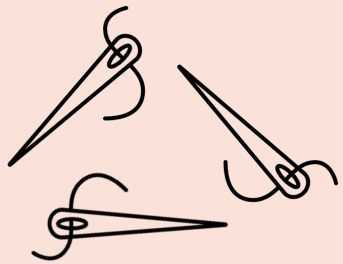


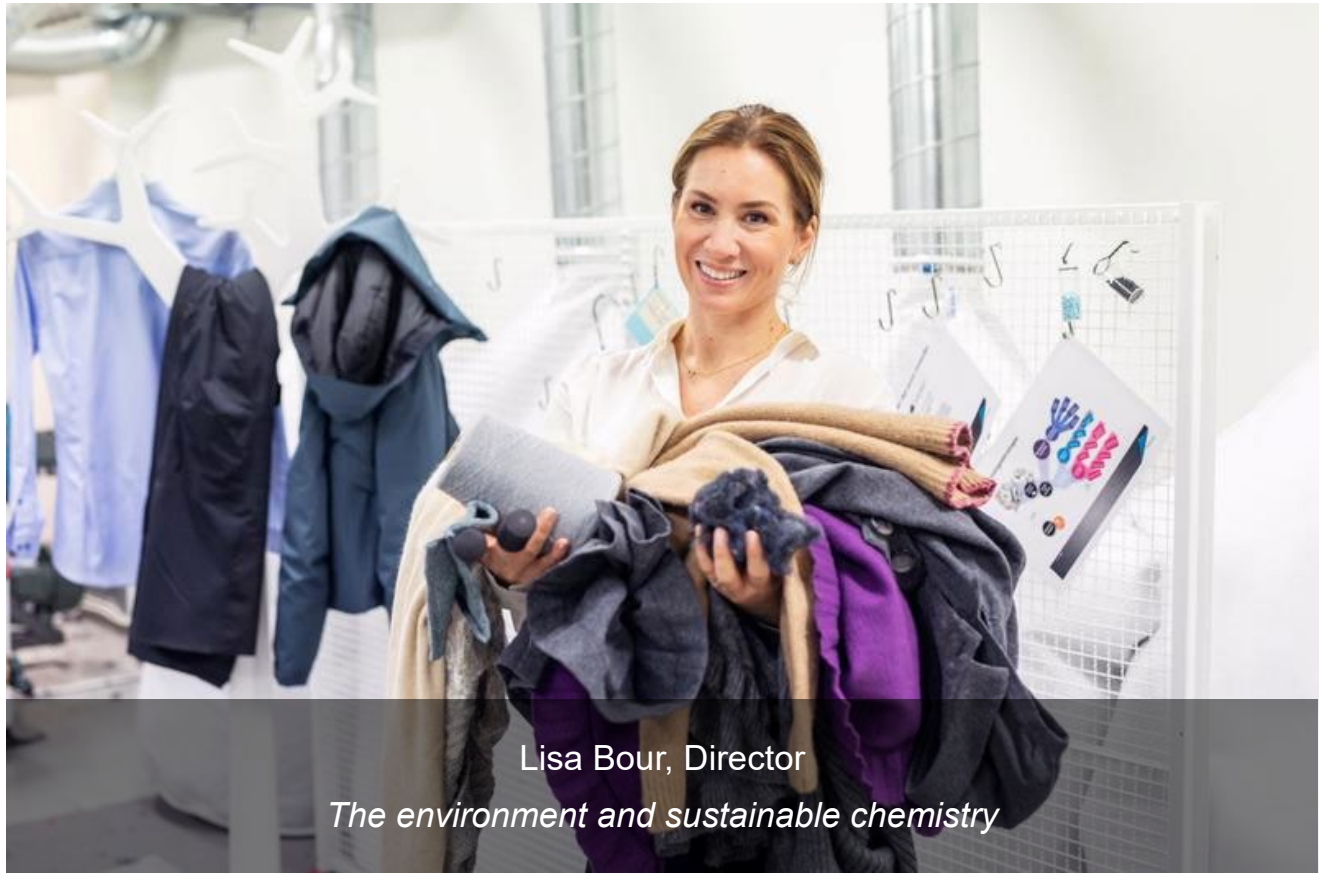
How do we handle our textile products at end-of-life?

Lisa Bour & Mattias Andersson

2020-11-26

RI.
SE

About us



Lisa Bour, Director

The environment and sustainable chemistry

Mattias Andersson, Researcher

Materials, processes and recycling

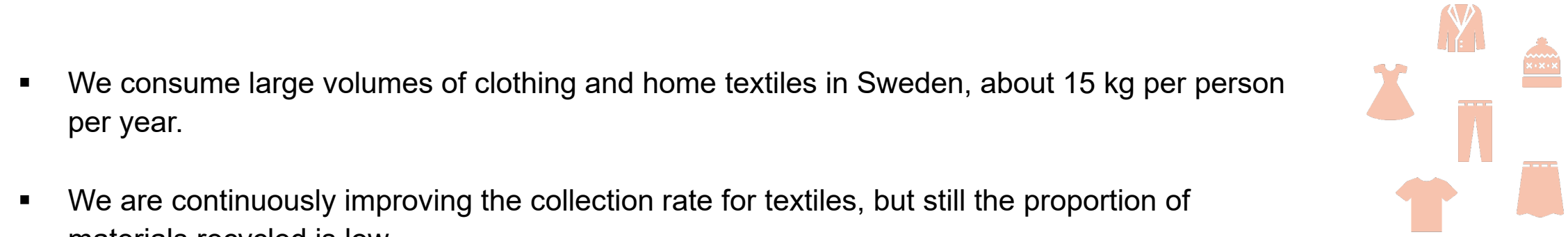
AGENDA

1. Rise in brief
2. Background - textile management for the future
3. What have we done in Sweden?
4. The textile material stream - closed & open loop
5. Recycling technologies & new materials
6. Information need at end-of-life
7. The workshop planned for December 14th

Sverige kraftsamlar

- RISE bildades för att accelerera Sveriges innovationskraft och skapa bättre förutsättningar för samhällets problemlösare.
- Drygt 30 forskningsinstitut och cirka 130 unika testbäddar har samlats i en organisation.
- Kraftsamlingen ger oss en unik bredd och samlad kompetens.
- RISE har ett särskilt uppdrag att stötta små och medelstora företag.

Handling of textile materials - background



- We consume large volumes of clothing and home textiles in Sweden, about 15 kg per person per year.
- We are continuously improving the collection rate for textiles, but still the proportion of materials recycled is low
- Every day, more than 200 tonnes of textiles are disposed of in the residual waste, more than half of which are estimated to be in such a condition that they could be reused.
- Research and work on textile recycling at RISE started with questions related to technologies for recycling but has expanded into system issues.
- → *Very complex material stream*
- → *Need for information for efficient recycling*
- → *The issue of chemicals in textiles is important*

”…. including the introduction of producer responsibility for textiles. Possible ways of significantly increasing the reuse and recycling of textiles will be tested involving the industry and non-profit actors”

The January-agreement, 2019

The government-assigned investigation related to the coming producer responsibility is ongoing

What are we aiming for?

Proposed textile waste targets

By 2025, the amount of textile waste in residual waste will be reduced by 65% compared to the base year 2015

By 2025, 90% of separately collected textile waste will be prepared for reuse or recycled using the waste hierarchy

Circular Economy Package – *adopted 2018*

- Textiles to be collected separately in all Member States by 2025
- By 2024, an assessment must be made regarding the implementation of reuse and recycling targets
- The European Parliament has been working for the recycling and recycling of textile materials for several years – textiles are now being singled out in Ursula von der Leyen's Agenda:

” I will propose a new action plan for the circular economy, focusing on sustainable resource use, especially in resource-intensive sectors with a high impact, such as the textile and construction industries."

