Responsible production

Lenzing Group
Focus Responsible Production
# Responsible Production 2019

## Overview

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biorefinery – pulp production in the Lenzing Group</td>
<td>5</td>
</tr>
<tr>
<td>Biorefinery plant in Lenzing, Austria</td>
<td>6</td>
</tr>
<tr>
<td>Biorefinery plant in Paskov, Czech Republic</td>
<td>6</td>
</tr>
<tr>
<td>Pulp bleaching in the Lenzing Group</td>
<td>7</td>
</tr>
</tbody>
</table>

## Overview of fiber technologies

- Two-stage production process                                       | 9    |
- EU Ecolabel                                                         | 10   |
- Lenzing’s viscose and modal production process                      | 11   |
- Lenzing’s responsible viscose criteria                              | 12   |
- Closing the loops in the viscose process: best practice             | 14   |
- Lenzing’s lyocell production process                                | 15   |
- Further technologies                                                | 17   |
- REIBRA™ technology                                                  | 17   |
- Eco Filament technology                                             | 18   |
- LENZING™ Web Technology                                             | 18   |
- Fiber types                                                         | 19   |
- Shortcut fibers                                                     | 19   |
- Trilobal fibers                                                     | 19   |
- Incorporation of additives into the spinning mass                   | 19   |

## Definitions/glossary

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>References &amp; suggestions for further reading</td>
<td>22</td>
</tr>
</tbody>
</table>
This focus paper "Responsible Production" describes the biorefinery and fiber production processes. It provides an overview of the Lenzing Group's manufacturing processes with particular regard to environmental aspects.
In recent years, interest in wood-based cellulosic fibers has increased due to their sustainability credentials. When the source of raw material is from sustainable forestry, as proven by forest certificates, and state-of-the-art production processes are applied, wood-based cellulosic fibers can have a very favorable environmental footprint.

Wood-based cellulosic fibers are produced from the natural polymer cellulose. Production starts with wood or other plant-based materials, extracts cellulose pulp from them, and then shapes the polymer into fibers and filaments using different technologies (viscose, modal, lyocell). The final fiber product consists of the natural polymer cellulose, with a chemical structure identical to natural fibers (e.g. cotton, wool).

Wood-based cellulosic fibers are biodegradable in and therefore provide an environmental responsible alternative to fossil-based plastic materials in textiles and nonwovens, but also in packaging and other applications.

Dissolving wood pulp is the most important raw material used in producing regenerated cellulose fibers, including Lenzing’s wood-based fibers.

Shaping of cellulose pulp into fibers requires a special quality of pulp, referred to as dissolving wood pulp, which has to meet different requirements from those for paper pulp. Among other things, dissolving wood pulp must have a higher pure cellulose content of over 90 percent, lower impurity levels, be bleached to a higher level of brightness and have a more uniform molecular weight distribution.

The Lenzing Group produces more than half of the pulp it requires at its sites in Lenzing (Austria) and Paskov (Czech Republic). Sufficient quantities of certified wood are purchased for this purpose. In addition to its own pulp production, Lenzing procures pulp on the global market, mostly within the framework of long-term supply contracts.

Lenzing contributes to Sustainable Development Goal (SDG) 12, “Responsible consumption and production”, with sustainable sourcing, efficient use of raw materials, longstanding experience with biorefineries, lifecycle based thinking along the value chain and a long pipeline of innovative and sustainable products.
A biorefinery is a facility for sustainable processing of biomass into a spectrum of marketable biobased products and bioenergy.

Lenzing’s biorefinery process ensures that 100 percent of wood constituents are used to produce dissolving wood pulp for fiber production, biobased products, and bioenergy, thereby maximizing value creation from an economic and environmental perspective.

Dissolving wood pulp production at the Lenzing and Paskov sites is not only self-sufficient in terms of meeting its own energy demand; the process actually generates more energy than needed. This surplus green energy is used on site, for instance for fiber production or for export to the local grid. The production of biorefinery products such as acetic acid, furfural and magnesium-lignosulphonate helps to increase the total yield from wood as well as creating additional economic and environmental value.

