



CHEMICAL RECYCLING OF COTTON AND POLYCOTTON TEXTILES

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*Telaketju R&D webinar
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Bachelor Program *Fashion and Textile Technologies*
(higher textile education since 1919)

Master Program *Innovative Textile Development*
(since 2014)

27 000 Students

Enschede

Deventer

Apeldoorn



Research group Sustainable & Functional Textiles

Applied Science in Textiles



Research group leader: **Dr. Jan Mahy**

Coordination of research line Sustainable Textiles: **Dr. Jens Oelerich**

Expertise: Textile Technology, Fashion Design, Circular Textiles, Rapid Prototyping, Sustainable Chemistry

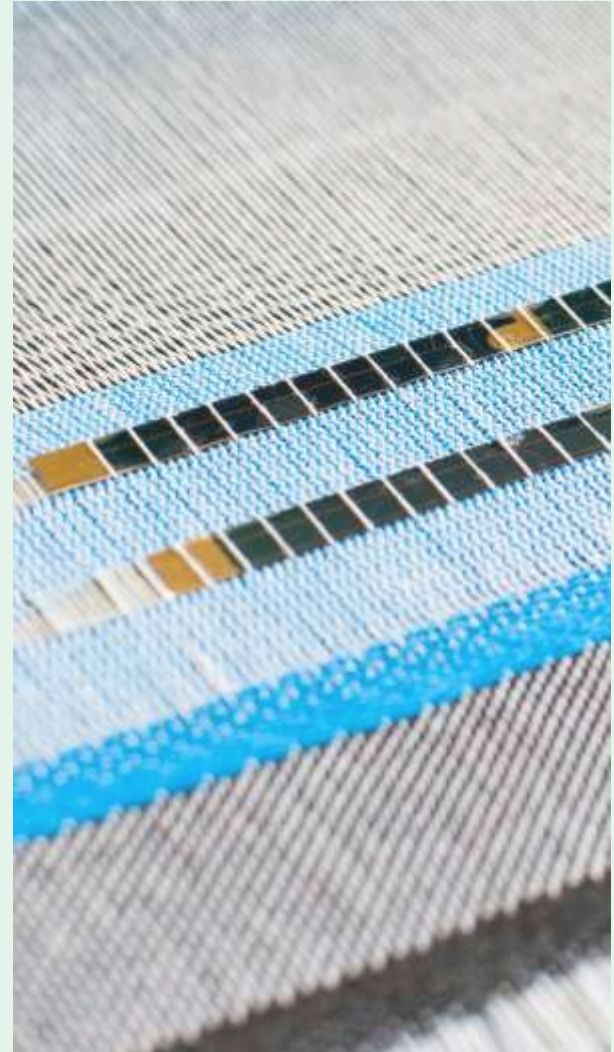
>100 Years Industrial experience

Research group Sustainable & Functional Textiles

Applied Science in Textiles



Sustainable
Textiles



Functional
Textiles



Sustainable Textiles

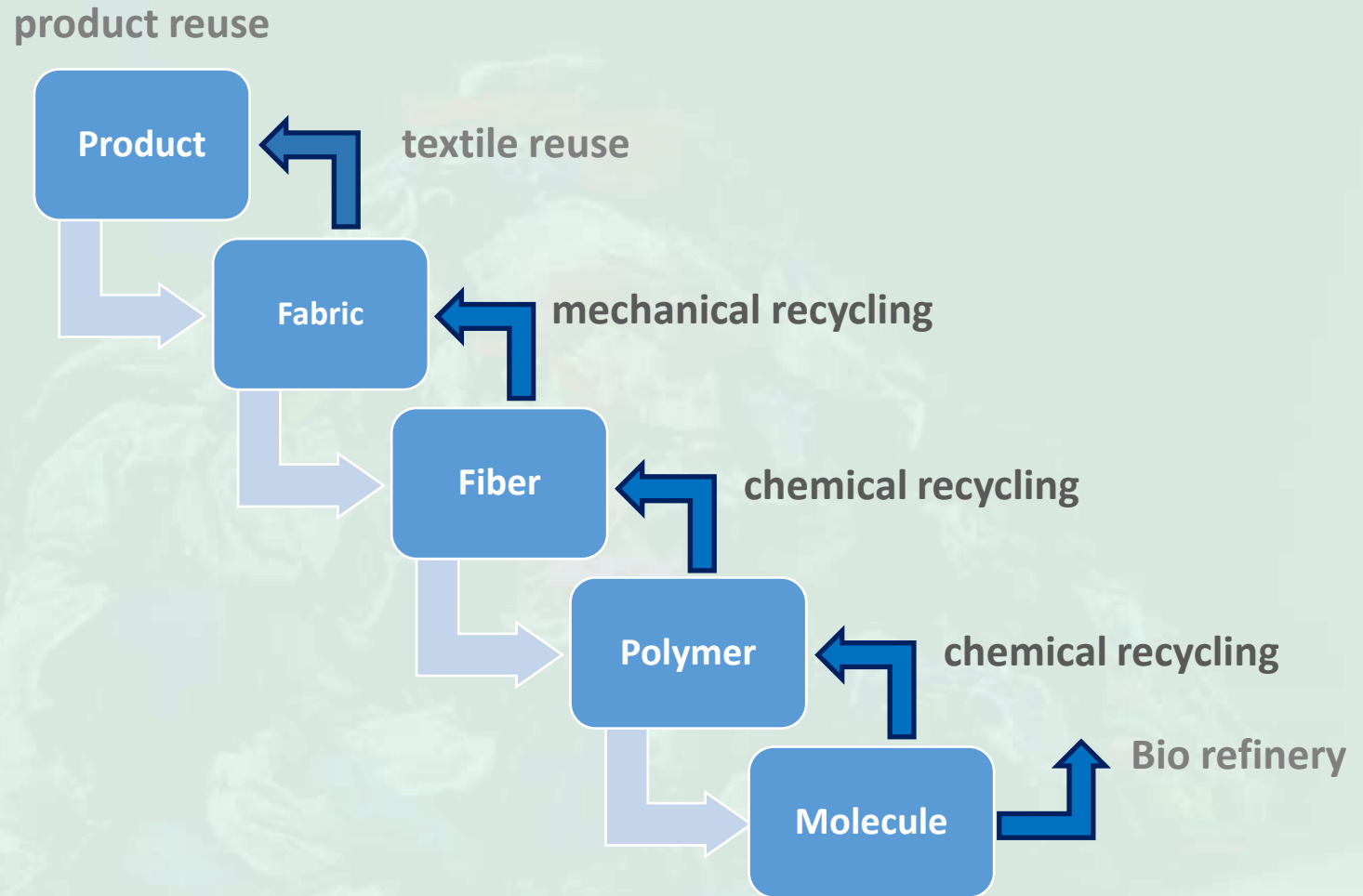
Reduce, Reuse,
Recycle

Mechanical and Chemical recycling
of cellulosic textiles

Applied Science

Intensive collaboration with industry,