And at the Swedish level:

In July, the Government Offices published a circular transition strategy, where it can be read, quote:

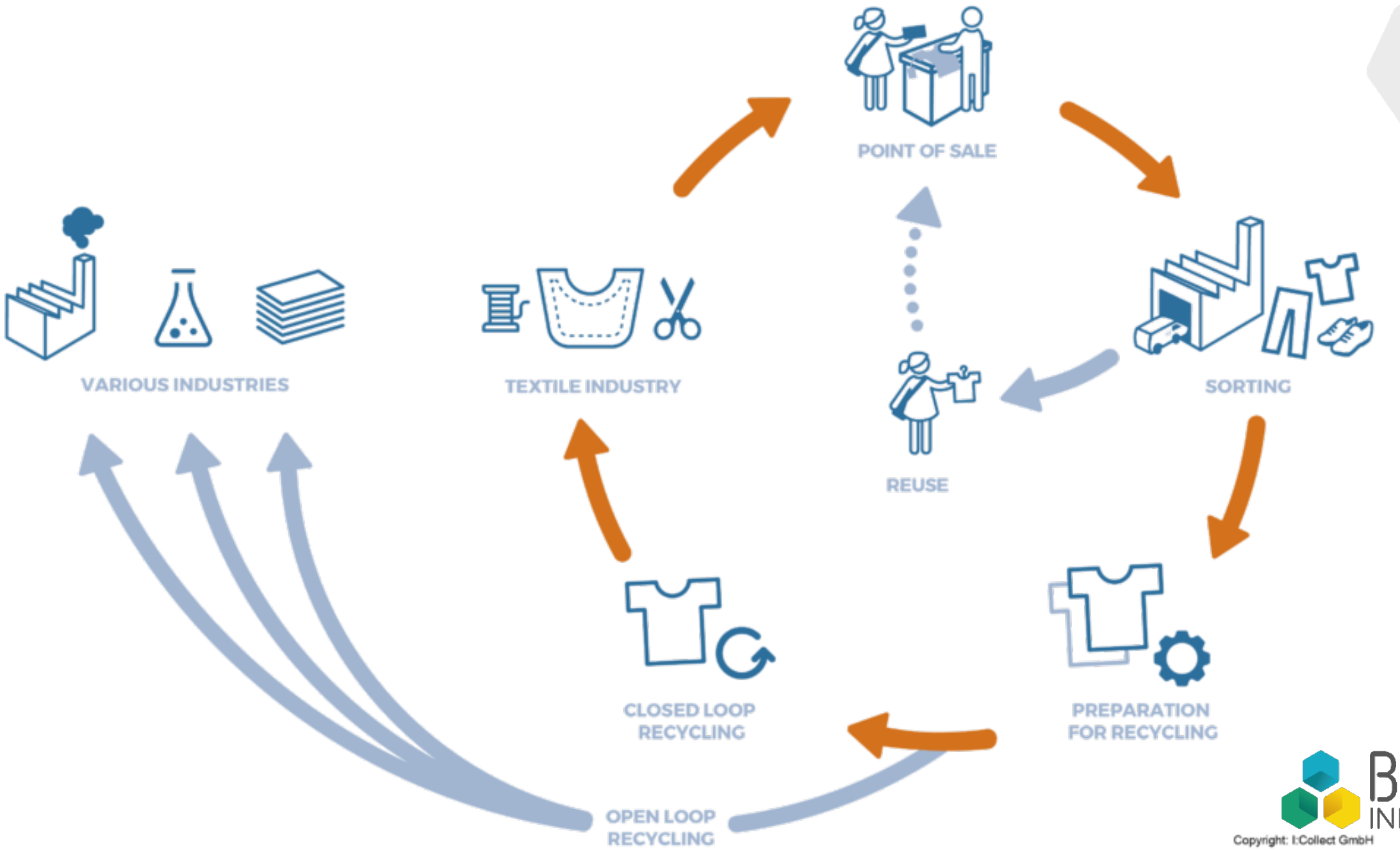
"In the forthcoming national work, priority will be given to plastics, textiles, renewable and bio-based raw materials, food, construction and real estate, including construction and demolition waste, as well as innovation-critical metals and minerals in the transition to a circular and bio-based economy."

How have we been working with these issues in Sweden?

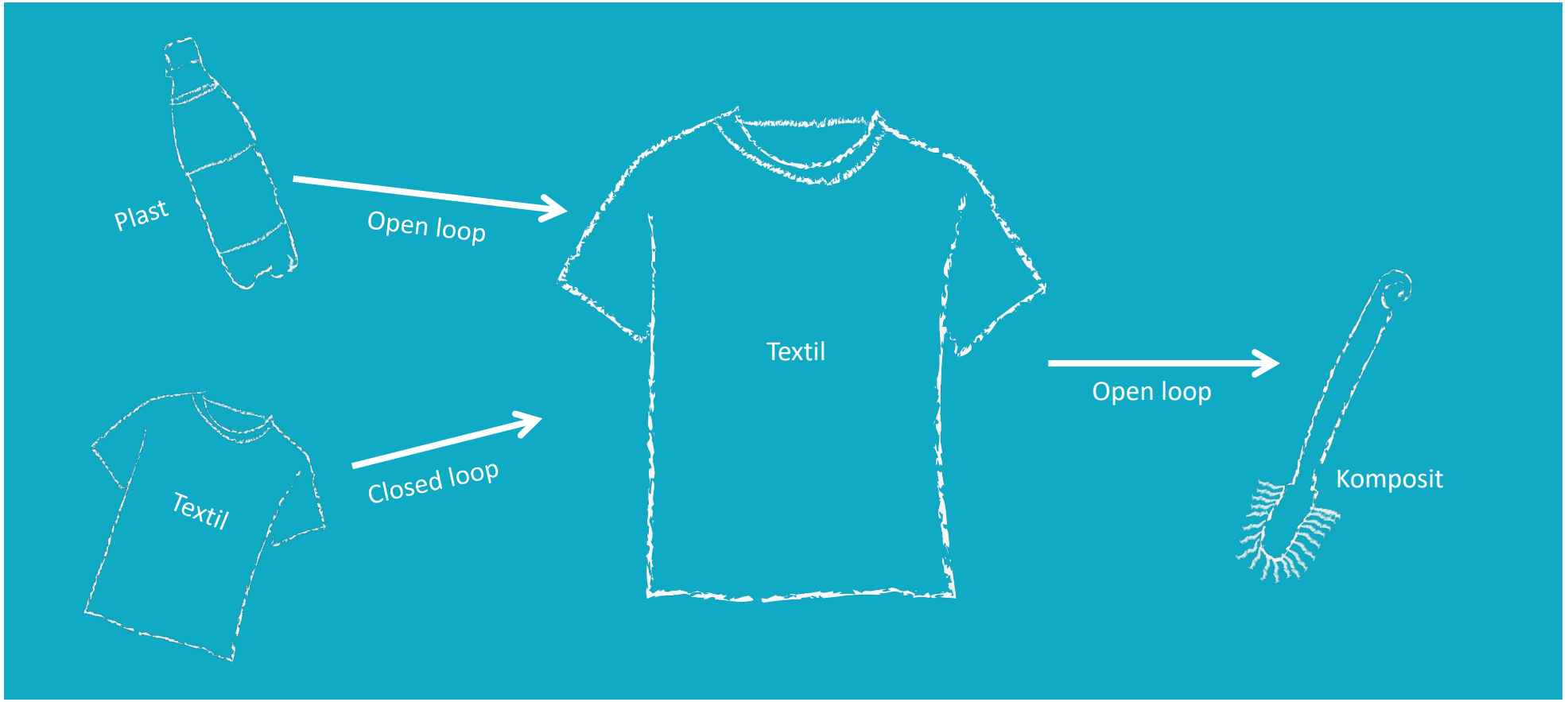
Swedish initiatives and projects in textile recycling in recent years

- re:newcell
- Södra OnceMore (Blend Re:wind)
- re:textile, F/ACT Movement
- Testbed for textile recycling
- WargoTex
- SIPTex
- ENTIS
- Classification and risk assessment of textiles for recycling
- Advocacy-platforms
- Mistra *Future Fashion*
- Tex.IT
- Wargön sorting pilot
- Textile & Fashion 2030
- Trash-2-Cash
- Chemical substitution microfibre release
- H2020 proposals