Lenzing’s biorefinery process ensures that 100 percent of wood constituents are used to produce dissolving wood pulp for fiber production, biobased products, and bioenergy, thereby maximizing value creation from an economic and environmental perspective.
Biorefinery – pulp production in the Lenzing Group

Biorefinery plant in Lenzing, Austria

The facility in Lenzing is the largest integrated pulp and cellulosic fiber production plant in the world. Integrated dissolving wood pulp and fiber production not only provides exceptional economic benefits, it also offers many environmental advantages and savings compared to non-integrated mills. For instance, there is no need for transportation of pulp because of the short distances involved, which itself eliminates the need for energy-intensive drying and packaging of pulp.

The Lenzing plant produces dissolving wood pulp required for fiber production on site. Traditionally, wood for pulp production at the Lenzing site consists mainly of beech (Fagus sylvatica). Logs are debarked, chipped and treated in a cooking liquor of magnesium bisulfite. Cellulose is a major component of wood – around 40 percent of the wood substance – and is separated as raw pulp in this process. This pulp is then washed and screened to remove the residual cooking liquor, knots, and impurities. The raw pulp is bleached in a totally chlorine-free (TCF) process and turned into pulp sheets or flakes. The other wood constituents remain within the thin liquor together with other cooking chemicals. Marketable biorefinery products such as acetic acid, furfural, and xylose are obtained in further processing steps. More than half of the wood is transformed into pulp and other biobased products. The cooking chemicals are recovered and recycled from the remaining liquor and the organic components are converted into bioenergy (steam and electricity).

Pulp production at the Lenzing site is not only self-sufficient in terms of meeting its own energy needs; it actually produces surplus energy. This surplus energy (steam and electricity) is used on site, for instance for fiber production. Lenzing’s expertise in integrated dissolving wood pulp and fiber production is the basis for future opportunities to become CO₂ neutral and to contribute to the greenhouse gas reduction target.

Biorefinery plant in Paskov, Czech Republic

The raw material base for the facility in Paskov is spruce wood (Picea abies) in form of logs and chips. The dissolving pulp production process based on magnesium bisulfite is similar to that at the Lenzing site (Austria). The other two major components of wood – lignin and hemicellulose – are dissolved in the liquor. The insoluble remainder is crude unbleached pulp. This pulp is then washed and screened. Further, deeper removal of lignin and hemicellulose is performed by means of alkali extraction and a TCF bleaching process. After final fine screening, the pulp is dried in sheets, baled, and dispatched. The Paskov site is completely self-sufficient in terms of heat and electricity generation. The plant supplies its surplus electricity to the public grid.

All pulp produced at Lenzing pulp production sites is totally chlorine free.
Pulp bleaching in the Lenzing Group

Bleaching is necessary to yield a dissolving pulp quality suitable for wood-based cellulosic fibers, such as viscose, modal, and lyocell. Most dissolving wood pulp producers use elemental chlorine free (ECF) pulp bleaching processes.

Lenzing’s two biorefineries produce pulp without using any chemicals containing chlorine, but with oxygen-based substances (totally chlorine free – TCF).

Due to the elimination of chlorine, dissolving wood pulp produced in the Lenzing Group not only has less impact on the environment and human health but also ensures the high quality required for fiber production.

The technology at both plants satisfies the Best Available Technology standards of the European Union.1

In addition to its own pulp production, Lenzing procures pulp on the global market (ECF). Not all fiber types offered by Lenzing can be produced using Lenzing’s own totally chlorine free (TCF) pulp because they require specific pulp qualities.

