Lenzing Group
Leading Fiber Innovation
Agenda

- Lenzing AG
- Lenzing Fiber Portfolio
  - Enduses
  - Fiber properties
  - Processing
- Lenzing Sustainability Concept
  - Sustainability & Environmental issues
Corporate Video
The Lenzing Group 2008

Sales: EUR 1,329.1 mill.
Export share: 88%
Staff: 5,945
The Lenzing Group 2008

Segment Fibers

Business Unit Textile Fibers
Business Unit Nonwoven Fibers
Business Unit Pulp
Business Unit Energy

Sales: EUR 1,107.9 mill.
EBIT: EUR 118.1 mill.

Segment Plastics

Business Unit Performance Products
Business Unit Filaments

Sales: EUR 182.2 mill.
EBIT: EUR 7.3 mill.

Segment Engineering

Business Unit Engineering

Sales: EUR 110.9 mill.
(Ext. sales: EUR 51.3 mill.)
EBIT: EUR 10.0 mill.
Fibers: Our core business

Lenzing Group

Sales by segment
100 % = EUR 1.33 bill.

- Fibers: 82.4%
- Plastics: 13.6%
- Engineering: 3.9%
- Others: 0.1%
Global network for our customers

Lenzing Group

Productions sites
- Fiber
- Plastics

Offices
- Fiber
- Plastics
- Engineering

New York
USA

Lexington
USA

Mobile
USA

Grimsby
Great Britain

Derby
Great Britain

Munderkingen
Germany

Kelheim
Germany

Lenzing
Austria

Heiligenkreuz
Austria

Affolterbach
Germany

Plana
Czech Republic

Nanjing
China

Beijing
China

Shanghai
China

Hong Kong
China

Coimbatore
India

Jakarta/Java
Indonesia

Purwakarta
Indonesia
Business Unit Textile Fibers in dialog with the textile chain
### Who’s who in fibers

<table>
<thead>
<tr>
<th>Natural fibers</th>
<th>Man-made fibers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein-based</td>
<td>From natural polymers</td>
</tr>
<tr>
<td>Wool, Silk, Angora, Cashmere, etc.</td>
<td>Cotton, Flax, Hemp, Jute, etc.</td>
</tr>
</tbody>
</table>

* Lenzing fibers
Lenzing Fiber Brands

**TENCEL® - The New Age Fiber**
- Home Textiles: quilts and bed linen
- Clothing: shirts, blouses, ladies’ and men’s wear, home wear and undergarments

**Lenzing Modal® - Makes the World a Softer Place**
- Home Textiles: terry cloth products
- Clothing: undergarments

**Lenzing FR® - The Heat Protection Fiber**
- special fiber for flame-resistant protective clothing

**Lenzing Viscose® - Sets the Industry Standard**
- Clothing made of woven textiles and knitwear
Lenzing brands – nonwovens fibers

**TENCEL®**
- Consumer and speciality wipes for cosmetic cleansing, household and industrial applications
- Medical products such as wound pads, surgical swabs and components of surgical gowns
- Filtrations
- Special papers for electronic components
- Carbon fiber precursor

**Lenzing Viscose®**
- Consumer products such as wipes for infant care
- Speciality wipes for cosmetic cleansing, household and industrial applications
- Medical products such as wound pads, surgical swabs and components of surgical gowns
- Tampons

**Viscostar®**
- Special fiber for tampons
Lenzing Modal® – the best out of beech

Lenzing Modal® presentation
TENCEL® - New Age out of Eucalyptus
## Physical fibre data

<table>
<thead>
<tr>
<th>Property</th>
<th>Cotton</th>
<th>Viscose</th>
<th>Modal</th>
<th>TENCEL®</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tenacity cond [cN/tex]</td>
<td>24-28</td>
<td>25</td>
<td>35</td>
<td>37</td>
</tr>
<tr>
<td>Elongation cond [%]</td>
<td>7-9</td>
<td>20</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Tenacity wet [cN/tex]</td>
<td>25-30</td>
<td>13</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>rel. wet tenacity [%]</td>
<td>105</td>
<td>50</td>
<td>57</td>
<td>81</td>
</tr>
<tr>
<td>Elongation wet [%]</td>
<td>12-14</td>
<td>23</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Loop tenacity [cN/tex]</td>
<td>20-26</td>
<td>7</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>Bisfa Modulus</td>
<td>10</td>
<td>3</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Grade of fibrillation</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4-5</td>
</tr>
<tr>
<td>Natural moisture content [%] (65 % rel F.)</td>
<td>8</td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Polymerisation degree DPv</td>
<td>3000</td>
<td>430</td>
<td>640</td>
<td>850</td>
</tr>
<tr>
<td>Volume swelling in water [%]</td>
<td>35</td>
<td>88</td>
<td>63</td>
<td>67</td>
</tr>
</tbody>
</table>