Textile materials and possible pathways through the value chain

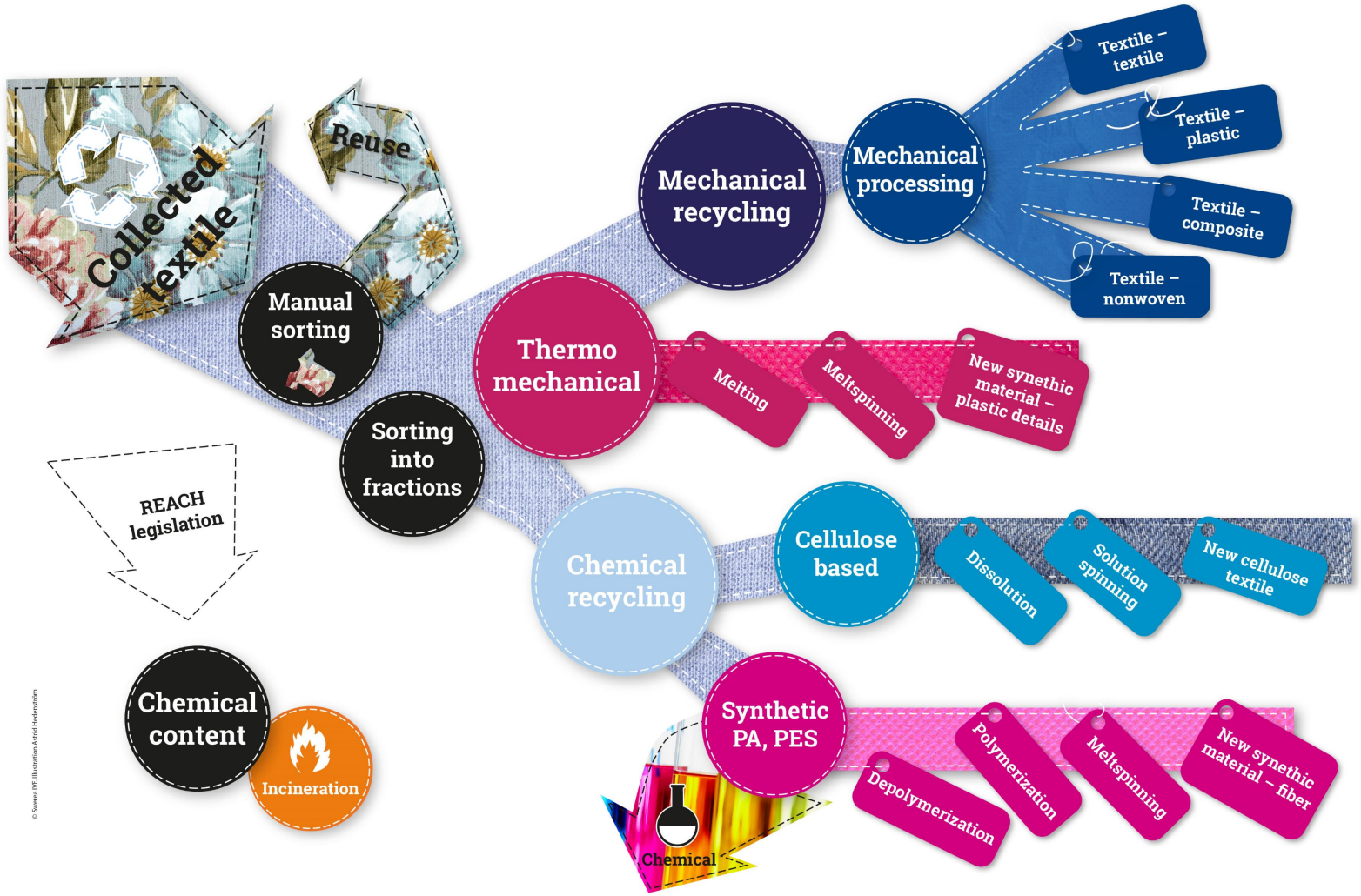


Closed and Open Loop-recycling



BIO INNOVATION

Recycling technologies

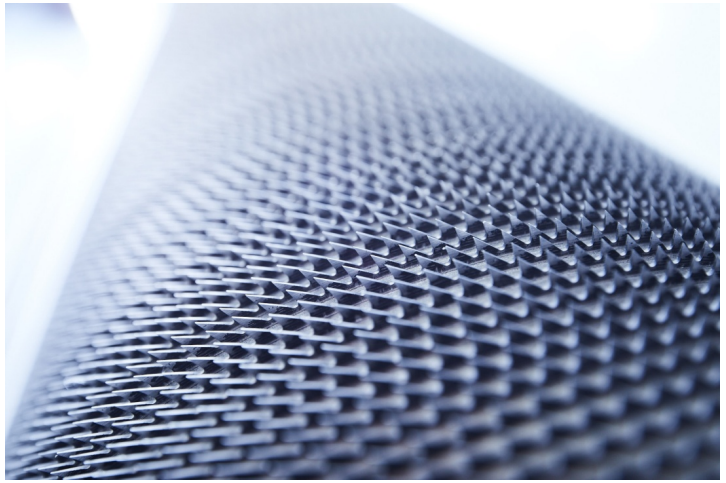


Recycling of cotton

- Only mechanical recycling can provide a retained cotton fiber, in chemical recycling another fibre type is created
- Two major processes exist for cellulose regeneration – the viscose process (viscose, modal) and the lyocell process (tencel)
- The cellulose-based textiles found commercially are produced from forest raw materials, in the future there is great potential for recycled raw materials as well
- In order to achieve efficient processes, fast and specific sorting of collected textiles is needed

What does mechanical recycling of textiles mean?

- Mechanical recycling involves a process where the fibre is released from the textile structure
- The incoming fabric is cut into smaller pieces. Metal parts, buttons and the like are removed
- The material is run through a textile tearing machine consisting of an opening step (8 mm nails) and 6-9 cylinders processing the material further (4 mm nails)



When does this method work?

- Mechanical recycling works for most materials made of knitted fabric, fabric, knitwear – however, the length of the fibre is always negatively affected
- The focus is always to maintain the fiber length as much as possible, but the design of the material greatly affects the result
- In natural and synthetic fibre mixtures, natural fibres are often most affected by the process
- How to improve the result?
  - Interesting to evaluate pre-treatment
  - Composition of feedstock

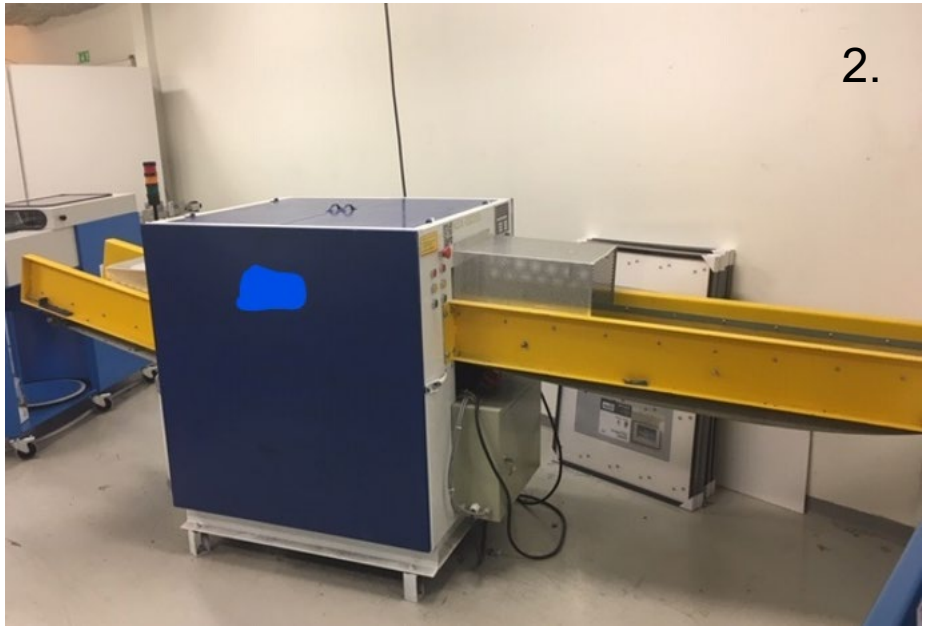
Textiles for textiles - mechanical recycling

- Basically only industrial waste (pre-consumer)
- Typical blend: ~20% recycled
- Resource-efficient recycling
- Common for denim
- Very unusual from post-consumer
- Exception wool – high material value and often easily recycled

Bild: hm.com, RISE IVF

BIO INNOVATION

Procedure/material flow mechanical recycling



Mechanical processing of textile materials

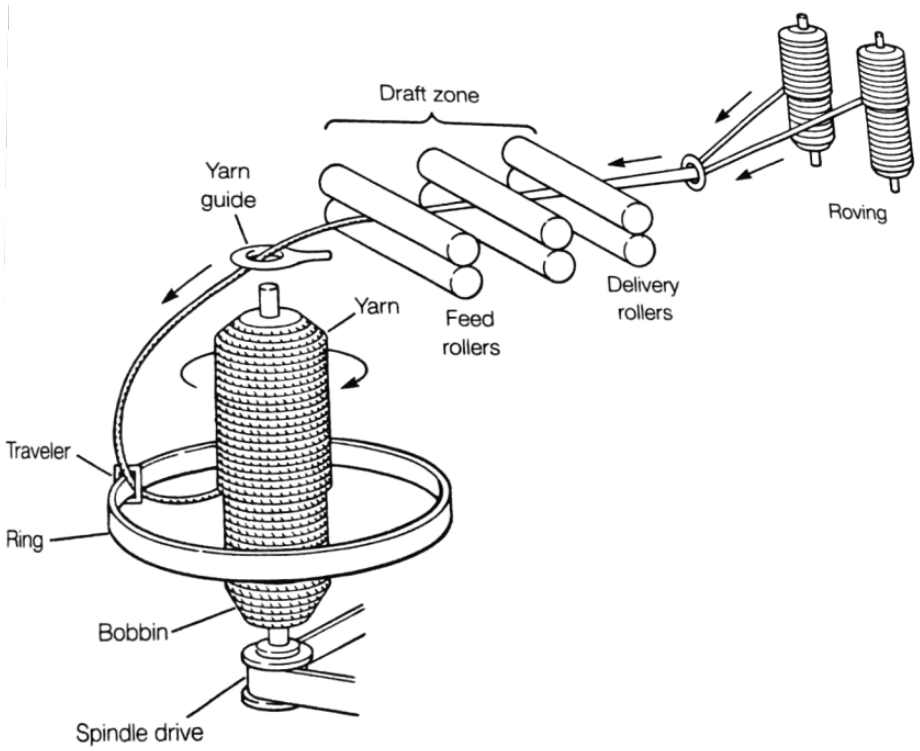
- Construction - woven or knitted material
- Fiber type/fiber mix, t.ex. synthesized or natural fiber and elastane
- Chemical profile of raw materials
- Colours and dyes