### Pulp production in the Lenzing Group

<table>
<thead>
<tr>
<th>Site</th>
<th>Lenzing</th>
<th>Paskov</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity 2019</td>
<td>320,000</td>
<td>275,000</td>
</tr>
<tr>
<td>(tons per year of air dry pulp @ 10% moisture/90% dry matter)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biorefinery products</td>
<td>Acetic acid, furfural, xylose, magnesium-ligninsulfonate, soda (sodium carbonate), hemiyle, mother liquor</td>
<td>magnesium-ligninsulfonate, soda (sodium carbonate)</td>
</tr>
<tr>
<td>Use of energy surplus</td>
<td>In integrated fiber production at site</td>
<td>Electricity delivered to public grid</td>
</tr>
<tr>
<td>Main wood source</td>
<td>Beech</td>
<td>Spruce</td>
</tr>
<tr>
<td>Sustainability features</td>
<td>TCF bleaching, high share of bioenergy (97%)</td>
<td>TCF bleaching, high share of bioenergy (98%), coal-free</td>
</tr>
<tr>
<td>Production technology</td>
<td>Magnesium bisulfite</td>
<td></td>
</tr>
<tr>
<td>Pulp cooking chemicals used</td>
<td>Magnesium oxide, sulfur dioxide</td>
<td></td>
</tr>
<tr>
<td>Bleaching chemicals used</td>
<td>Oxygen, ozone, hydrogen peroxide, sodium hydroxide</td>
<td></td>
</tr>
</tbody>
</table>

1 Suhr et al. 2015
Lenzing’s product portfolio extends from dissolving wood pulp as a basic raw material to standard fibers and innovative specialty fibers as well as energy, biorefinery products and co-products.

The Lenzing Group combines comprehensive expertise in operating pulp and biorefinery processes with decades of experience in three major fiber process technologies:

- Viscose (rayon)
- Modal
- Lyocell

Based on the lyocell process, three new process technologies have been developed in recent years: REFIBRA™ technology for textiles (respectively Eco Cycle technology for Nonwovens), Eco Filament technology and LENZING™ Web technology. For more information see chapter “Fiber types”, page 19 of this focus paper.
Lenzing’s high-quality fibers are supplied to the textile and non-woven industry as well as for industrial applications. Each of the fiber types has its special properties valued in textile, nonwoven and industrial applications and is therefore an integral part of the product portfolio.

**Two-stage production process**
Regenerated cellulosic fibers are produced from wood in a two-stage process. In the first stage pulp is produced, very similar to the production of paper. In a second stage, pulp is dissolved and cellulosic fibers are regenerated from the solution into a shape suitable in diameter and length for use in textile and nonwoven applications. The final product consists of chemically unmodified cellulose, and is biodegradable and compostable.

**Overview of fiber technologies**

- LENZING™ Lyocell
- LENZING™ Viscose
- LENZING™ Modal*
- Lenzing Group: Selected fiber types, technologies and branded offers

---

* Complete name: LENZING™ Modal with Eco Soft technology
EU Ecolabel

The Lenzing Group Environmental Standard is based on the best available technology (BAT) associated emission limit values as proposed in the EU BAT reference document (EU BREF), as well as prominent ecolabel requirements, such as the EU Ecolabel.

The EU Ecolabel was established by the European Commission in 1992. It is an environmental label awarded to products and services that have less impact on the environment and human health throughout their entire life in a certain product category. Products bearing the EU Ecolabel are therefore among the most environmentally friendly on the market.

Independent experts, scientists and NGOs devised the guidelines and criteria for awarding the EU Ecolabel in collaboration with the EU member states. The criteria are determined on a scientific basis and take into account the entire product life cycle. Regular revisions ensure that the criteria are adapted to new developments and that assessments remain current.

For the Lenzing Group this means that strict criteria have to be met in pulp and fiber production, both with regard to emissions released to air or water and with regard to the management of chemicals used. Apart from Lenzing’s Indonesian operation, which strives to meet these criteria by 2022, all Lenzing production sites fulfill the stringent criteria of the EU Ecolabel. The Lenzing Group can provide viscose, modal and lyocell fibers with EU Ecolabel certificate.²