education and research

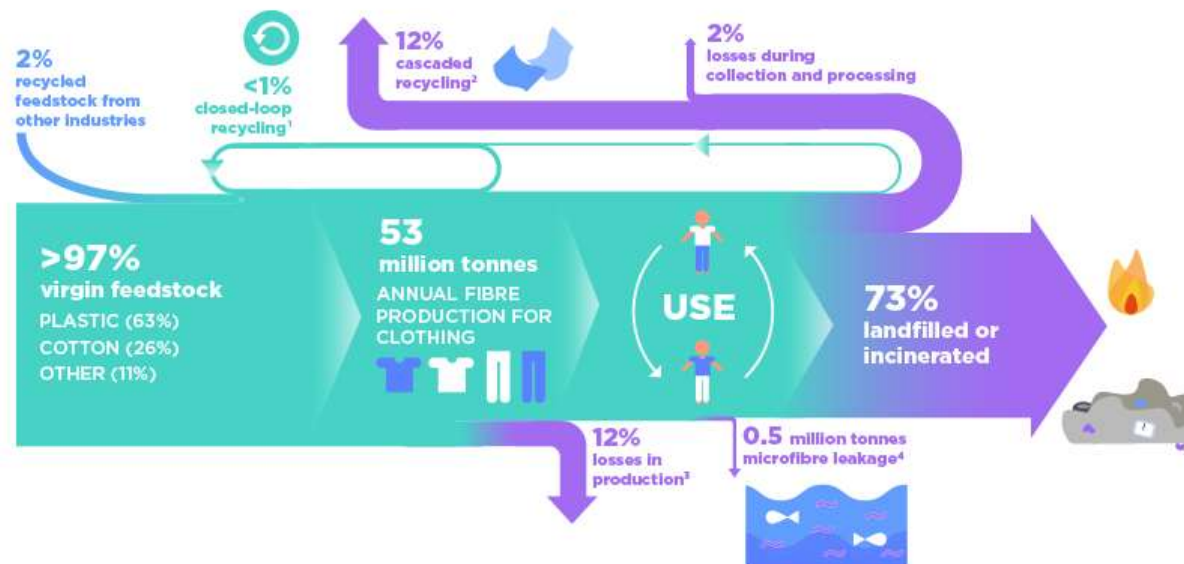
Research activities



Textile fiber production

Worldwide textile fiber production in 2018 ~111 Mt

- 79 Mt synthetic fibers
- 32 Mt natural fibers (26 Mt cotton fibers)



¹ Recycling of clothing into the same or similar quality applications

² Recycling of clothing into other, lower-value applications such as insulation material, wiping cloths, or mattress stuffing

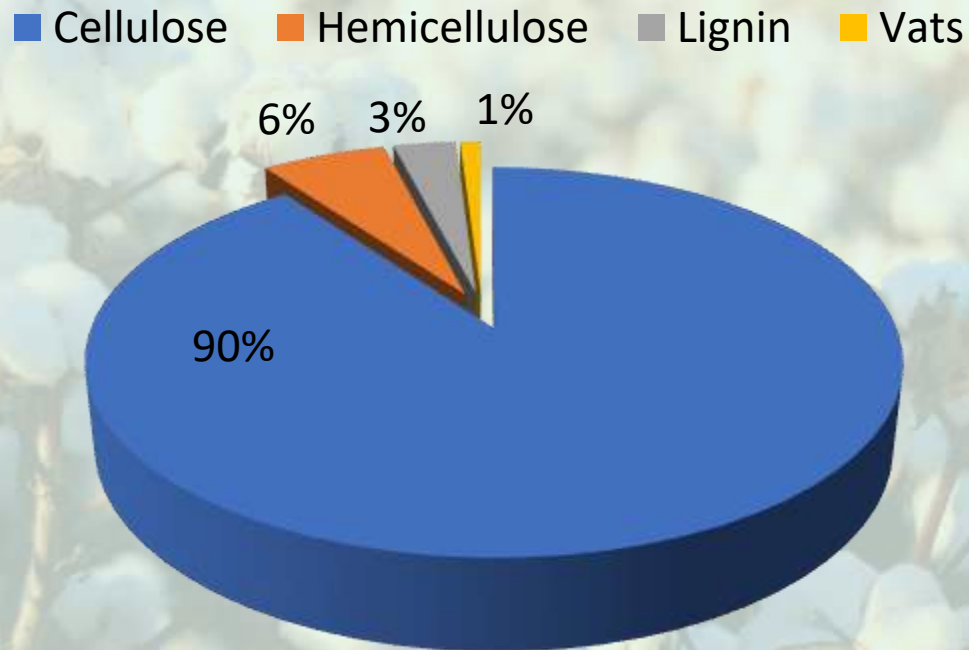
³ Includes factory offcuts and overstock liquidation