Data according Lenzing specification
Cross-section of Lenzing Modal® and Cotton
Cross-section TENCEL®

TENCEL® Heiligenkreuz

TENCEL® Mobile/Grimsby
Cross-section of Lenzing Viscose® and Bamboo

Lenzing Viscose®

Bamboo Viscose
TENCEL® shows a nano fibrillar structure
Why TENCEL®

- Strength & Durability
- Versatility – hands and optics
- Function & Comfort
- Botanic origin
TENCEL® for Function & Comfort

- Moisture management
- Natural air-condition
- Reduced bacteria growth
- Sensitive skin
Peach Skin processing route for TENCEL®

Primary fibrillation

Enzyme treatment

Peach Skin
second fibrillation
Mechanical polishing process

Prewashing
Reactive dyeing
Resin finish

Tumbling

No pilling and fibrillation
After homelaundering due to resin finish
TENCEL® LF/A100 - Control of fibrillation by chemical crosslinking reaction

TENCEL® A100: Trifunctional TAHT crosslinker

TENCEL® LF: Crosslinking agent based on anchor-chemistry of reactive dyestuffs, colourless, non toxic, free of formaldehyde
Fibrillation tendency of cellulose fibres

<table>
<thead>
<tr>
<th>No fibrillation</th>
<th>Strong fibrillation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscose, Modal, TENCEL® A100</td>
<td>Cotton</td>
</tr>
<tr>
<td>TENCEL® LF</td>
<td>Polynosic</td>
</tr>
<tr>
<td></td>
<td>TENCEL®</td>
</tr>
</tbody>
</table>

Fibrillation after reactive dyeing process

TENCEL® A100 or LF                                      Standard TENCEL®

LENZING LEADING FIBER INNOVATION
End-uses and working procedures for TENCEL®

- **Denim**
  - Garment dye
  - Garment wash
  - Standard TENCEL®

- **Outerwear**
  - blouses, shirts, bottom weights
  - Continue processes
  - Open width
  - Standard TENCEL®

- **Hometextiles**
  - bed sheets, Inletts
  - Discontinue processes
  - Rope form
  - TENCEL® LF, TENCEL® A100

- **Knitted goods**
Sustainability in the Lenzing Group
Lenzing sustainability concept

Sustainable economic success
- Growth, innovation, productivity, technology leadership, quality leaders

Responsibility for the environment
- Lenzing sets environmental standards
- Closed loops and integration
- Renewable raw material wood

Responsibility for the people
- Attractive jobs
- High safety and health standards
- Regional support of social, sports and cultural activities
The Cellulose Cycle

- **Disposal**
- **Forest**
  - 1. Sunlight
  - 2. Water
  - 3. Carbon Dioxide
- **Use**
- **Pulp**
- **Textile and Nonwoven Products**
- **Cellulose Fiber Production**: Viscose fibers, Modal fibers, Lyocell fibers
91% increase of fiber production in Lenzing between 1990 and 2008
Utilisation of wood in Lenzing

Wood is the raw material and the fuel for pulp production in Lenzing.

50% thick liquor recovery of chemicals and energy production

39% Pulp

11% Acetic acid Furfural Xylose

Energy surplus

Source: Lenzing AG

LEADING FIBER INNOVATION
Reduction of Wastewater in Lenzing

1982 - 2009

Wastewater in equivalents of inhabitants
Comparison of energy sources

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>World</th>
<th>Lenzing Group 2008</th>
<th>Lenzing Site 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-fossil fuels</td>
<td>8.0%</td>
<td>51.2%</td>
<td>88.2%</td>
</tr>
<tr>
<td>Nuclear</td>
<td>6.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Oil</td>
<td>39.0%</td>
<td>1.8%</td>
<td>0.7%</td>
</tr>
<tr>
<td>Gas</td>
<td>23.0%</td>
<td>21.6%</td>
<td>5.1%</td>
</tr>
<tr>
<td>Coal</td>
<td>24.0%</td>
<td>24.0%</td>
<td>5.9%</td>
</tr>
</tbody>
</table>

* incl. RVL
The Cellulose Cycle

LCA

Green Finishing

Eco-Metrics
LCA - Life cycle analysis of fibers

- Comprehensive evaluation of fibers (ISO 14040 series)
- Utrecht University, The Netherlands (Prof. M. Patel, Li Shen)
- Assessment of sustainability of Lenzing fibers in comparison to cotton, polyester and polypropylene.
- 11 environmentally relevant factors studied
- Peer studies confirm results

Result:
Environmental load of Lenzing fibers is significantly lower than that of cotton!
What are the environmental impacts?