EU Ecolabel criteria

<table>
<thead>
<tr>
<th>EU Ecolabel criteria</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Man-made cellulose fibers criteria</strong></td>
<td></td>
</tr>
<tr>
<td>Pulp: wood sourcing</td>
<td>Sustainable forestry: $&gt; 25%$ e.g. FSC®, PEFC™ or equivalent schemes</td>
</tr>
<tr>
<td>Pulp: bleaching agent</td>
<td>Elemental Cl free</td>
</tr>
<tr>
<td>Pulp: OX on finished fiber</td>
<td>$\leq 150$ ppm</td>
</tr>
<tr>
<td>Pulp: sourcing</td>
<td>50 % input from mills with energy or chemicals recovery</td>
</tr>
<tr>
<td>Staple fiber: Sulfur emission to air</td>
<td>30 g/kg</td>
</tr>
<tr>
<td><strong>Chemicals and processes criteria</strong></td>
<td></td>
</tr>
<tr>
<td>Restricted substance</td>
<td>Spin finishes: 90 % of the component substances readily biodegradable</td>
</tr>
<tr>
<td>Substitution of hazardous substances</td>
<td>Should satisfy restrictions concerning certain hazard classifications</td>
</tr>
</tbody>
</table>

² Please note that LENZING™ fibers are certified with the EU Ecolabel Standard for textile products. Single use end products are NOT included in this Standard. Any labeling or marketing of single use end products made of LENZING™ fibers as EU Ecolabel certified must be checked independently and depends on the compliance with applicable EU Ecolabel Standards (such as e.g. EU Ecolabel Standard for PCPs and AHPs).
Lenzing’s viscose and modal production process

Viscose fibers were the first wood-based fibers produced on an industrial scale since the late 19th century and are produced in a multi-step process. In contrast to the lyocell process, where cellulose is directly dissolved in a respective solvent (NMMO)\(^3\), the cellulose in the viscose process needs to be derivatized by a chemical reaction (xanthation with carbon disulfide) prior to being dissolved in sodium hydroxide solution.

Modal fibers are exclusively produced in Austria in a modified viscose process using an integrated production process in which the raw material pulp is produced at the same site as the fiber itself.

In the first step, pulp is steeped in a sodium hydroxide solution and is converted to alkaline cellulose (AC) after pressing out excess lye (1). The AC is then aged in a drum or chamber (2) prior to being reacted with carbon disulfide (CS\(_2\)) in a reaction chamber (3). The resulting xanthate is then dissolved in lye prior to being filtered (4). The resulting deep orange and highly viscous cellulose solution (hence the name) is then ripened (5) and deaerated (6) before the viscose enters the spinning process. The cellulose solution is pressed through a number of orifices into an acidic spin bath where a plurality of single filaments (tow) is formed (7). After stretching of the tow (8) it is cut into the desired staple fiber length (9). In the after-treatment (10) the staple fibers are desulfurized, repeatedly washed and bleached and finally a finish agent is applied. After drying (11) of the viscose fibers they are pressed into bales and finally packed (12).

Carbon disulfide (CS\(_2\)) is recovered from different waste gas streams (13) and is fed back into the system. Sulfur compounds containing waste gas streams are also converted into sulfuric acid (H\(_2\)SO\(_4\)) in several process steps and are reused in the process (14). Zinc is precipitated and recovered from the waste water. Sodium sulfate, generated as a reaction product of sulfuric acid and sodium hydroxide in the spin bath, is isolated as a co-product in a multi-step process (15) and is sold to other industries.

---

3) NMMO – N-Methylmorpholine N-oxide is an aqueous, biodegradable, organic solvent
Overview of fiber technologies

Lenzing’s responsible viscose criteria

1. Responsible wood and pulp sourcing
Wood and pulp used in the viscose production process come from sustainably managed forests and plantations.

Evidence 1
FSC® (FSC-C041246) or PEFC™ (PEFC/06-33-92) certified and controlled sources, and CanopyStyle verification (by NEPCon) of the entire wood and pulp supply.

2. Responsible production and closing the loops
Viscose production requires chemicals that need to be handled safely and effectively to reduce impacts on human health and ecological systems. Proper recovery and emission treatment equipment is required to prevent air and water emissions and close the loops in the viscose process. For further details, see closing the loop, page 14.

Evidence 2
LENZING™ ECOVERO™ and VEOCEL™ branded fibers with Eco Care Technology are certified with EU Ecolabel (see page 10).

Higg MSI score for LENZING™ Viscose fibers shows substantially better performance than generic viscose.