⁴ Plastic microfibres shed through the washing of all textiles released into the ocean

Source: Circular Fibres Initiative analysis – for details see Appendix B of the full report

Cotton

Cotton composition



>9 Mt textile products are incinerated in the EU each year

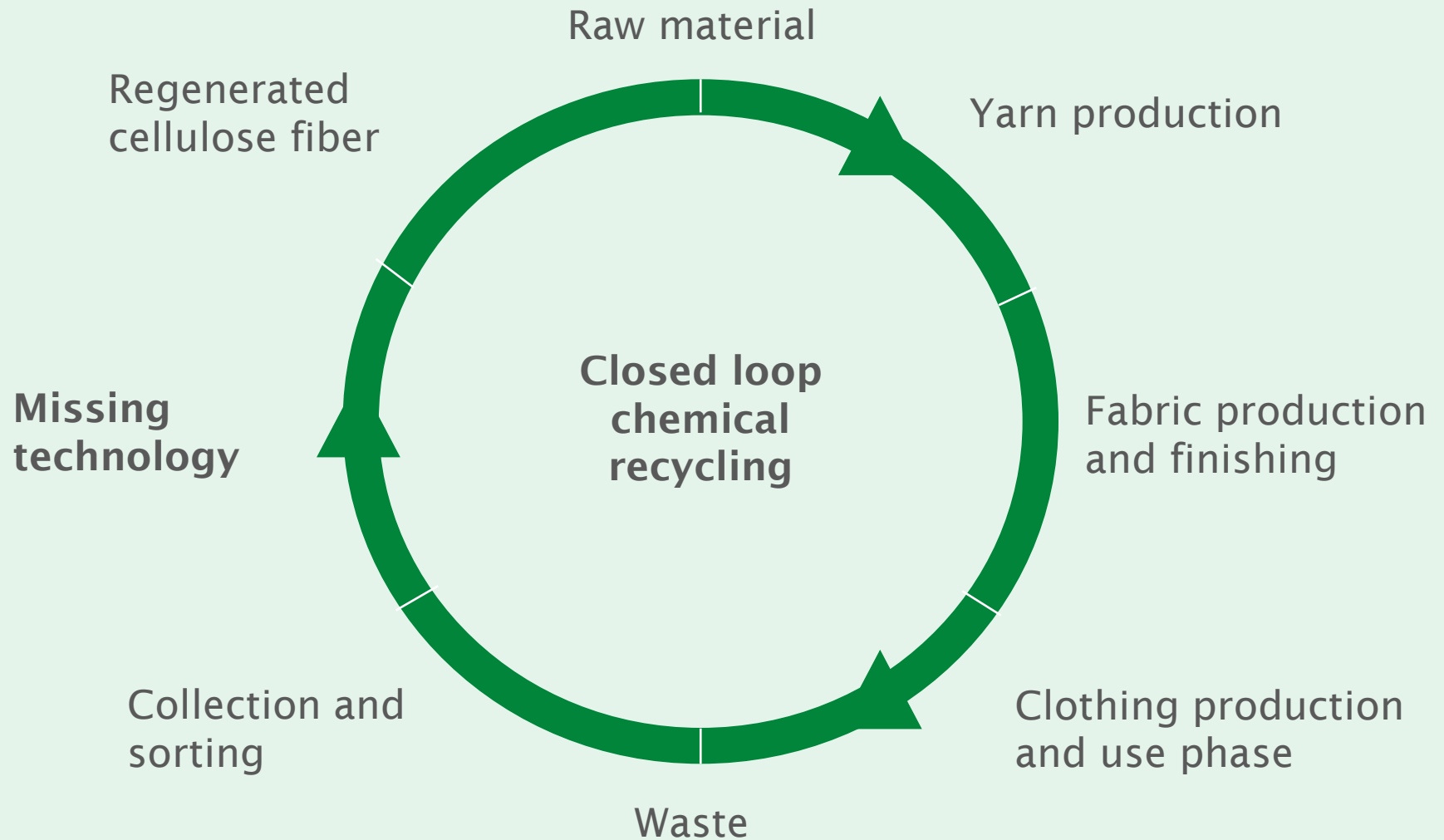
