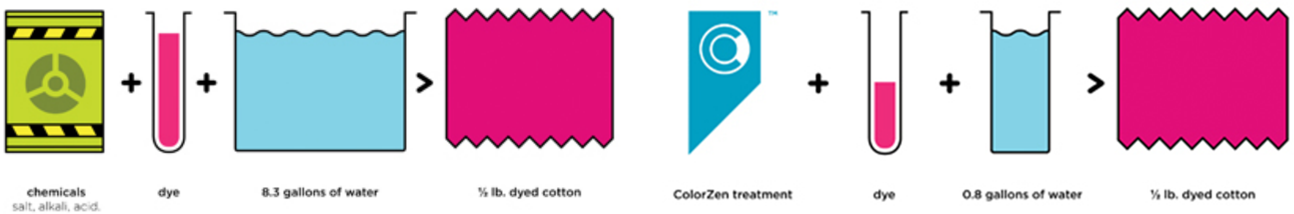
Cotton dyeing, which is one of the most chemically-intensive industries on earth, contributing to a major global pollution crisis. Generally, cotton and dye are both negatively-charged and this repellent behavior creates the need for significant amounts of natural resources, high temperatures, toxic chemicals, and long cycles to force them to bond together. With the standard dyeing process, a single dye cycle can take up to 8 to 12 hr to complete, increasing costs while constraining the productivity for manufacturers and brands.

ColorZen® by ColorZen Inc. is a sustainable, cost-effective, and more efficient solution based on applying a patented permanent treatment to raw cotton that creatively changes the molecular structure of cotton to a positive charge, thus generating a natural attraction to dye. The treated cotton during dyeing requires far less water (as much as 90%), energy (75%), time (70%), and toxic dyes and chemicals (up to 95%). In addition, with up to 97% dye retention, the water left over after the dye cycle has minimal color and can be reused as opposed to the traditional dyeing, which can leave up to 50% of dyes in water. As a result, it protects the freshwater supply while increasing the production capacity by up to 300%. The treatment at the fiber level also provides supply chain flexibility, giving the ability to ship the treated fiber to any manufacturer around the world.

ColorZen Inc.
www.colorzen.com

case study: ColorZen®

The fiber’s unique properties allow it to be dyed in innovative colors and patterns that would otherwise be too costly and take too long to produce. By blending the treated and traditional untreated cotton into a single yarn, the product can be dyed as a fabric or garment to produce heathers, stripes, and other new effects on demand, thus accelerating their speed to market. The treated cotton fiber is Oeko-tex 100 certified. The ColorZen treatment is based on a technology that works by altering the molecular structure of the cotton fiber. Think of conventional cotton and dye like magnets that are both negatively charged, repelling each other with identical polarities. When ColorZen’s treatment is applied to the surface of raw cotton, the technology reverses the charge of the cotton, allowing the dye to quickly and easily bond with it. That’s what allows ColorZen to eliminate the need for the toxic chemicals that otherwise are required in modern dyebaths. When ColorZen’s treatment is applied to the surface of raw cotton, the technology reverses the charge of the cotton, allowing the dye to quickly and easily bond with it. Moreover, this technique reduces the amount of water to produce cotton, which normally it is needed 10.000L of water for dyeing 1 kg of cotton.



ColorZen Inc.
www.colorzen.com

case study: Food Textile

The Food Textile project is a joint effort between Toyoshima & Co., Ltd., food and beverage manufacturers who provide the ingredients for obtaining the dyes, and garments and accessories manufacturing companies that use the fabrics colored with these dyes to create their products.

Food Textile is a new range of cotton textiles that brings out the ‘color’ of food through food-derived dyes. Using a patented technology, it recreates gentle food hues by taking vegetables and other leftover food from local food processing companies that is typically discarded and converting it into dyes.

The dye contains over 90% natural ingredients. By upcycling food waste, the manufacturer produces textiles that are naturally dyed yet durable and resistant to fading. The collection offers a wide range of color shades derived from specific fruits, vegetables, herbs, and beverage residues.