STANDARD 100 by OEKO-TEX®, Annex 6, product class I - aligned with Detox Campaign

3. Safety and health for workers and community
Management practices such as safety trainings, safety walks & talks, safety and environmental management systems are required to run the process effectively and to make continuous improvements. This avoids health risks for employees and the community.

Evidence 3
ISO 14001: 2015 at all viscose sites
OHSAS 18001: 2007 at all viscose and lyocell sites
Overview of fiber technologies

4. **Quality and product safety**
Quality is a key pillar of sustainability and product responsibility. Without quality, no product is sustainable, since it will not satisfy the intended function. Products must be safe to use and meet the purity requirements for the respective application.

**Evidence 4**
ISO 9001: 2015, STANDARD 100 by OEKO-TEX®, Annex 6, product class I, Medically Tested - Tested for Toxins

5. **Transparency along the value chain**
Customers and consumers can support sustainable products if they have information about how and where the products are made. Track- and traceability of raw materials in the final product ensure that they originate from responsible resources, thereby preventing counterfeiting by unscrupulous producers. In the long run, this will help improve the overall sustainability of the industry thanks to informed decision-making by all parties.

**Evidence 5**
Fiber identification technology for LENZING™ ECOVERO™ fibers

Blockchain technology

Lenzing fiber certification scheme

6. **Substantiated claims for sustainability communication**
Communication is essential for improving transparency. Responsible producers take communication seriously and help their customers and final consumers to use sustainable products with substantiated claims.

**Evidence 6**
Marketing/Branding support

LENZING™ ECOVERO™ and VEOCEL™ branded fibers with Eco Care Technology fulfill Lenzing’s criteria for responsible viscose and provide a solution to improve the sustainability of the industry. These fibers are available from the Lenzing (Austria) and Nanjing (China) sites. The Lenzing Group’s Indonesian operation is striving to meet these criteria by 2022.
Closing the loops in the viscose process: best practice

In the viscose process, carbon disulfide (CS₂) and caustic soda (NaOH) are used to dissolve cellulose pulp to form the spinning mass. During this process, some carbon disulfide is transformed into hydrogen sulfide (H₂S). When regenerating the dissolved pulp as fiber in an acid spin bath, carbon disulfide and hydrogen sulfide are released as exhaust gases at different locations along the production process. As shown in the figure below, the three recovery systems required to close the loop and to safely handle these waste streams are:

1. Condensation unit
2. Wet Sulfuric Acid plant (WSA) and
3. Carbon disulfide Adsorption Plant (CAP)

Carbon disulfide exhaust streams with low hydrogen sulfide content are treated in the condensation unit as well as in the carbon disulfide adsorption plant (CAP) to recycle carbon disulfide. CS₂ exhaust gas streams with higher hydrogen sulfide content are preferably recycled as sulfuric acid (H₂SO₄) via catalytic oxidation in wet sulfuric acid plants (WSA).

Viscose production facilities without a WSA plant face the challenge of handling hydrogen sulfide emissions from the viscose process. In this case, hydrogen sulfide may be disposed of through energy generation boilers or by absorbing hydrogen sulfide in caustic soda to form sodium hydrosulfide hydrate. Both of these alternative H₂S control measures have the disadvantage of lower recycling rates of sulfur chemicals compared to the WSA option. In addition, burning hydrogen sulfide in energy generation boilers also results in higher SO₂ emissions, unless the SO₂ emissions are recovered as gypsum.

Without a WSA plant, H₂S rich gas cannot be handled safely, so it is a potential hazard to human health. The recovered carbon disulfide in the condensation process and CAP plant and the sulfuric acid produced in the WSA plant are directly reused in the viscose process. This closes the loop of sulfur compounds used in the viscose process. Both technologies, state-of-the-art CAP and WSA, are essential. Proper maintenance of these systems is key to avoiding any release of CS₂, H₂S, SO₂, or SO₃ (intermediate product WSA). With state of the art CAP and WSA, and their proper maintenance, more than 90 percent of the carbon disulfide can be recovered safely and reused in the process.