>25% cotton

Large part can be used for chemical recycling

Cleaned virgin cotton:
88-94% α -Cellulose

Cleaned cotton waste:
96-98% α -Cellulose

Cellulose circle



Technological approaches

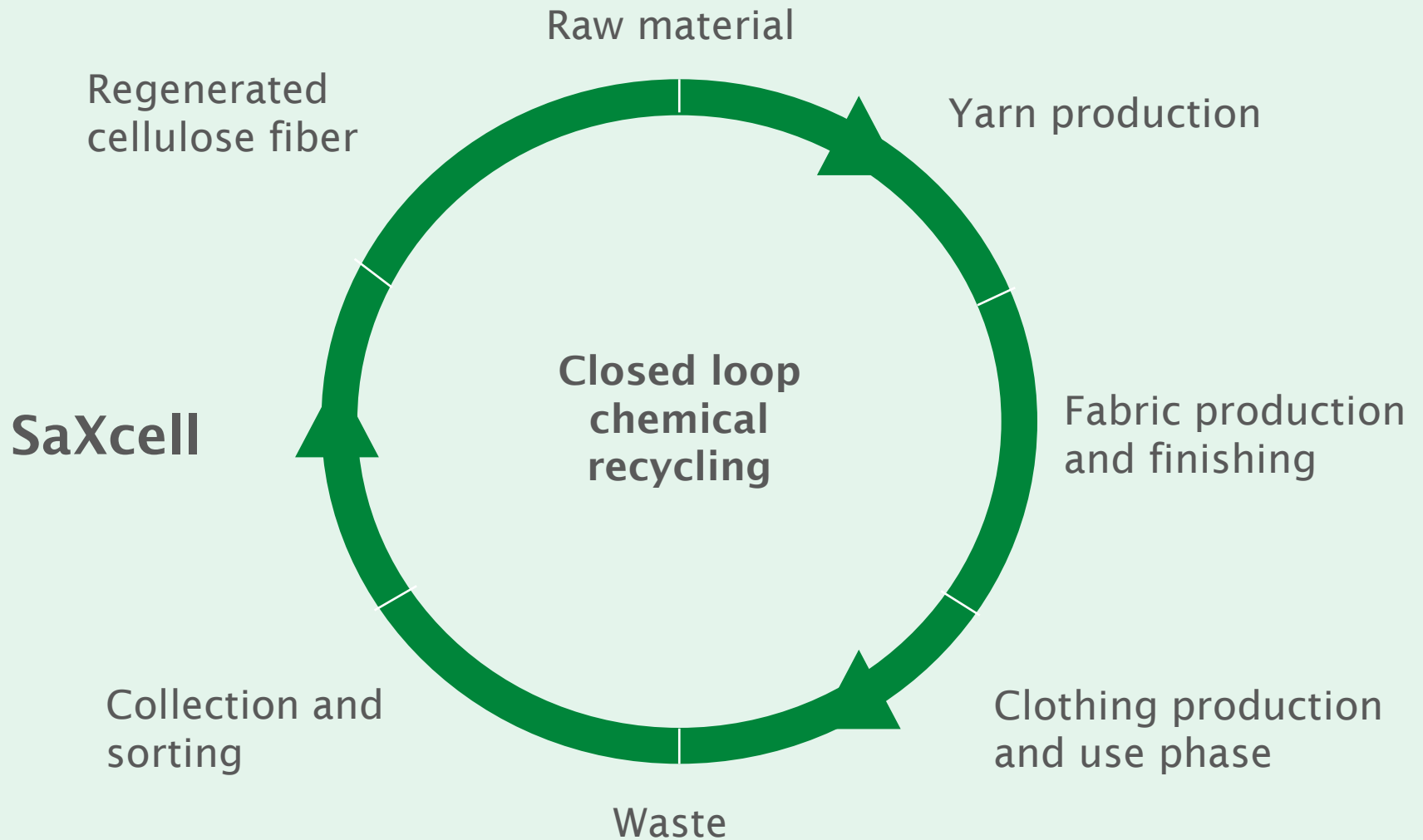
Preparation of cellulose pulp from cotton waste