- Energy: Non-Renewable Energy Use (NREU)
- Global Warming (kg CO₂ equivalents)
- Land use for biomass production
- Water use
- The CML indicators (Center for Environmental studies, University Leiden / Netherlands)
  1. abiotic depletion
  2. human toxicity
  3. fresh water ecotoxicity
  4. terrestrial ecotoxicity
  5. photochemical oxidant
  6. acidification
  7. eutrophication
Net NREU (GJ/t fibre), Cradle-to-factory gate plus post-consumer waste incineration
Net GWP (t CO₂ eq./t fibre), Cradle-to-factory gate plus post-consumer waste incineration

- PET (W.Europe)
- PP (W.Europe)
- Cotton (US&CN)
- Tencel, Austria
- Tencel, Austria, 2012
- Lenzing Modal
Up to 70 % less required acreage

Required acreage for the production of 1 ton of fiber
Up to 20 times less water consumption
Life cycle analysis - relative environmental load per ton of fiber

- Global warming
- Consumption of non-renewable resources
- Human health
- Soil pollution
- Water pollution
- Air pollution
- Ozone layer depletion
- Acidification of air, water and soil
- Eutrophication

Graph showing the relative environmental load per ton of fiber for different materials and regions, with a focus on soil and water pollution.
Awards

- VÖNIX Sustainability Index
- CSR Ranking Austria 2008
- Eco-Label of the European Commission
- Responsible Care
- Panda-Award (WWF Austria)
- DIN CERTO
- R.I.O. Award 2006
- ÖKOTEX
- European Environmental Award
- Nordic Swan
Green Finishing

Lenzing AG in co-operation with Dystar, Huntsman, Then
Efficiency in Dyeing & Finishing

- TENCEL® is the purest cellulosic fiber with no contamination like cotton seeds, heavy metals, waxes or sulphur therefore
  - Little or no scouring is needed in knitted fabrics
  - No bleaching
  - No mercerising

- TENCEL® shows very high dyeing efficiency allowing exceptional reduction of
  - Dyes
  - Salt
  - Alkaline
  - Water
  - Energy usage
  - Processing time
Processing route for knits

Washing → Reactive dyeing → Soaping

Bleaching

cotton and cotton blends

Compacting ← Stenter drying ← Dewatering ← Softening
TENCEL® - dyeing efficiency

Exhaust dyeing process for knits applying same amount of dye

Dye bath after dyeing

Dystar and Huntsman co-operation
Unfixed Dye removed in washing sequences

TENCEL® A100

Cotton
Savings in dyeing and finishing

*T-Shirt 100% TENCEL® A 100
- ½ Dyestuff
- ½ Chemicals
- ½ Energy
- ½ Water

**Trouser 100% TENCEL®
- 1/3 Dyestuff
- 1/2 Chemicals
- 1/2 Energy
- 1/2 Water

*Savings compared to 100% cotton

*exhaust dyeing
**cold pad batch process
Eco-Metrics is a tool from COLOUR CONNECTIONS to evaluate the whole life cycle of a garment.
Eco-Metrics

- Enable comparisons between fibres, fabrics and processes
- Highlights areas for improvement
- Highlights areas for new products
- Provide basis for in depth analysis

Product Classification

- **Green**: Recommended for use, move ahead with confidence
- **Amber**: Suitable for use - with some limitations
- **Red**: Products meet all legal requirements but do not meet your eco-specified - these products will not be marketed to your suppliers
# Eco-Metrics

<table>
<thead>
<tr>
<th></th>
<th>Cotton T-Shirt</th>
<th>TENCEL® T-Shirt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber</td>
<td>Water</td>
<td>Energy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yarn</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fabric weight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dye Method</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life expectation</td>
<td>Total EDUs / garment</td>
<td>6.8</td>
</tr>
</tbody>
</table>
Environmental Cost of a Black T-shirt
Fibre manufacture (based on 250g)

<table>
<thead>
<tr>
<th></th>
<th>Cotton</th>
<th>TENCEL ®</th>
<th>Lenzing Modal ®</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water (l)</td>
<td>1430</td>
<td>66</td>
<td>123</td>
</tr>
<tr>
<td>Energy (MJ)</td>
<td>10</td>
<td>11</td>
<td>6.2</td>
</tr>
<tr>
<td>CO₂ (kg)</td>
<td>0.75</td>
<td>0.52</td>
<td>0.22</td>
</tr>
<tr>
<td>Land Use (m²)</td>
<td>3.4</td>
<td>0.52</td>
<td>1.52</td>
</tr>
</tbody>
</table>

Figures from LCA by Patel & Chen
Environmental Cost of a Black T-shirt
Fabric manufacture

Yarn spinning – TENCEL ® has 20% less waste compared with cotton.