→ Raw material for new textiles, fibre-reinforced composites and/or nonwoven

Yarn spinning

- The major techniques for yarn spinning will be mentioned here, these are commercially used to produce yarn from fiber of staple length up to around 50 mm
  - *Ring spinning*
  - *Rotorspinning (Open-end)*

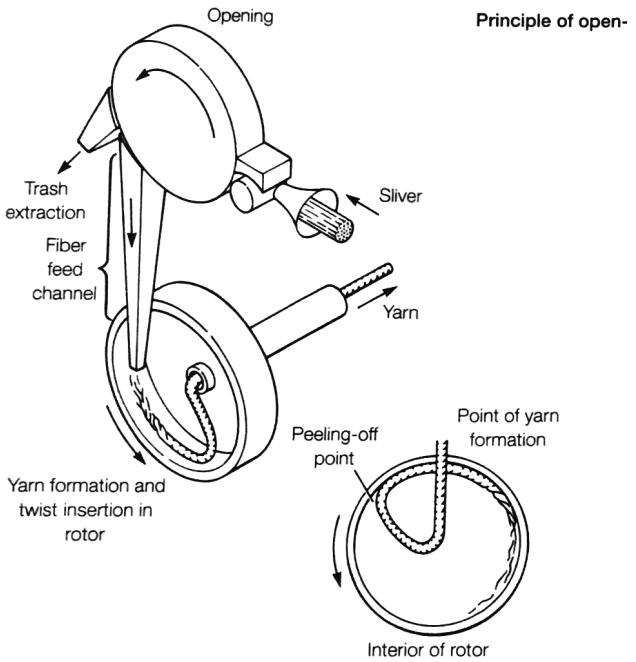
Ring spinning



- In ring spinning, a roving is drawn to the desired yarn count, with an added twist. These processes take place simultaneously and continuously.
- Ring spinning is a relatively expensive process due to slow production speed and the extra processes (roving and winding) required to produce ring-spun yarns.
- Ring spinning provides high-quality yarn and usually thinner yarn types.

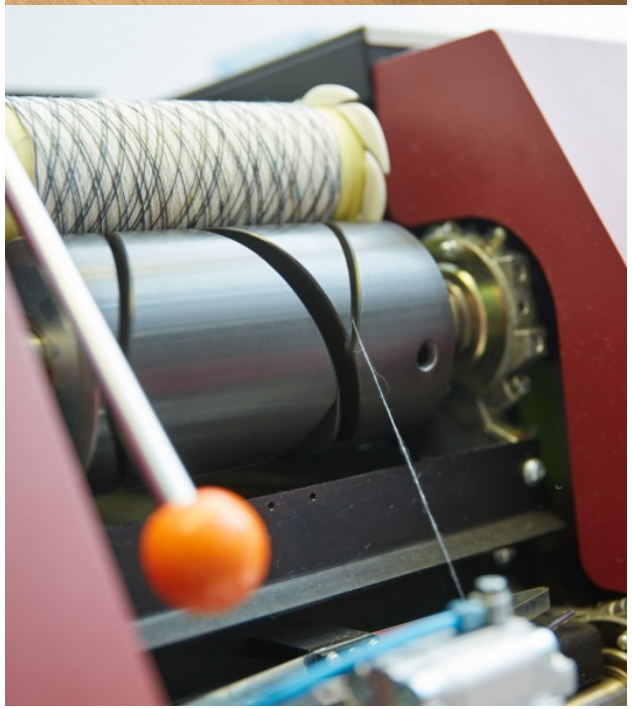
Rotor spinning (OE-spinning)

- The process is fed with sliver that is combed and individualized
- Fibres are transferred to the rotor unit where air current and centrifugal forces distribute the fibres along a channel in the rotor where they are distributed evenly
- The fibres twist through the rotor and the yarn is continuously pulled out of the centre of the rotor unit
- The production speed of rotor spinning is 6-8 times higher than ring spinning because the process is directly fed with sliver
- Rotor-spun yarn is more uneven, slightly weaker and has a slightly harder feel than ring-spun yarn. Produces medium to coarse yarn



Principle of open-

Rotor spinning



50% recycled PES
50% Organic cotton

100% Textile to textile

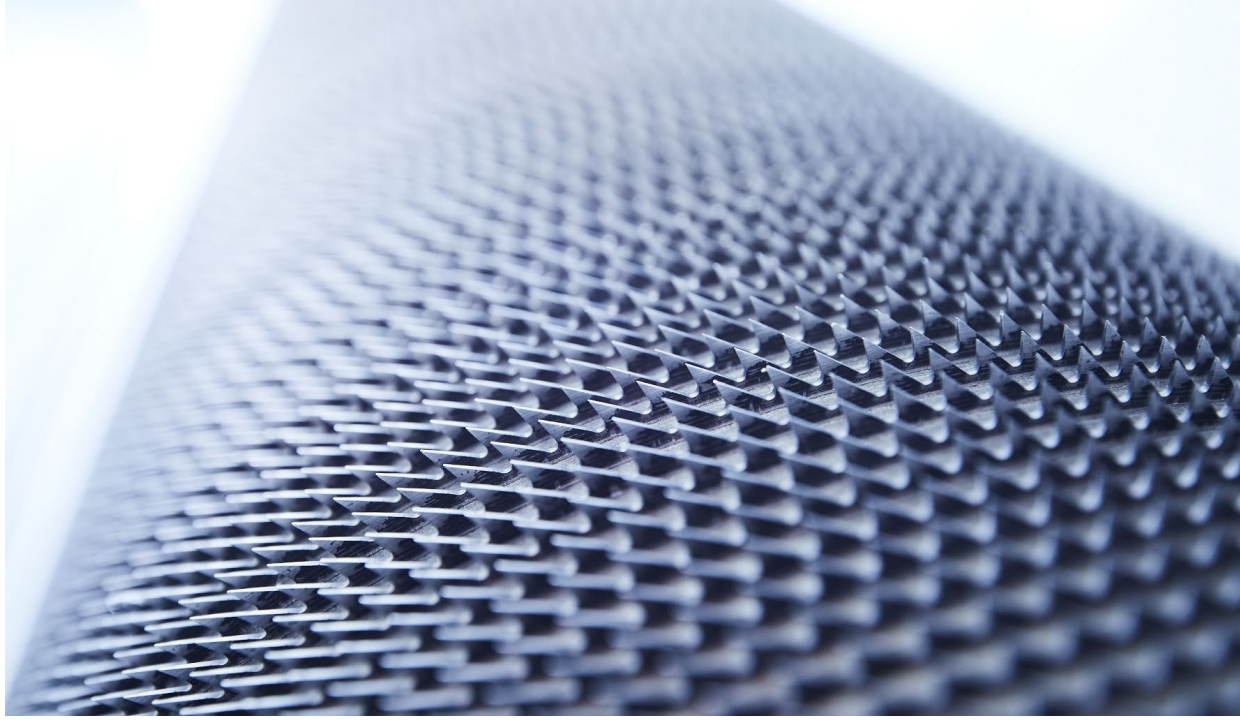
- Mechanically recycled industrial waste
- Saves a lot of water
- Free staining
- Small scale
- http://www.purewastetextiles.com/

Bild: purewastetextiles.com

BIO INNOVATION

Process - Nonwovenprodukter

- Tearing
- Carding
- Needling
- Press
- Punching



Hazardous waste bins for sharp and/or pointed objects from clinical/ medical/ biological activities

Strict quality requirements for healthcare products

Clear influences from sharp and stabbing objects

Must cope with a fall of 1.2 m at -18°C with 1 kg deadweight

20-25% low-grade recycled textile in recycled PP

E-module, etc..

