FINNISH TEXTILE & FASHION

Ecological
Textile Fibres
from Finland

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Finnish Textile & Fashion 09/2023
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Cover photo: Halti/Spinnova

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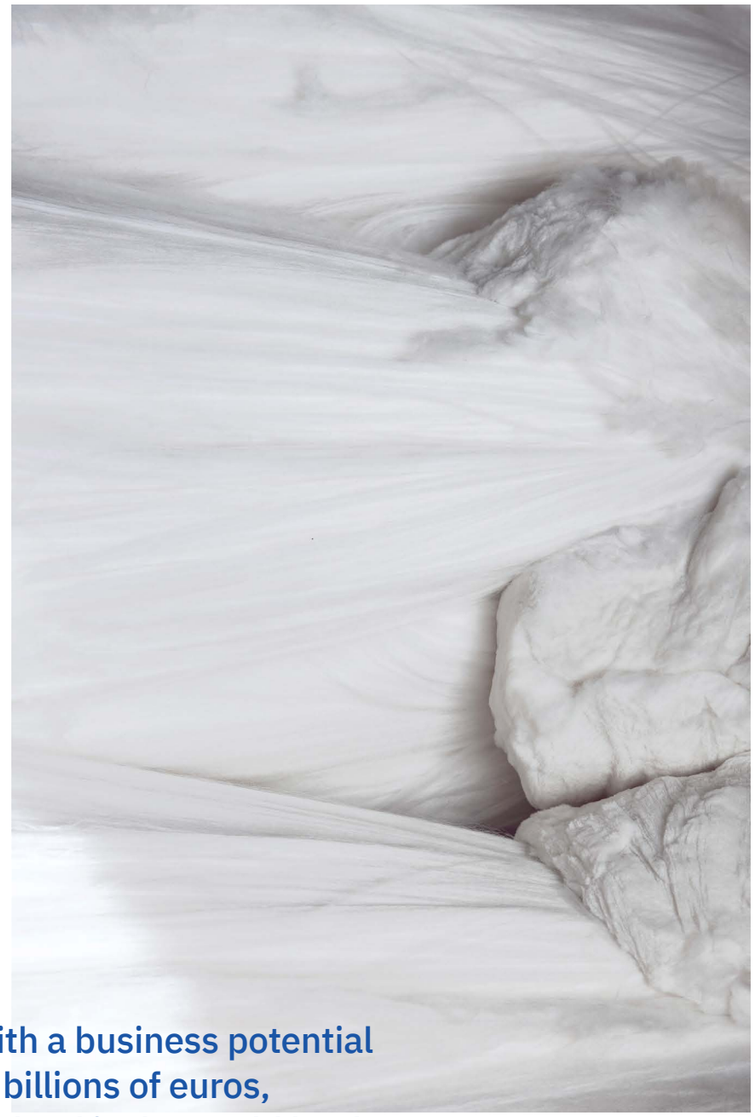
Introduction



With a business potential of billions of euros, Finland is the world leader in new cellulose-based textile fibre innovations.

Photo Spinnova

This is an introduction to the new generation of textile fibres – innovations that offer huge opportunities!

New fibres are entering the market at a fast pace revolutionising our current perceptions of responsibility, and opening doors for a more sustainable textile and fashion industry.

As a result of successful research and development in Finland, there are now several new ecological textile fibres that can be manufactured from bio-based and recycling-based raw materials high in cellulose. Favourite garments that have reached the end of their lifespan, wood, agricultural side streams, wheat and rice straw – all this is valuable raw material when Finnish companies develop solutions for the biggest problems in the global textile industry.

Over the last 30 years, the production and consumption of textile fibres have almost tripled. The production of natural materials has not increased significantly. The increase is almost exclusively a result of the rapid growth of the production of man-made fibres. In addition to synthetic fibres, the fastest growth potential is now predicted for man-made cellulosic fibres.

World's clothing giants are eagerly waiting for new materials to enter the market to fulfil their strict climate and responsibility targets.

Finland is the world leader in the development of new cellulose-based fibres for several reasons. First, Finland has a strong tradition in forestry and solid knowledge in the processing of cellulose. This gives Finnish companies a unique advantage in creating new textile fibres and utilising local competence. Second, Finland puts a strong emphasis on research and innovations, which attracts leading experts in the field and promotes the development of new technology.

Successful fibre companies have a great impact on the Finnish textile and fashion sector. Fibre companies boost the local economy and employment. Success opens doors for new investments and jobs which in turn strengthens Finland's position in the global market. Finland also has the opportunity to enhance the value chain of domestic textile production – all the way from the manufacturing of raw materials to the branded final product.