<table>
<thead>
<tr>
<th></th>
<th>Cotton</th>
<th>TENCEL ®</th>
<th>Lenzing Modal ®</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (MJ)</td>
<td>4.5</td>
<td>1.8</td>
<td>2.0</td>
</tr>
<tr>
<td>Water (l)</td>
<td>47</td>
<td>18</td>
<td>22</td>
</tr>
<tr>
<td>Chemical (g)</td>
<td>320</td>
<td>150</td>
<td>225</td>
</tr>
<tr>
<td>Dyestuff (g)</td>
<td>20</td>
<td>12</td>
<td>18</td>
</tr>
</tbody>
</table>
Lenzing Fibers

examples - POS and Internet
Tianello – natural clothing

Soft, Fluid, Natural

TENCEL® is known for its “drape.” It flatters the human form.

The look is luxurious and refined for comfort. TENCEL® is soft, breathable, lightweight and durable.

Shrink-resistant and easy to care for, it is an exceptionally strong fiber both wet and dry. Color rich, TENCEL® was created with color in mind, because of the fiber’s high absorbency.

The fabrics can be dyed to high quality standards. Easy to maintain, TENCEL® garments are easy to pack, resist wrinkling and dry quickly. All styles are machine washable and tumble dry. Always refer to care label.

Natural fiber from wood

Made from natural cellulose found in wood pulp, TENCEL® is harvested from managed tree farms. Produced in a non-chemical manner, the fiber is economical in its use of energy and natural resources, and it’s fully biodegradable.

Taking Care of Tencel

Garment dyed and laundered clothing offers a terrific easy care way to dress. Here are the simple basics of keeping your clothes looking their best:
Adidas

Better Place

PRODUCTS  ABOUT  MORE

Idea  Design  Materials  Tracking  Future  3-Tree Logo

Tencel®

This wood-based material comes from a renewable source. It is produced by Lenzing from independently certified, sustainably managed eucalyptus forests. The wood fibre is organically harvested and manufactured in a closed-loop process, which means that there is no waste created during its processing. Tencel® is very biodegradable, and is seen as the best quality rayon on the market at the moment.

http://www.adidas.com/campaigns/better_place/content/
Fabric: Tencel® Lyocell

A Naturally Efficient Process

Tencel® is a branded lyocell fiber similar to rayon that comes from the pulp of eucalyptus trees. The trees are grown on sustainably run farms certified by the Forest Stewardship Council (FSC) and the fiber carries the Pan European Forest Council (PEFC) quality seal. It is possible to use bamboo, or other sources of cellulose, but eucalyptus yields the best quality fiber with the least amount of waste. Therefore we think this process is the best available option.

The wood pulp is processed in a non-toxic organic solvent solution that’s reclaimed and recycled in a closed-loop spinning process that conserves energy and water—up to 99% of the solvent is recovered and reused. We ensure that the processing of Tencel and lyocell fibers does not utilize any of the harmful chemicals (like formaldehyde) sometimes used to treat the fibrillation of these fibers.

Benefits

- Derived from fast-growing trees farmed sustainably
- No toxic chemicals or solvents used to process fibers
- Chemicals and solvents are recovered and reused
Patagonia – footprint chronicles

Short-Sleeved Kamala Top

The Good
A versatile top in an intimate, soft-wearing blend of 55% organic cotton and 45% Tencel®, an environmentally sensitive cellulose-based fiber that drapes beautifully, has the moisture-wicking properties of polyester and provides nice stretch without the use of spandex. It’s also durable, wrinkle-free and easy to care for.

The Bad
The fabric is not yet recyclable in a closed-loop process, though we’re working on it. Unlike polyester, the cotton/Tencel® blend has to be mechanically recycled (chopped up) to yield a new fiber (and fabric) of lesser quality than the original. Note that cotton/Tencel, like 100% cotton, uses significantly more water than do polyester, nylon and other synthetics.

What We Think
The fabric offers exceptional performance, a soft hand and relatively less environmental harm than many alternatives. Future recyclability will be a plus.