Fotpluggar till möbler

Quality requirements for furniture parts:

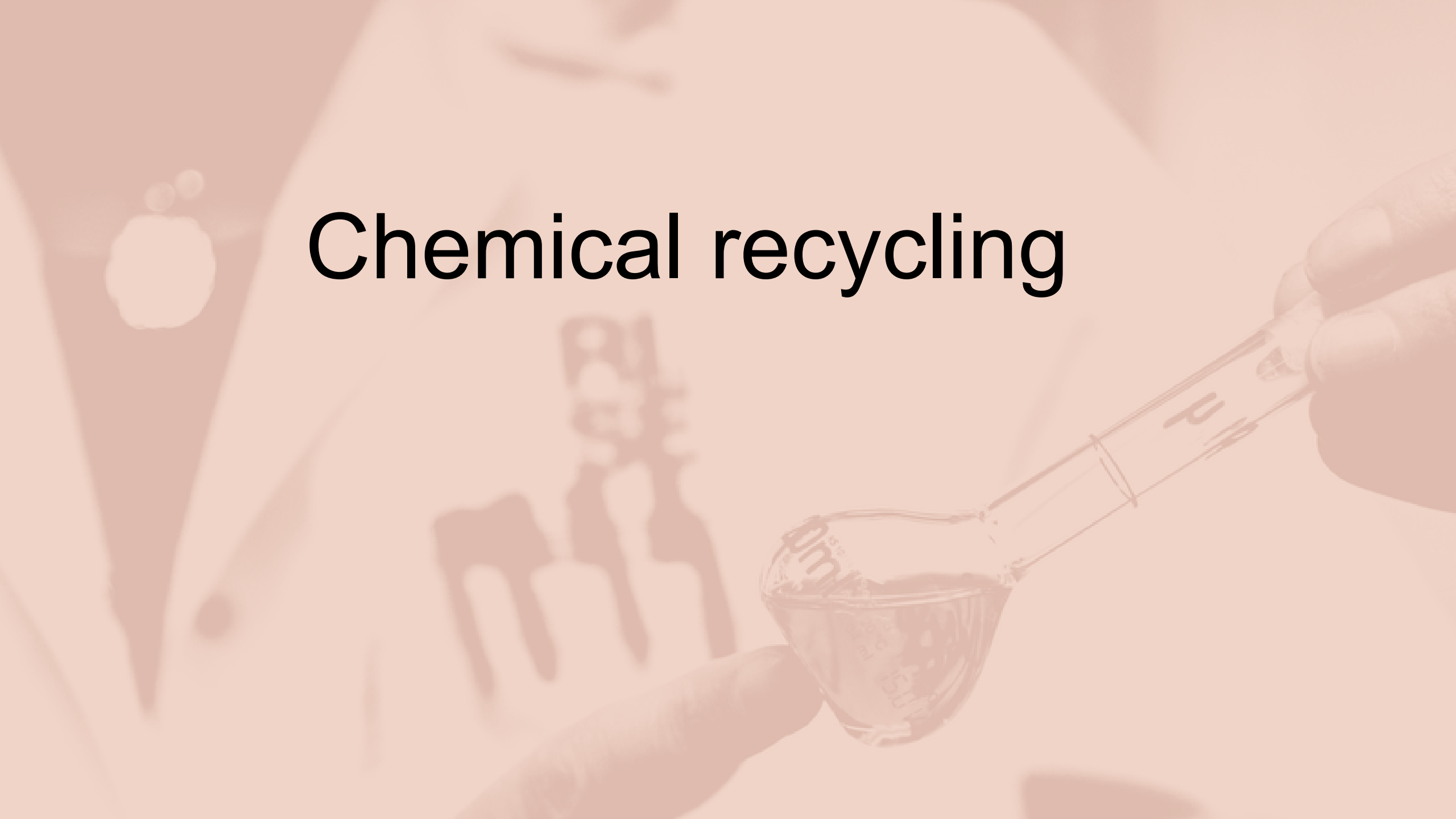
E-module

Brottstyrka

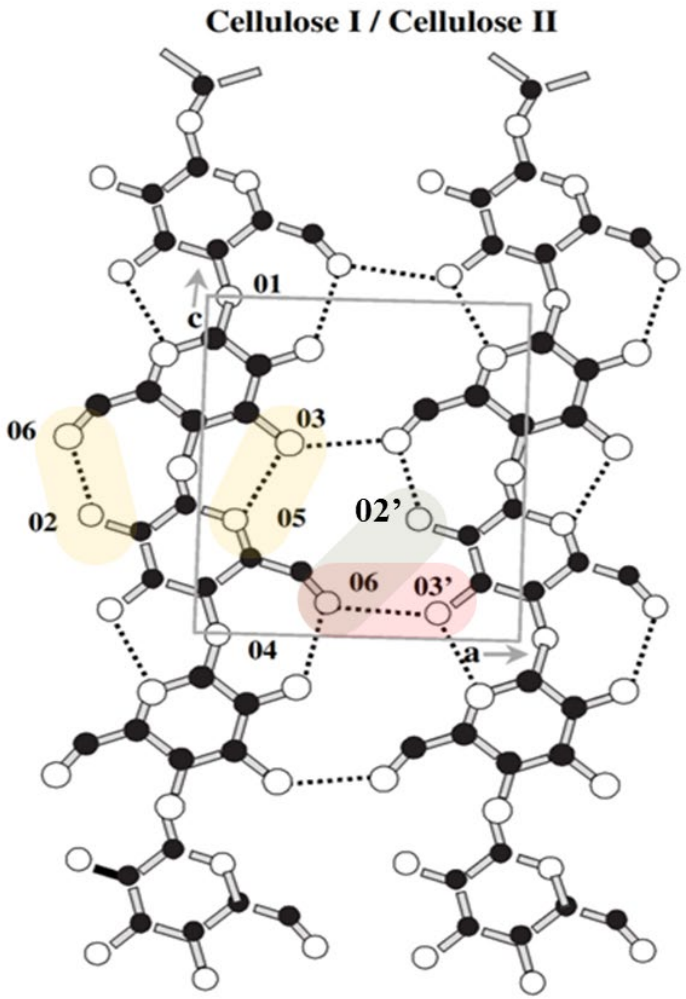
Elongation

etc..