Another prerequisite of a safe viscose process is a plant design with sufficient capacity in equipment such as blowers to ensure safe extraction and transfer of carbon disulfide and hydrogen sulfide to the recovery equipment described above.

Best practice reporting
As there are many emission points along the viscose fiber production process, the Lenzing Group reports CS₂ and H₂S emissions, expressed as sulfur emissions, based on mass balance calculations which reflect the reality much better than the single point measurements.
Overview of fiber technologies

Lenzing’s lyocell production process

Lyocell fibers are the latest generation of wood-based cellulosic fibers. They have been produced at a commercial scale for about 25 years. The generic fiber name is lyocell. The branded products from Lenzing are marketed as TENCEL™ Lyocell and VEOCEL™ Lyocell fibers.

The initial idea in developing the lyocell process was to derive cellulosic fibers from pulp without relying on the chemically complex viscose process.

Similar to viscose fiber production, the raw material pulp is derived from renewable wood or to a certain extend from alternative sources such as cotton scraps. In contrast to the traditional chemical viscose process, the lyocell process directly dissolves cellulose in the organic solvent N-Methylmorpholine-N-oxide (NMMO) without the need to derivatize the cellulose. This means that, in contrast to the viscose process, no carbon disulfide (CS₂) is used and the overall production process for lyocell fibers is therefore simplified.

Waste generation in the production process is minimized thanks to closed loops and lower consumption as well as higher utilization of both, chemicals and raw materials.

The lyocell production process starts by suspending pulp in water and NMMO in order to get a homogenous slurry (1). In the next process step, water is removed and cellulose is thereby dissolved to form a solution called dope (2). Prior to spinning, the cellulosic solution is filtered in order to remove undesired particles and undissolved material (3). The heart of the production is the spinning process (4) where the cellulosic solution is pressed through a number of very small orifices thereby forming cellulosic filaments. These filaments are cut into staple fibers of desired length and then enter the after-treatment zone where the fibers are washed and a finishing agent is applied (5). The wet staple fibers are then dried, opened, pressed into bales and finally packed to obtain the final product (6).

The recovery rate of NMMO in the lyocell process is >99 %. The recovery starts with filtration and pre-purification steps (7) of the spin bath before water is removed by evaporation (8) to obtain make-up NMMO and the whole cycle can start again. Water that is obtained from the evaporation step is also fed back into the process (9) and only a small amount of water is sent to the waste water treatment plant (10).

4) For literature on the lyocell production process, see White 2001 and Ganster & Fink 2009
Overview of fiber technologies

Lenzing has also developed technological measures to minimize the process energy required in lyocell production. The second-generation plant installed at the Lenzing site (Austria) includes new heat recovery systems to reduce energy consumption compared to the former plant design. In principle, due to the generally simple process requiring less effort to close the loops, the total energy use of a lyocell fiber production plant is lower than that of a viscose plant with equal production capacity.

Use of lyocell fiber offers great advantages from an environmental perspective compared to other cellulosic fibers. Compared to the viscose process, the lyocell process is much less resource-intensive and leads to a significant reduction in chemical use due to conversion of pulp into fiber in a closed-loop process.

Lyocell fiber is the latest generation of wood-based cellulosic fiber. It has been produced at a commercial scale for 25 years. The generic fiber name is lyocell. The branded products from Lenzing are marketed as TENCEL™ and VEOCEL™ fibers.
Further technologies

**REFIBRA™ technology**

TENCEL™ Lyocell fibers with REFIBRA™ technology use pre- and post-consumer cotton waste and wood from sustainably managed forests as a raw material. The cotton material is recycled into a pulp which is blended (up to 30 percent) with wood pulp to produce a high-quality lyocell fiber.

This not only makes Lenzing the world’s first manufacturer to produce cellulose fibers partly using recycled cotton scraps as a raw material on a commercial scale, but also offers new possibilities for a circular economy.

Since its market introduction in early 2017, REFIBRA™ technology has received great interest from brands and retailers as well as consumers. It has been adopted and used by various fashion brands – some globally active – and some initial home textile brands in several collections worldwide. In all of its applications, it is the special feature of the REFIBRA™ technology that it results in virgin quality fibers while providing a first solution for textile recycling and closing loops along the textile value chain. Lenzing REFIBRA™ technology was awarded the renowned TRIGOS Award 2019 for its contribution to climate protection by reducing the need to source primary resources.