Toyoshima & Co., Ltd.
www.foodtextile.jp

3. Finishes

In order to improve or modify the physical, performance and sensorial qualities of an existing textile product - its appearance, performance, hand and functional properties - different finishings may be applied through a series of processing operations.

Performing wet processing techniques typically implies consuming a lot of energy and water, making the water and carbon footprints of these procedures extremely high, furthermore vast quantities of complex and frequently potentially hazardous chemicals are often used.

In addition to being based on improved, sustainable formulations using natural ingredients, water-free technologies and further potential substitutes for water and chemical-intensive wet fabric finishings should be suitable for a variety of textile product types and possibly not require specific equipment and significant investments: easy to implement, effective procedures have greater chances of being acquired.

case study: ecorepel® Bio

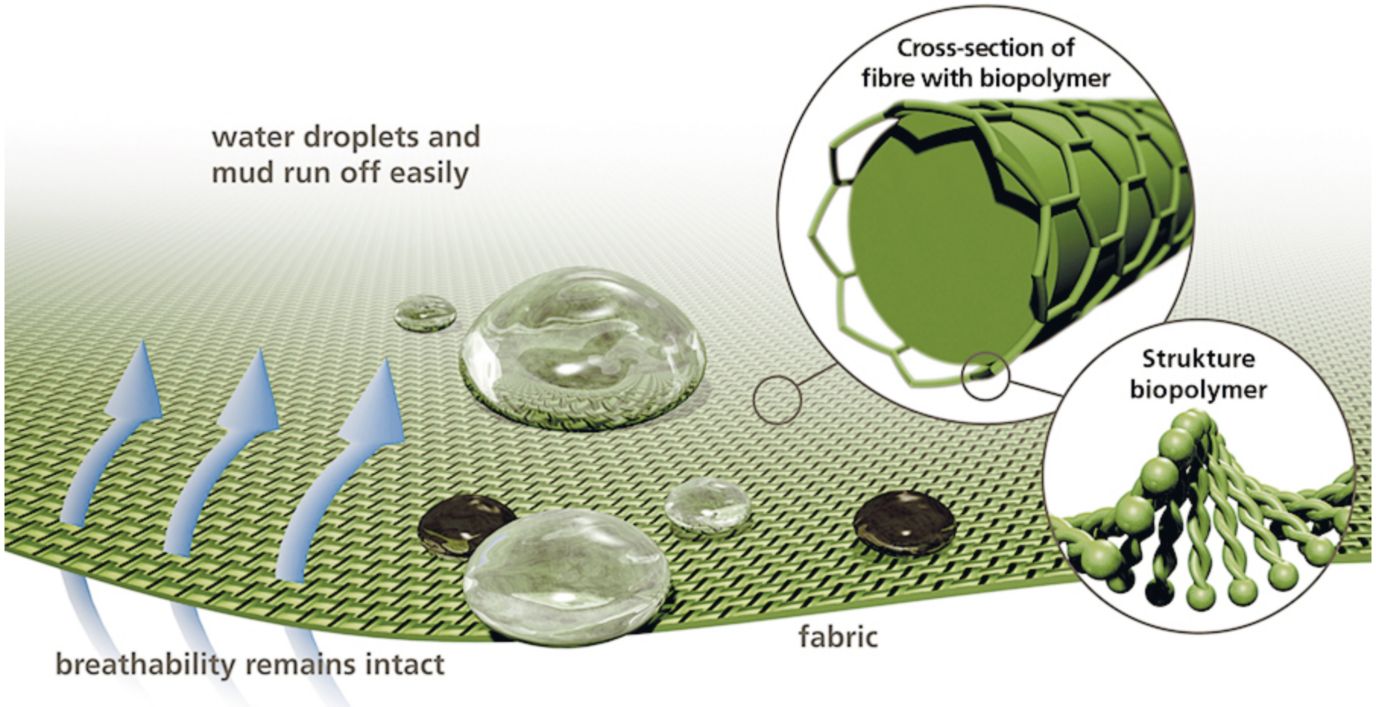
ecorepel® Bio by Schoeller Textil AG is a water and stain repellent finish for textiles which mimics the natural protection of ducks and other water fowl, available exclusively on Schoeller® fabrics. Ducks produce an oily secretion that allows their plumage to repel water; this finish mimics this natural impregnation through a very fine film of biodegradable paraffin ‘chains’ that wrap and bind themselves spiral-like around individual fibers, filaments or yarns. The paraffin ‘chains’ act to reduce the surface tension of the textile so that water droplets and watery dirt run off easily.