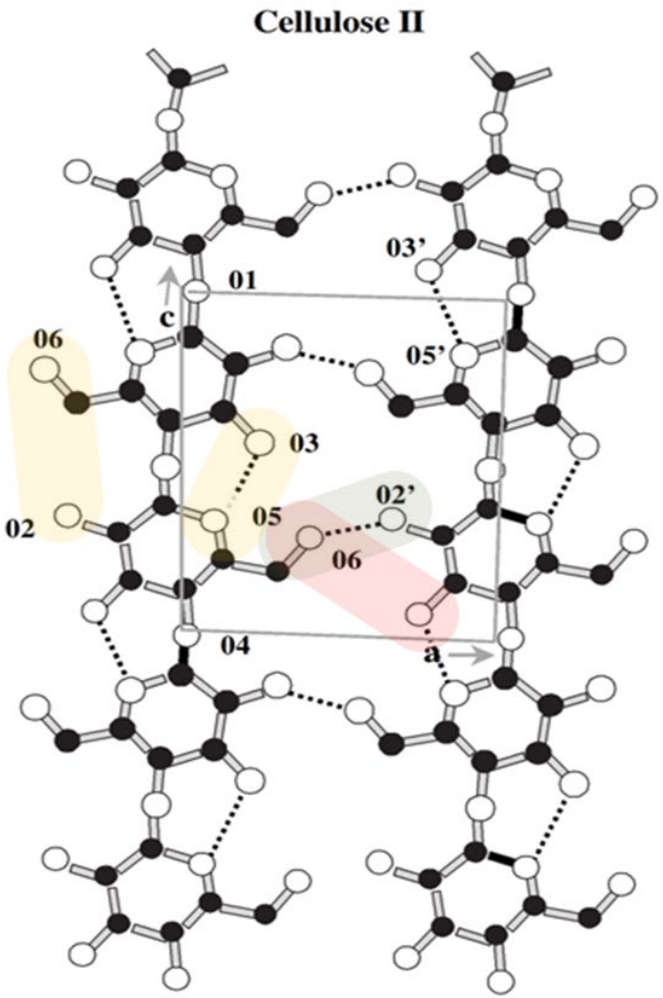
Chemical recycling



Cotton and viscose/lyocell



Virgin

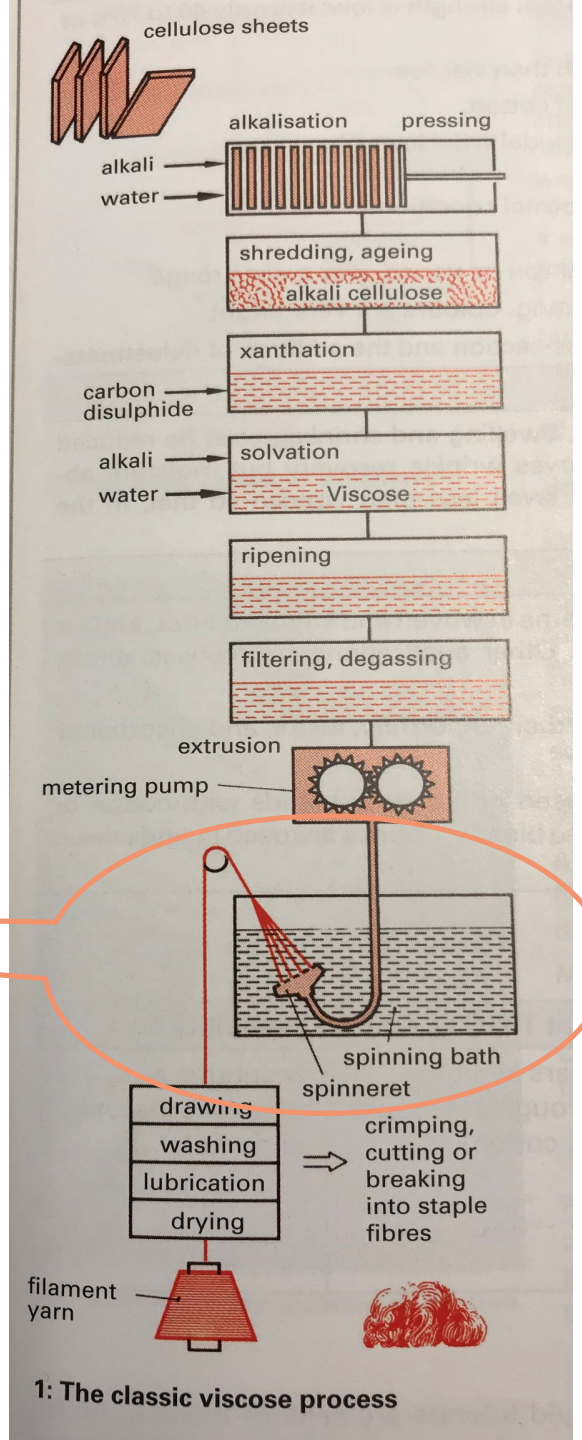


Regenerated

There are two dominating processes for producing man-made cellulosic textile fibres from wood: the Viscose and Lyocell processes

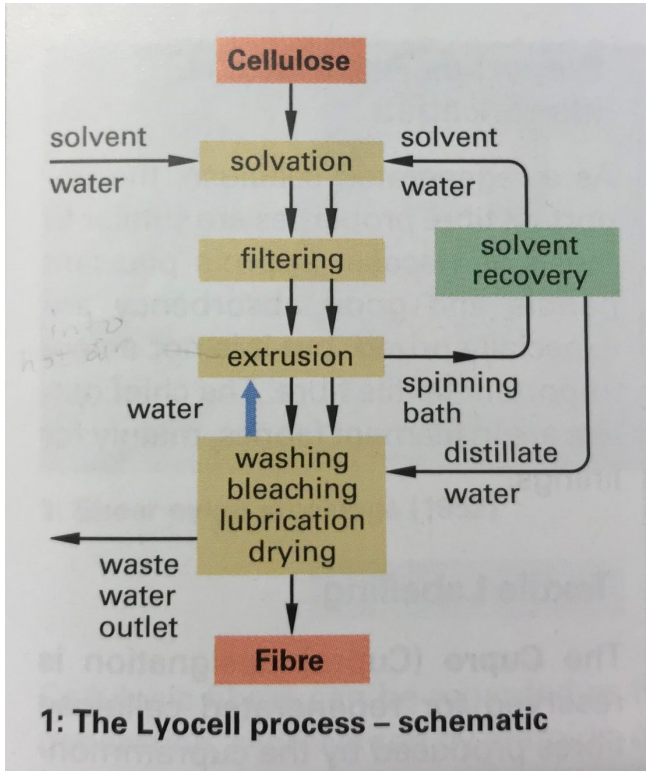
Viscose

- Old process (>100 years)
- Chemical derivatization with CS_2 in order to make cellulose soluble, followed by a regeneration step during spinning
- Several process steps and chemicals used
- No recycling steps
- Traditional wet spinning

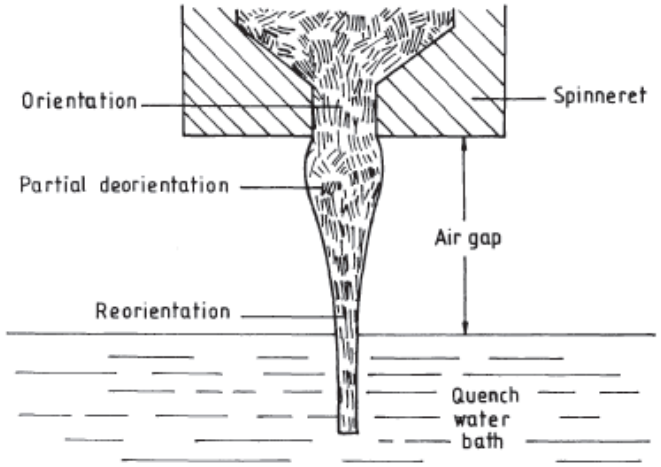


Lyocell

- Full scale production started in the 1990s
- No cellulose derivatization needed
- Fewer process steps and chemicals are required compared to the viscose process
- Solvent and water are recovered for recycling
- Air-gap (dry-wet) spinning



1: The Lyocell process – schematic



Issues to resolve…

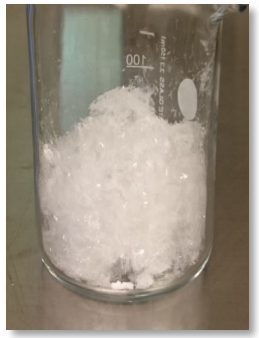
Viscose

Despite continuous improvements in the last decades to recycle the hazardous carbon disulphide used in the process, wastewater and exhaust air treatment is still complex and far from complete.

Lyocell

Despite being in the market for years the production is relatively small. One reason for this is the instability of the solvent (N-methyl morpholine-N-oxide) which make demands on major investments in safety technology.