In addition to having a world-class product, conquering the world market also requires close co-operation with the value chain of the entire textile industry. Nobody wears simply just fibres. It is therefore vital that the development of fibres is targeted to respond to the right kinds of needs and market requirements. Together we will make the circular economy for textiles the new normal and manufacture lasting high-quality products that meet consumer expectations and promote a sustainable textile and fashion industry.

This publication introduces seven Finnish fibre innovations and the companies behind them.

Spinnova®

Raw material: SPINNOVA® fibre is manufactured by mechanically refining pulp into microfibrillated cellulose (MFC). **Spinnova** uses FSC-certified eucalyptus but can also use as raw material textile waste containing cellulose, or agricultural waste such as wheat or barley straw. The method can also be used in manufacturing fibre from leather waste.

Method: Closed-loop manufacturing does not require any harmful chemicals or solvents. There are no waste streams. The method is not based on dissolving pulp. The raw material is ground so finely that it can be pressed into fibre. The material can be recycled again without the quality of the fibre deteriorating.

The manufacturing method of SPINNOVA® fibre is significantly more environmentally friendly than the manufacturing of cotton or viscose: for example, according to Spinnova, the process uses 99,5% less water compared to conventional cotton. The carbon dioxide emissions of this method are 74% lower than the global average of conventionally grown cotton. In addition to a low carbon footprint, Woodspin, a joint venture of Spinnova and Suzano, recovers heat from the production and directs it to the local district heating network. According to estimates, heat recovery saves 2,4kg CO2 equivalent per production of one kilogramme of fibre. This means that the production of SPINNOVA® fibre has even a positive climate impact.

Properties of material: The hand feel is closest to cotton or linen, and the properties of the fibre are modifiable to a certain extent. SPINNOVA® fibre is suitable for clothing, home textiles, and other products, such as composites.

Objectives and co-operation: Spinnova and partner company Suzano have invested EUR 22 million to build the first commercial-scale SPINNOVA® fibre production facility. Production was launched in May 2023. The Woodspin factory is situated in Jyväskylä, central Finland. It is estimated to produce 1,000 tonnes of textile fibre annually. The company has already announced its plans to open another production facility and the aim is a production volume of up to one million tonnes by 2033.

Suzano is the world's leading producer of eucalyptus pulp and a co-owner of Spinnova. Spinnova is the technology supplier of the joint venture, whereas Suzano is responsible for the availability of microfibrillated cellulose.

The fibre produced by the factory is sold under the SPINNOVA® trademark and it is available for global textile brands in 2023. The global interest for Spinnova's technology has been enormous and there is broad co-operation with international clothing brands such as H&M, Bestseller, Adidas and Marimekko. Spinnova listed on Nasdaq First North Growth Market Finland in 2021, raising funding of EUR 115 million euros.

Photo Halti / Spinnova

SPINNOVA® fibre manufacture uses 99,5% less water and the carbon dioxide emissions are 74% lower than conventional cotton.

The total investment of Infinited Fiber Company's factory in Kemi, northern Finland, is EUR 400 million. Production is scheduled to begin in 2025.

Photo Infinited Fiber Company

Infinna™

Raw materials: **Infinited Fiber Company's** cellulose carbamate technology can be utilised in making completely new textile fibre from textile waste. Infinna™ fibre can also be made using other cellulose-rich waste streams, such as recycled cardboard and paper, as well as side streams, such as wheat straw from agricultural origin.

Method: When using textile waste, the manufacturing process begins by sorting and mechanical shredding of the fibre. Cellulose fibres are then separated from other fibres, such as polyester. At the core of the method is the carbamation process in which cellulose reacts with urea. From this point on, the method is the same regardless of the raw material. The process results in cellulose carbamate powder dissolved into a liquid. The liquid is spun into cellulose carbamate fibres.

After use, textiles made from the Infinna™ fibre can be recycled with other textile waste using the same process. The fibre, as such, is biodegradable.

The main environmental impacts of the manufacturing process are related to keeping biomass in circulation and reducing the global textile waste problem. The manufacturing of Infinna™ produces less carbon dioxide emissions especially compared to the production of cotton, viscose and polyester. Also water is used considerably less than in cotton production. According to the company, the production of fibre needed for a single T-shirt requires about 14 litres of water whereas producing the same amount of cotton requires over 600 litres of water.

Properties of material: Infinna™ has a natural, cotton-like feel, and it takes dye well. Infinna™ can be used just like any other textile fibre to manufacture yarn, fabric or non-woven fabric. It has already been used in making different types of textiles and clothing.