Particularly in the development of circular flow models that enable economic growth without increasing the consumption of natural resources, close collaboration all along the value chain is essential for Lenzing. Accordingly, cooperation was sought and continues to take place with various partners – from raw material producers to fashion companies – in further development of the REFIBRA™ technology. Lenzing’s R&D department is also actively engaging with the market, cooperating with interesting start-ups as well as guiding others in their approach. Lenzing also actively participates in cross-industry organizations (e.g. Ellen MacArthur Foundation, Sustainable Apparel Coalition’s policy group) to further increase awareness and importance of the topic in the public and political sector.

Lenzing itself is further improving REFIBRA™ technology and showcasing its ecological benefits. On the technological side, this not only involves optimizing the processes, but also expanding the raw material base. Among others, it has been possible to increase the recycled content in these fibers to 30 percent, as well as enabling new applications in the textile sector by expanding the spectrum of available fiber types.

**Eco Cycle technology**

VEOCEL™ fibers with Eco Cycle technology use the groundbreaking process of the REFIBRA™ technology for creating fibers for the nonwoven sector.
Overview of fiber technologies

TENCEL™ fibers made with REFIBRA™ technology are fully biodegradable and available with Recycled Claim Standard (RCS).

Additionally, a special manufacturing system enables TENCEL™ Lyocell fibers with REFIBRA™ technology to be identified in the final product, even after long textile processing and conversion steps through the value chain.

Furthermore, recycling options for discarded textiles (post-consumer waste) are being investigated. This involves mixed textiles made from different fiber types, making it a very complex and challenging process.

LENZING™ Web Technology

The LENZING™ Web Technology is a nonwoven web formation process that starts with dissolving wood pulp and produces a direct formed nonwoven fabric made of 100 percent continuous lyocell filament. The technology offers a unique self-bonding mechanism where substantially endless fibers bond into a fabric during the laydown process. This self-bonding mechanism allows for a much wider variety of basis weight, surface textures, drapeability and dimensional stability than other nonwoven technologies based on cellulose. The sustainable products are fully biodegradable and thus offer new opportunities for the future nonwoven market.

Eco Filament technology

The majority of Lenzing’s fiber products are staple fibers, i.e. they are cut in staples of defined length and packed into bales. The reason for cutting to the same length as cotton fibers (“staple fibers”) is that fibers from Lenzing are also processed into blended yarns with other fibers of the same length, such as cotton or polyester. This makes it possible to combine certain fiber properties.

With the launch of TENCEL™ Luxe branded filaments produced with Eco Filament technology in 2017, Lenzing has advanced the filament market and created a forward-looking innovation.
In line with its strategic focus on specialties, the Lenzing Group offers a portfolio of different fiber types on the basis of the technologies described above. In order to meet the broad range of requirements for textile, nonwoven or other industrial applications, wood-based fibers from Lenzing can be offered:

- with different fiber fineness, from the finest microfibers to coarse fibers for carpets
- with modified cross-sections
- in various cut lengths (from shortcut fibers for special applications in paper or as reinforcing material in fiber composites to long staple fibers for wool blends)
- or as tow.

Furthermore, wood-based fibers can be functionalized by incorporating certain compounds into the spinning mass. Examples include flame retardant agents, spin dyes, dulling agents, antimicrobial properties, etc.

### Shortcut fibers

The production of Lenzing™ Lyocell Shortcut fibers is based on lyocell technology. Fiber cut lengths are between 2 and 12 mm, compared to the standard lengths of about 40 mm. Shortcut fibers blended with wood pulp are used in nonwoven applications, such as flushable moist toilet tissues, but can also be found in specialty paper applications such as filters and battery separators.

### Trilobal fibers

The production of Lenzing™ Viscostar fibers is based on the viscose technology. The fibers are produced using spinnerets with trilobal cross-section. Lenzing™ specialty viscose with trilobal cross-section has a high liquid absorbency for use in tampons.