Schoeller Textil AG

www.schoeller-textiles.com

case study: ecorepel® Bio

This finish is based on renewable primary products: agricultural products not used for foodstuffs or animal feed, which do not include genetically-modified plants. It foregoes all fluorocarbon-containing components and is therefore PFC-free. It is odorless, contains no fluorocarbons, does not affect the breathability or hand of the fabric, has outstanding wash resistance, and the functionality can be reactivated in the dryer. This finishing technology is effective on many types of fibers and fiber blends and is bluesign® approved.

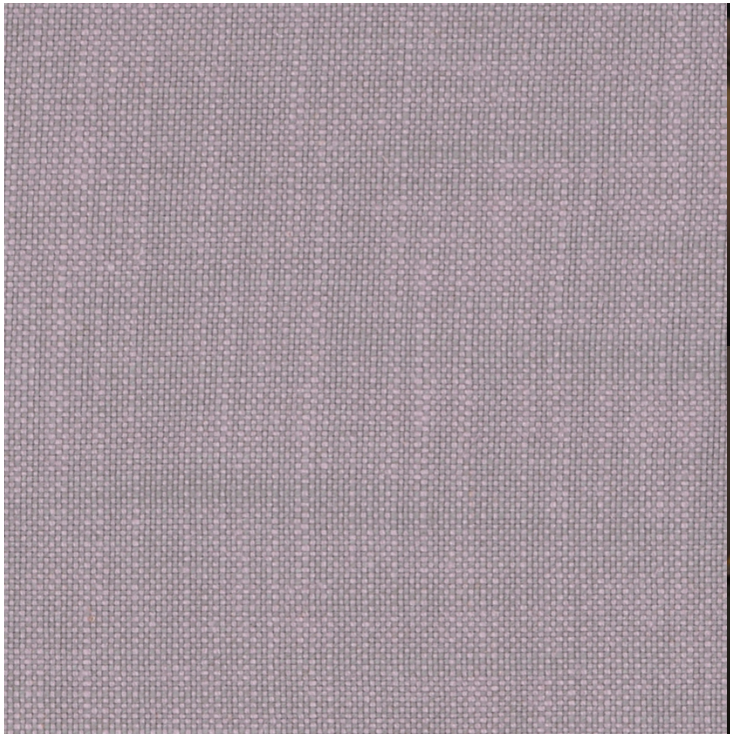


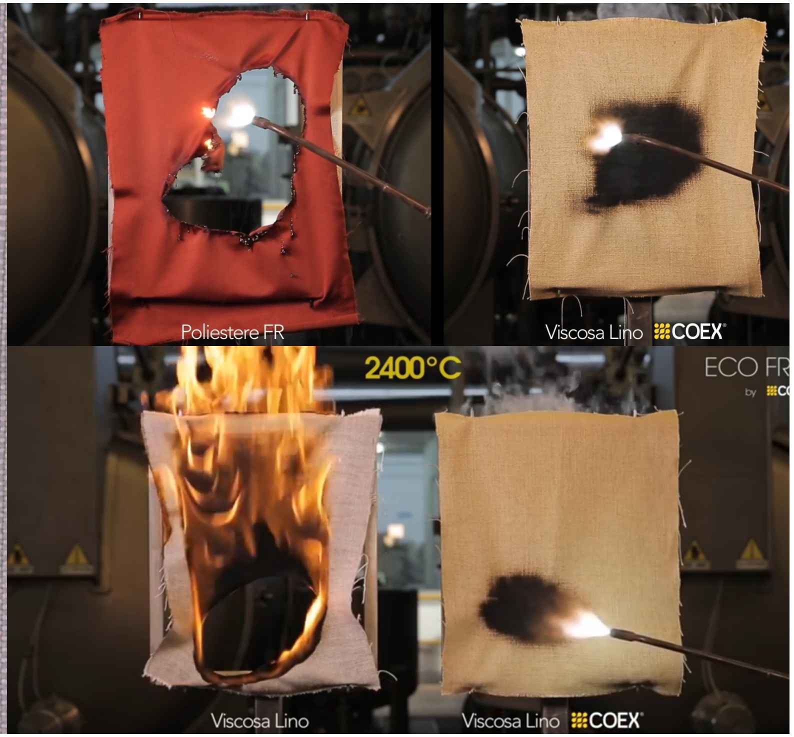
Schoeller Textil AG

www.schoeller-textiles.com

case study: ECO FR

ECO FR is a drapery and upholstery fabric made of 70% viscose and 30% linen that is both flame retardant and biodegradable. An innovative, patented technology is used to create a natural flame-retardant yarn. A molecular modification of the cellulose causes the fabric to carbonize, binding oxygen and therefore controlling the flames.