Chemical recycling of PET (PES) through depolymerisation

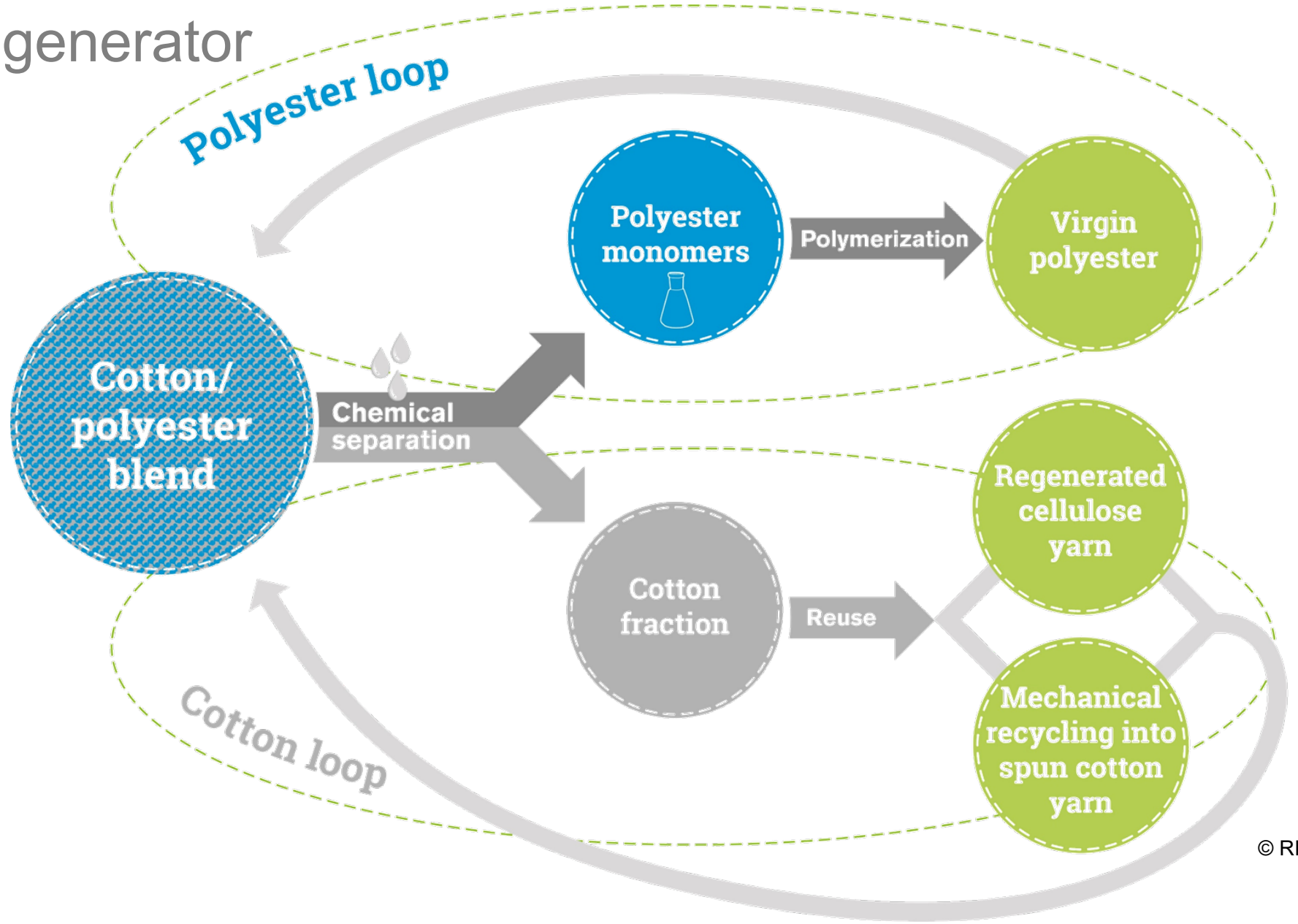


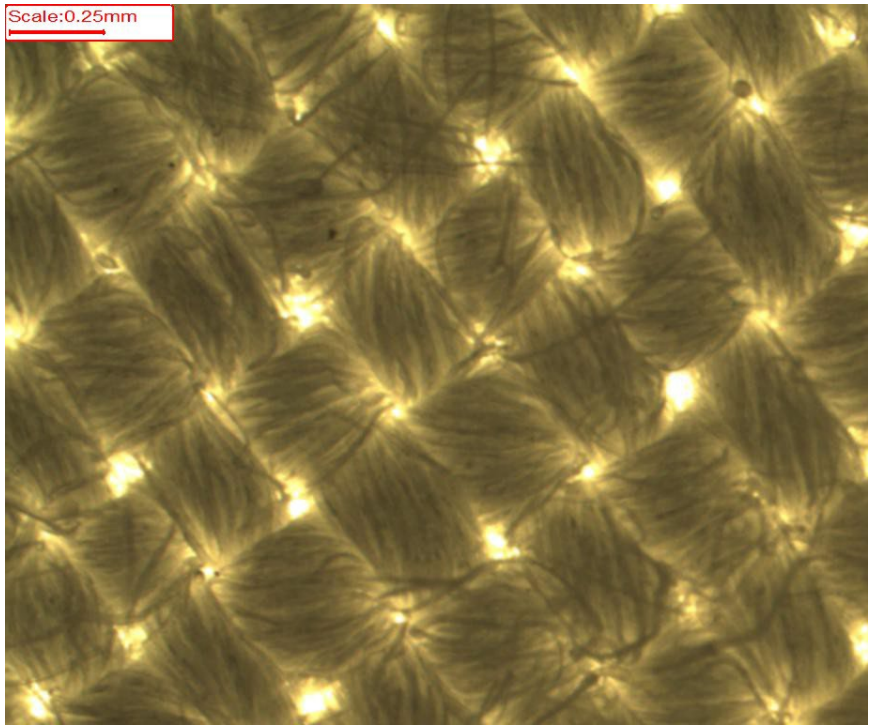
PET monomer

Ethylene-glycol

Pigment

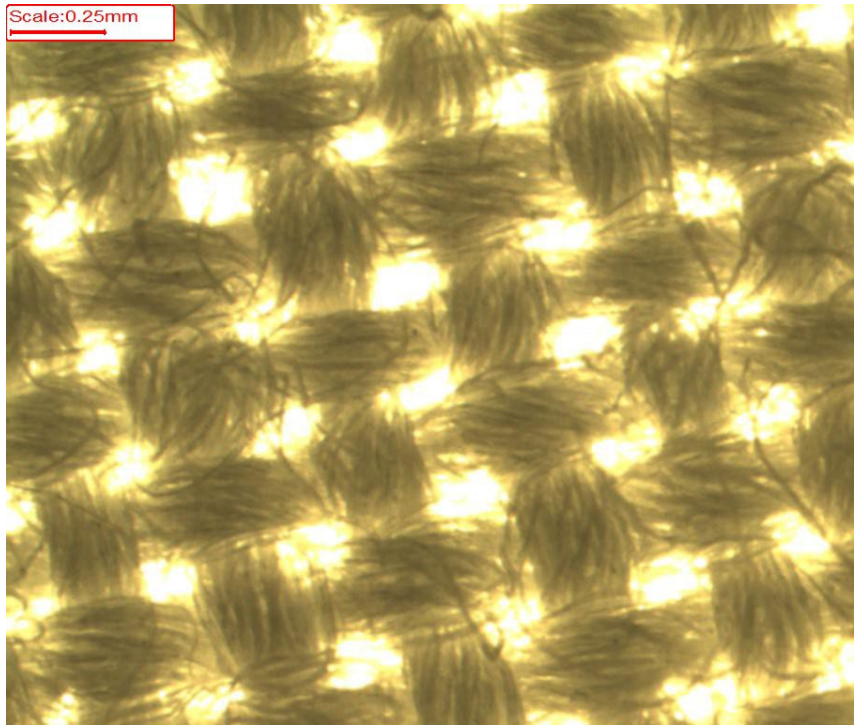
The Regenerator





Before depolymerisation

Cotton and polyester fabric



After depolymerisation

Only cotton fabric left

Melt spinning

- Recycled plastic (or textile) is melt-spun to form fibres.
- Can be based on both chemically and mechanically recycled raw materials.
- Delicate process, great demands on purity.
- Collected textiles often contain Elastane (=lycra, spandex) that cannot be separated.
-

Bild: adidas.com

BIO INNOVATION

Polyester textile from recycled PET

- Recycled PET bottles can be re-spun into new fibre.
- Very common solution today.
- With good control of the constituent plastic raw material, quality as conventional polyester can be achieved.
- Confirm origin!
- About 20% more expensive.

Bild: hm.com

BIO INNOVATION

Recycled polyamide

- Stronger and longer-lived than recycled polyester, more expensive.
- Functional, exercise, swimwear
- Some polyamide waste can be melted into textile fibres.
- Fishnets
- With good control of the included plastic raw material, high fiber quality can be achieved.
- Chemically recycled polyamide
- Econyl, mfl.

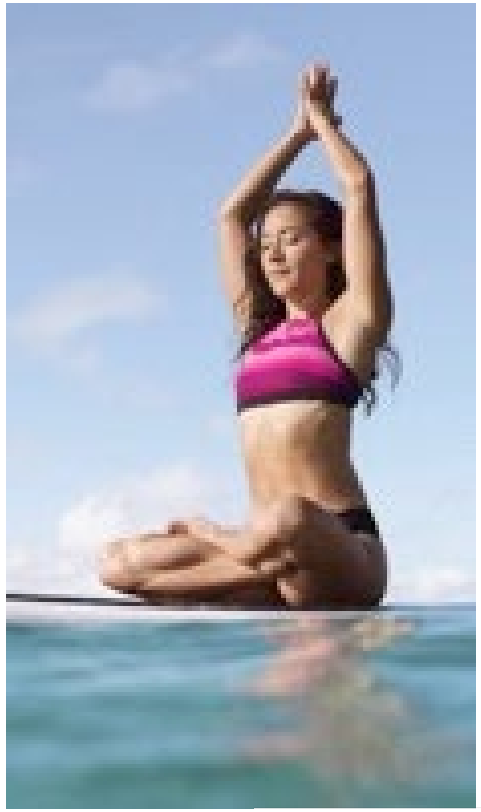


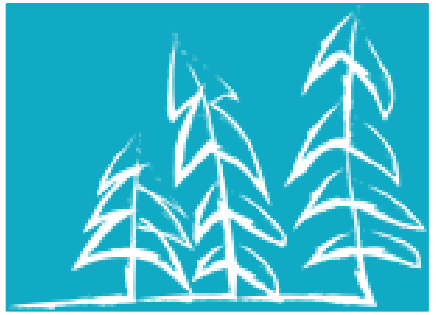
Bild: adidas.com/houidinisportswear.com

BIO INNOVATION

Bio-based textile fibres

Bio-based textile

- Bio-based textiles are fibres made entirely or partly of renewable raw material (biomass). Some of these biodegradable.
- All natural fibres, such as cotton, wool, flax and silk, are bio-based and renewable. This does not necessarily mean that they are environmentally sustainable.
-