Objectives and co-operation: Infinited Fiber Company has announced that it will be investing EUR 400 million in a flagship factory in Kemi, northern Finland. Production is scheduled to begin in 2025. The factory's annual capacity will be 30,000 tonnes, which would be sufficient for manufacturing 100 million T-shirts. The production will be intended mainly for export.

Even though the technology is developed in Finland, the market potential is global. The manufacturing method can be used in existing cellulose and viscose fibre mills. One objective of the company is to license the technology. According to Infinited Fiber Company, the first licensed commercial-scale factory is planned for the near future.

Infinited Fiber Company has attracted prominent co-operating partners worldwide. Inditex, PVH, H&M Group, BESTSELLER, Wrangler, Patagonia and the Finnish manufacturer of non-woven fabrics, Suominen, are among the clients.

A third of the raw material, cotton-rich textile waste, comes from Finland. SOEX, a leading German textile sorting and recycling company, will also supply raw material to produce Infinna™.

Ioncell®

Raw material: The patented Ioncell® technology was developed by **Aalto University**. It enables manufacturing high-quality textile fibre using wood, recycled paper and cardboard as well as textile waste. The recycling of hemp knit fabric to manufacture new fibre has also been studied.

Method: The Ioncell® manufacturing process uses ionic liquid to dissolve cellulose, after which the manufacture of fibre takes place utilising air gap spinning. The only chemicals used in the process are non-toxic ionic liquid and water. Both can be recycled in the process. When the Ioncell® process utilises textile waste, the properties of the fibre improve compared to the original because Ioncell® is stronger than virgin cotton.

Properties of material: Ioncell® fibre has the soft feel of a natural fibre, a silky sheen and it is very strong even when wet. Fabric made from the fibre takes dye well and is easy use. Ioncell® fibre as such is biodegradable. When researching the recycling of hemp knit fabric into Ioncell® fibre, the properties of the material improved by the recycling process. Compared to the original hemp knit fabric, Ioncell® knit fabric was not only stronger, but also shinier and softer. Due to the strength of the fibre, it can be used to manufacture materials made using 100% Ioncell®.

Objectives and co-operation: Founded in 2022, **Ioncell Ltd** is Aalto University's spin-off company aiming to commercialise Ioncell® technology in the coming years. Currently the Ioncell® technology is being developed in a pilot-scale plant in Espoo, southern Finland.

Over the years, Ioncell® has been tested for different uses with many companies. Demo fabrics have been made using either 100% Ioncell® fibres or blended with other fibres.

Ioncell® fibre has a soft feel, a silky sheen, and it is very strong.

Photo Ioncell, design Anna Semi ja Sofia Ilmonen, photographer Juho Huttunen

Photo Matsä Spring

Kuura®

Raw material: Kuura® textile fibre is made utilising undried paper pulp made of Finnish conifer wood provided by **Metsä Fibre**, part of Metsä Group.

Method: The method is based on direct dissolution using a novel ionic solvent for the pulp. The special feature of the process is that the starting material is undried paper pulp instead of dissolving pulp, which is used in the manufacturing of materials such as viscose or lyocell. There is greater benefit in utilising paper pulp than manufacturing fibre from dissolving pulp.

Properties of material: Kuura®, a textile fibre developed by Metsä Group's innovation company **Metsä Spring**, has properties similar to lyocell. As such, it is biodegradable and suitable for recycling using the same process.

Objectives and co-operation: The research and development of the manufacturing method and the Kuura® textile fibre have been in a demo phase since the end of 2020. At the heart of the research and development is the unique demo plant in Äänekoski, central Finland. Its maximum capacity is approximately one tonne of Kuura® fibre per day. Metsä Spring is responsible for the development of the manufacturing method, and Japanese partner company Itochu Corporation provides the market research for the Kuura® fibre. The first production batch was completed in the autumn of 2020, and the expected duration of the demo plant phase is approximately three years.

Metsä Spring's Kuura project aims to develop a competitive concept that would create conditions for Metsä Group to consider commercial production. It would require the building of the first commercial factory. The next assessment of the conditions will take place in 2024. The first commercial plant would be built in Finland. The planning of the technical concept has begun.

In 2020, Metsä Group and Fortum launched a collaboration project, ExpandFibre. The aim of this Business Finland leading company project is to develop technologies and business concepts to help manufacture textile fibres and other new bioproducts using straw and wood pulp.

There is a greater benefit in utilising paper pulp compared to dissolving pulp.

Photo Ioncell, design Susanna Raiskio, photographer Mikko Raskinen

Biocelsol

Material: Biocelsol fibre has been made mainly from dissolving wood pulp, but the fibre can also be manufactured using paper pulp and cellulose separated from textile waste.