Christian Fischbacher
www.fischbacher.com

case study: ECO FR

The textile protects naturally against fire and fulfils all standard tests for flame retardancy. Furthermore, Eco FR fabrics exhibit natural humidity regulating qualities and are hypoallergenic, as well as antistatic. All fabrics in the range are made in Italy. Applications include residential, hospitality and retail environments.

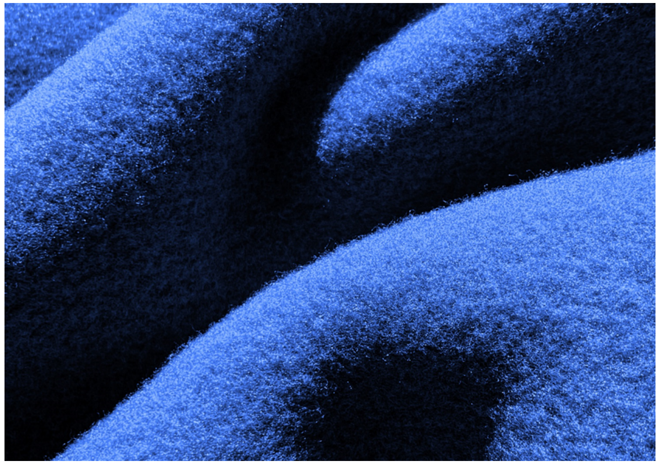
Christian Fischbacher
www.fischbacher.com

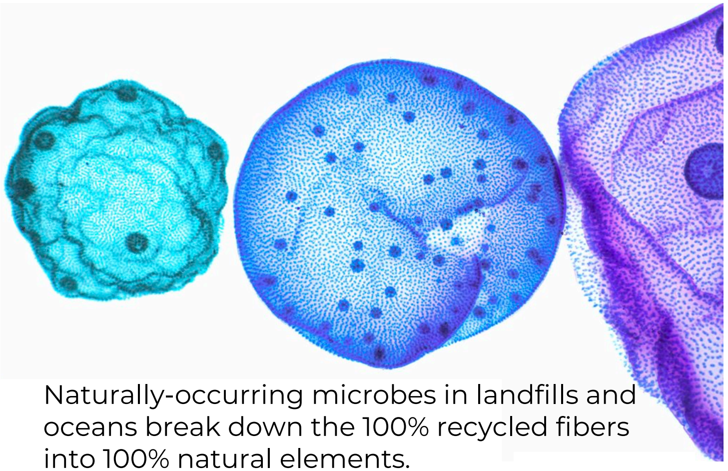
4. End-of-life options

Manufacturing sustainable textiles also implies carefully designing their end-of-life destination. Typical solutions rely on simple or optimized recyclability and/or compostabily, and on the possibility of making textile products with mixed compositions easily separable into their distinct fibres, layers or constituents. Advanced solutions include the possibility of switching from one cycle to another, e.g. from a technical cycle to a biological one by using raw materials from the technosphere to manufacture textile products meant to end as nutrients for the biosphere.