### Incorporation of additives into the spinning mass

Lenzing™ Viscose Color and Lenzing™ Modal Color fibers are produced by incorporation of color pigments into the viscose or modal spinning mass for nonwoven and textile applications. This technology provides considerable ecological advantages by replacing the resource-intensive conventional dyeing process.

Lenzing™ FR is a cellulosic fiber produced by incorporation of a flame retardant additive into the spinning mass based on the modal process.
**Definitions/glossary**

**Best available techniques (BAT)**
Best available techniques means the most effective and advanced stage in the development of activities and their methods of operations. The techniques should indicate the practical suitability of particular techniques for providing, in principle, the basis for emission limit values designed to prevent, and, where this is not practicable, generally to reduce emissions and the impact on the environment as a whole.

**Biobased**
Biobased products are those that originate partially or completely from renewable resources. These products can be either biodegradable or non-biodegradable.

**Biodegradable**
The ability of a substance to be broken down by micro-organisms (bacteria, fungi, etc.) into carbon dioxide (CO₂) and water so that it can be consumed by the environment. Test methods describe a certain time, conditions of temperature, oxygen availability, and humidity, and set a certain percentage of breakdown.

**Bioenergy**
Bioenergy is energy derived from biomass. The term refers to various forms of energy, including heat and electricity. Also the biomass that contains this energy can be referred to as bioenergy. The main sources of bioenergy are renewable resources.

**Biorefinery**
A biorefinery is a facility for sustainable processing of biomass into a spectrum of marketable biobased products and bioenergy.

**Cellulose**
Cellulose is a component of all plants and the most abundant natural polymer in the world. The cellulose content of wood is about 40 percent.

**Co-product**
Co-products are by-products recovered during fiber production.

**Dissolving wood pulp**
A special kind of pulp with special characteristics used to manufacture viscose, modal and lyocell fibers and other cellulose-based products. This grade of pulp is characterized by higher alpha cellulose content and by a high degree of purity.
Definitions/glossary

**ECF**
Elemental chlorine free – a bleaching process that does not use elemental chlorine

**Finishing agent**
Soap-like materials, applied in the final wash cycle. The adhesive properties of the fibers are adjusted in such a way that facilitates common types of processing for textile or nonwoven production. The effect is similar to using a fabric softener when washing household laundry. A mixture of gliding agents, adhesive agents, and anti-static agents is used. All these agents are completely biodegradable.

**Higg Index**
The Higg Index is the core driver of the Sustainable Apparel Coalition (SAC), an association of leading companies in the textile and chemical industry, non-profit organizations as well as research and educational experts aiming to create a more sustainable international textile industry. This suite of self-assessment tools empowers brands, retailers and facilities of all sizes to measure their environmental, social and labor impacts at every stage in their sustainability journey, and identify areas for improvement. The Higg Index provides a holistic overview of the sustainability performance of a product or company – a big-picture perspective that is essential for progress to be made.

**MSI**
Materials Sustainability Index. The quantitative part of the Higg Index, scoring materials according to their environmental impacts in on global warming, eutrophication, water scarcity, and abiotic resource depletion (fossil fuels), and according to chemistry applied.

**TCF**
Totally chlorine free (bleaching process)

**Tow**
Tow is a bundle of (several million) individual fibers.

**Wood-based fiber**
A fiber industrially produced from raw materials derived from wood sources, known in the industry as man-made cellulosic fiber or regenerated cellulose fiber.
References & suggestions for further reading


Focus Papers

The Lenzing Group publishes a series of focus papers on different sustainability-related topics:

- Lenzing Group Sustainability Strategy
- Responsibility for People
- Responsible Production
- Wood and Pulp (2020)
- Circular Economy (2020)
- End of Life (2020)
Imprint

Copyright & published by:
Lenzing Aktiengesellschaft
4860 Lenzing, Austria
www.lenzing.com

Design:
ElectricArts Werbeagentur GmbH

Photographs by:
Isaiah & Taylor Photography/Stocksy United
PeopleImages/gettyimages.com

Photographers:
Richard Ramos