Method: Biocelsol is a technology developed by **VTT Technical Research Centre of Finland** and Tampere University of Technology. Pulp is processed with enzymes, dissolved using a cold alkali method and spun into fibres with a wet spinning technique. The lightness of the fibre colour is the same as that of the starting material, and there is no need to bleach fibres when using dissolving pulp. There are no toxic chemicals, and the process does not release harmful emissions. The functionalisation of cellulose can be added to the method. It enhances dyeability, which enables the reduction of dye and even salt-free dyeing.

Feel of material: The finished fibre has properties similar to viscose, but the fibre absorbs moisture better than cotton or viscose. This means it takes dye very well and does not get static. Fabric made using Biocelsol has a nice drape to it, it is warming, and it is softer than cotton.

Objectives and co-operation: VTT Technical Research Centre of Finland is currently looking for partners to continue developing the Biocelsol technology even further and come up with different uses for it. There is currently a strong global interest in the technology.

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Norratex™

Raw material: Nordic Bioproducts Group (NBG), Aalto University's spin-off company, has developed a method for producing new types of regenerated cellulose fibres. The company launched a wood-based Norratex™ fibre in 2022. It does not require carbon disulfide or other harmful chemicals used in viscose processing.

In addition to Norratex™ fibre, the company focuses on the recycling and utilisation of agro residue materials and cotton-polyester textile waste to produce new textile fibre and other high-quality end products.

Method: The company uses patented Aaltocell™ technology which is based on acid hydrolysis. The method only uses water and very mild chemicals, which are recovered from the process and recycled. The strength of the Aaltocell™ technology is in its versatility, making it utilisable in the processing of different raw materials.

The manufacturing of the Norratex™ fibre is based on the same Aaltocell™ method. In the future, the fibre can be manufactured easily in connection with pulp mills as both the raw material and the chemicals needed for the manufacture of the fibre are same as those used by the paper industry. The integration of textile production to a paper mill enables optimised use of raw materials and energy as well as a closed-loop circulation system for chemicals and water. Transport distances decrease as raw material comes from the same place where the fibre is made.

Properties of material: The properties of Norratex™ fibre are somewhere between those of viscose and cotton. The company's other regenerated cellulose fibres made using agricultural side streams and cellulose-rich textile fibre are under development, and their properties are being developed.

Objectives and co-operation: Nordic Bioproducts Group is developing Norratex™ fibre with the world's third largest pulp producer, the Chilean company CMPC, which has invested in the development of the fibre. The objective of NBG and CMPC is to launch an environmentally friendly regenerated cellulose fibre with an optimised production to genuinely respond to the growing cellulose fibre need on the market. NBG is currently forming partnerships with several operators in the agricultural and textile waste-based raw material processing business.

Photo Norratex

Norratex™ will be easy to produce in the future in connection with pulp mills as it requires the same chemicals as those used by the paper industry.

Bio2™Textile

Raw material: Fortum's Bio2™Textile's raw material is a pulp that comes from fractionated straw pulp which is spun into textile fibres using the fibre technology of the selected partner company.

Method: At Fortum's biorefineries, the biomass raw material will be processed using fractionation technology developed by Chempolis Ltd. The technology separates cellulose, hemicellulose and lignin into their own fractions with a material efficiency of up to 90 percent. The fractions can be further processed with different technologies for numerous different applications. The most advanced product development is the processing of straw-fractionated cellulose into a textile fibre.

Objectives and co-operation: Vast amounts of biomass is going to waste in the world today. Straw is a crop production side stream with considerable untapped potential. In developing countries, it is often burned, resulting in significant CO^2 emissions. Fortum Bio2X aims to develop high-value items, especially using agricultural residue. The objective is to replace the use of fossil materials and other similar materials that have an environmental impact. The use of straw as raw material minimises waste and reduces the environmental impact of carbon dioxide emissions, and the use of water and chemicals. In addition, this reduces soil degradation and deforestation and boosts regional prosperity and wellbeing.

Bio2X ecosystem programme is off to a promising start: the first commercial biorefinery is under construction in India as a joint venture. It is scheduled to start in 2023. The company has already manufactured its first straw-based garments using different technologies.

In 2019, Fortum piloted the world's first wheat straw outfit with Spinnova. In early 2021, Bio2™Textile fibre was introduced to international audiences in the Pitti Connect event. Awarded designer Rolf Ekroth used Bio2™Textile fibre in his AW21 collection. The fibre material used in the collection was manufactured using Infinited Fiber Company technology.

Photo Fortum

The aim is to use agricultural residue to develop high-value products such as textile fibres.

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