case study: PrimaLoft® Bio™

PrimaLoft® Bio™ is the first 100% recycled, biodegradable synthetic insulation and fabric. It is made from 100% post-consumer recycled material and its fibers break down, without affecting their performance characteristics, when exposed to specific environments, such as a landfill or the ocean. The fibers have been enhanced to be more attractive to the naturally-occurring microbes found in these environments, which eat away at the fibers at a faster rate, returning the fabric or insulation to natural elements: 93.8% biodegradation in 646 days under ASTM D5511 conditions (accelerated landfill environment); 74.3% biodegradation in 889 days under ASTM D6691 conditions (accelerated marine/ocean environment) - the stated rate and extent of degradation do not mean that the product will continue to degrade.



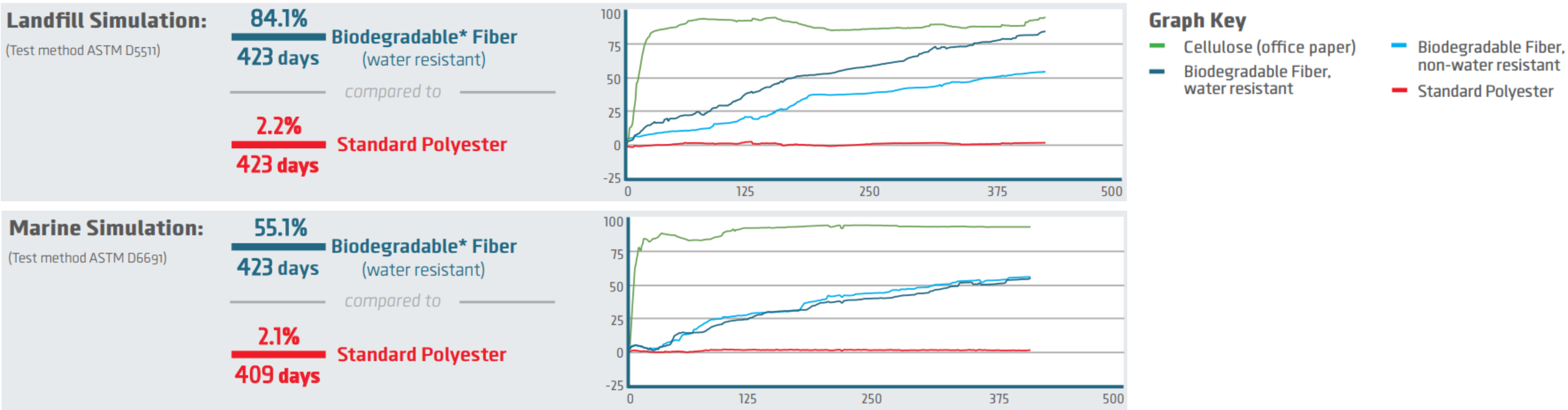


Naturally-occurring microbes in landfills and oceans break down the 100% recycled fibers into 100% natural elements.

PrimaLoft, Inc.
www.primaloft.com

case study: PrimaLoft® Bio™

The biodegradation process leaves behind water, methane, CO2 and biomass.
It is estimated that half a million tons of plastic micro-fibers shed during the washing of plastic-based textiles such as polyester, nylon, or acrylic end up in the ocean every year. PrimaLoft Bio fibers will only biodegrade when exposed to the naturally-occurring microbes in landfills or bodies of water, thus, the fabric remains highly durable throughout its usable life cycle in a garment.. Applications include synthetic fabric and insulation, which can be found in outwear, accessories, sleeping bags, bedding and mid layers.



PrimaLoft, Inc.

www.primaloft.com

Visit http://destexproject.eu/ to see the rest of the intellectual outputs of the project

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