- ReNewcell (pre- and post-consumer cotton waste)
- WornAgain (Polyester/cotton blends)
- Cumapol (Polyester/cotton blends in collaboration with Saxion)

Fiber production from cotton waste

- Lenzing/Refibra (Lyocell, up to 30% pre/post-consumer waste)
- Infinite Fiber Company (Carbamate Technology, cotton waste and other cellulose)
- Ioncell and Deakin University (Ionic liquids, cotton textile waste)
- SaXcell (Lyocell, 100% pre/post-consumer cotton waste)

Cellulose circle



Key aspects in the development of the SaXcell fiber

Transformation of waste into a valuable raw material

No investments in processing machinery needed

Fiber needs to fit in existing supply chain

Large scope of applications

Sustainable production and processing

SaXcell recycling process

1) Waste collection and sorting

2) Unravelling and/or milling

3) Removal of polyester and other impurities

4) Discolouration of remaining textile waste

5) Adjustment of the degree of polymerization (DP)

6) Spinning of SaXcell fibers

7) Yarn production

8) Fabric production

9) Fabric finishing

10) Garment tailoring



Patented process to adjust cellulose DP

Parameter	Advantages of the patented process
Time	80% shorter
Temperature	20°C reduction
Hazards	no
Neutralization	Not necessary
Washing steps	50% less



SaXcell fiber production and properties

- staple fibers (1.8 dtex, 38 mm)
- very good mechanical fiber properties
- suitable for common textile processing

Sample		SaXcell fiber properties
Fiber fineness	dtex	1.81
Elongation	%	12.7
Tenacity, cond.	cN/tex	43.6



Processing of SaXcell fibers



100% SaXcell® fiber in warp and weft

ARTÖFIL

High Tech Yarn & Coatings

Rotor spun yarn
Nm 17, Nm 34/2



Mechanical properties 100% SaXcell fabrics

Tensile strength and elongation to break ISO 13934

dry

	Weft - Strength [N]	Weft - Elong. [%]	Warp - Strength [N]	Warp - Elong. [%]
SaXcell original	767	11,6	708	20,0
SaXcell bleached	600	8,9	604	11,1
Cotton	474	7,4	525	10,6

wet

	Weft - Strength [N]	Weft - Elong. [%]	Warp - Strength [N]	Warp - Elong. [%]
SaXcell original	701	18,4	611	31,4
SaXcell bleached	425	13,3	430	16,4
Cotton	429	10,4	500	14,2

Comparable to existing cellulose fibers



100% SaXcell garments tailored at Humanoid BV



50% cotton / 50% SaXcell towels



Ring spinning

RIETER

100% SaXcell ring spun yarn

- small problems with electrostatic charging
- fineness of Nm 68 were realized



Quotes

“Feels like combed cotton”

“Better processible than similar fibers”



Industrial knitting

Aldo Nägeli AG



Dyeing with reactive dyes

Dyeing of knitted SaXcell fabric
with Benzema Go reactive dye

Dark black:

SaXcell: 5% dyestuff,
50 l/kg water consumption

Cotton: 9% dyestuff,
~150 l/kg water consumption

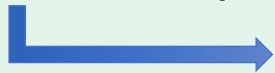


Life cycle assessment SaXcell pulp

Executed by CE Delft

Challenges:

- Laboratory scale experiments



Industrial scale application

- Availability of data

Feedstock	Comparison with average impact of existing pulping processes*
100% cotton waste white	Lower in all impact categories
100% cotton waste white (new process)	Lower in all impact categories
Cotton / polyester blend, white	Lower or comparable
Cotton / polyester blend, dark blue	Higher in most impact categories

*based on available data from Ecoinvent

From Workwear to Workwear



Project partners:



Workwear material cycle



SaXcell® workwear trousers



In collaboration with Havep BV

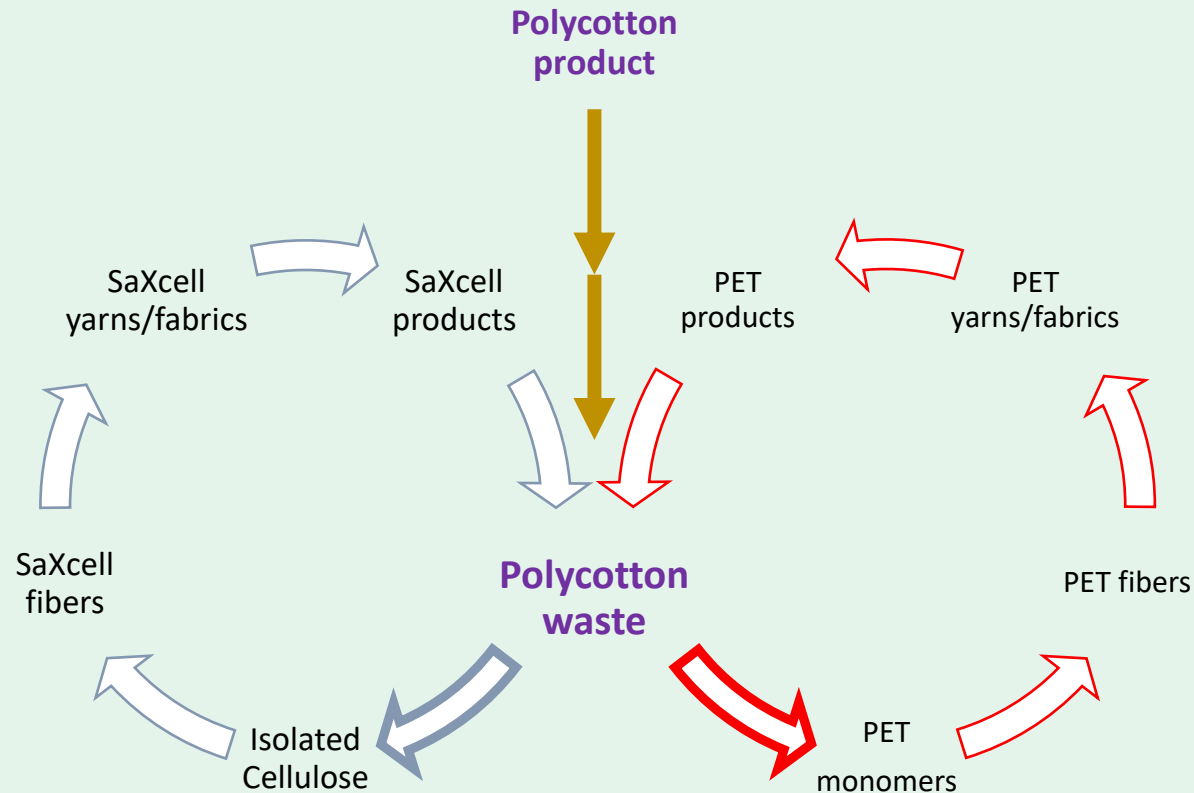


Breakthrough in polycotton recycling



Breakthrough in polycotton recycling

Recycling concept



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SaXcell BV



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