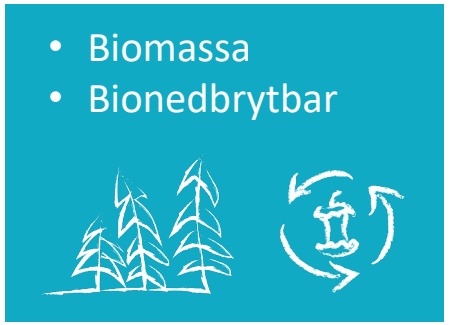
Bio-based synthetic fibre

- Bio-Polyamid, Bio-PET, Bio-PEF, PTT (Sorona)…
- Same property profile as fossil-based fiber materials.
- Generally lower volumes and higher price.
-

BIO INNOVATION

Other bio-based textile fibre

- Casein (milk protein)
  - Soft and silky
- PLA (polylactide, lactic acid)
  - Starch-based. Corn, potatoes, rice, etc.
- Bio-based polyester
  - Biodegradable
- Soy protein
  - Soft
  - Lustre
  - Able to prevent shrinkage
  - Sensitive from a sustainability perspective related to the potential use for food production or use of arable land



Source: Sustainable Fibre Toolkit 2018

Chemicals

Examples of the impact of chemicals

Dispersive Red 4

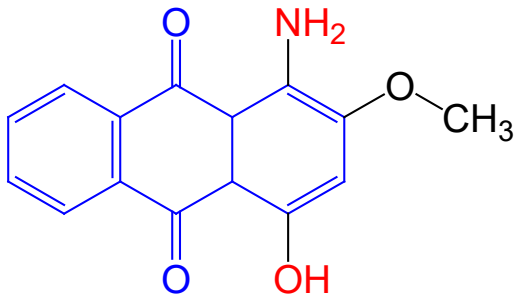
Dispersive Red 19

Dispersive Red 60

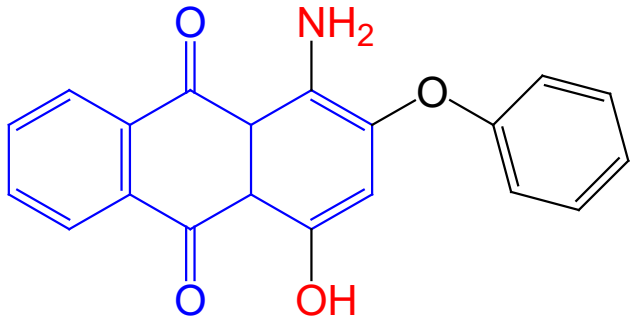
Dispersive Red 153

Health, Environment & Processes

Anthraquinone

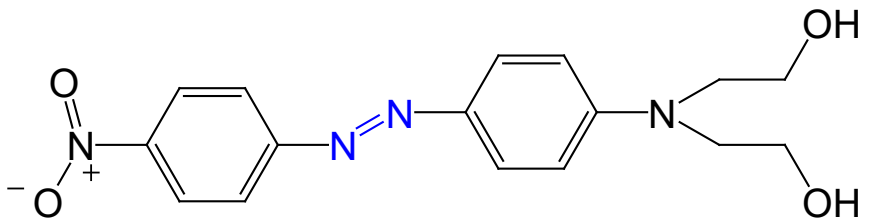


Dispersive Red 4

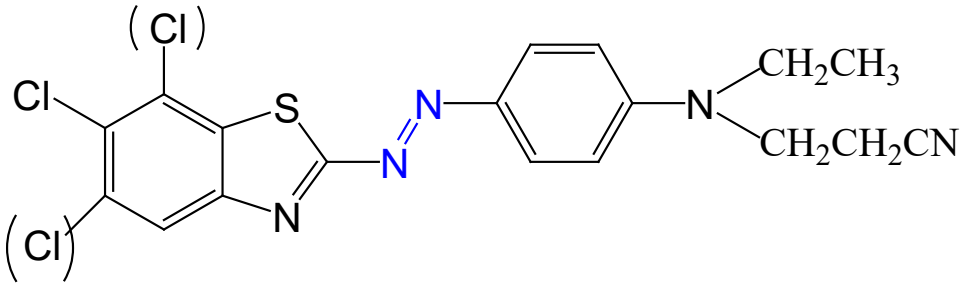


Dispersive red 60

Azo

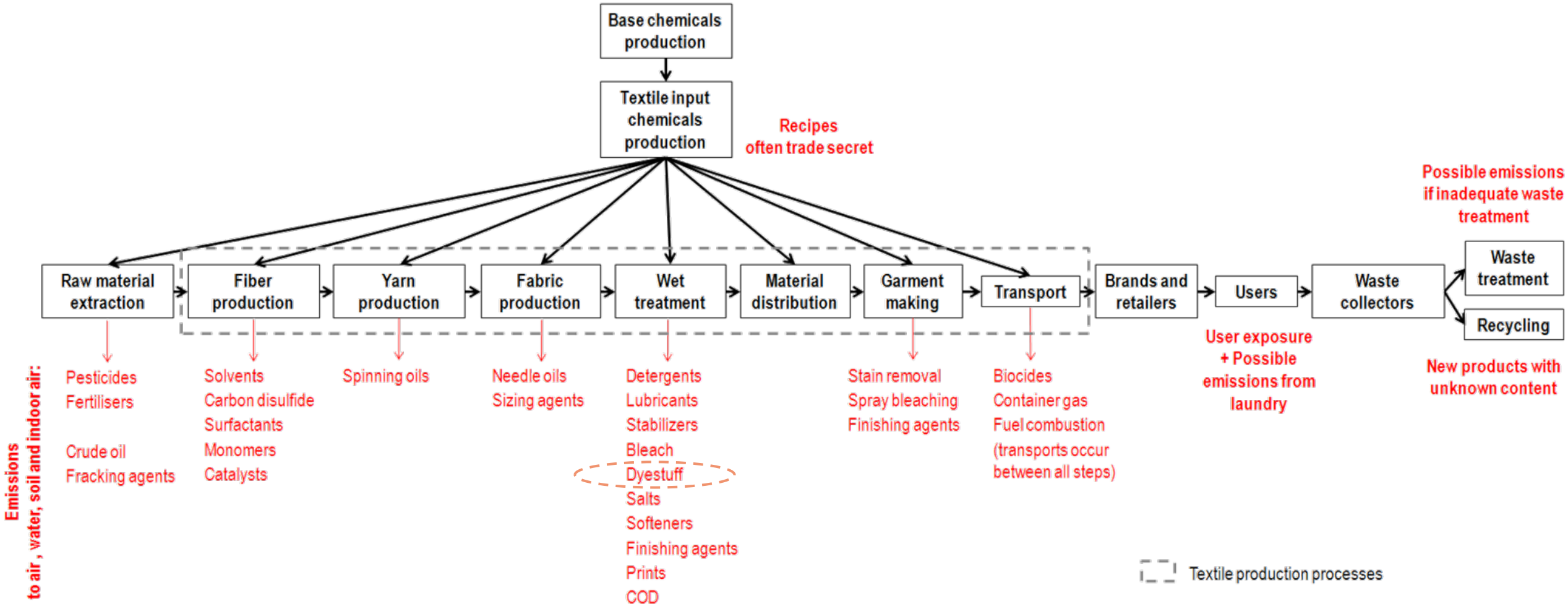


Dispersive Red 19



Dispersive Red 153

Chemical use in the textile value chain



Classification and risk assessment of textile for material recycling

The transition to a circular economy requires that much of the material that today is regarded as waste is utilized as a material resource. In this project, we focus on investigating the chemical content of textile materials for material recycling based on fiber type as well as product type.

For efficient use of the material resource that textiles for material recycling constitute, it is of the utmost importance to have control over the composition of the material. This regarding fiber composition, as well as chemical content.

In a circular economy, non-toxic textile raw material is a prerequisite. Thus, recycled textile fiber must be below the applicable limit values for chemical content. Content of harmful substances above the tolerance limit can, depending on recycling technology, place restrictions on the application of recycled material and it is therefore of utmost importance that this is under control prior to processing and utilization. Chemical content can also affect chemical processes, for example in various types of chemical recycling, pointing to the fact that information regarding chemical content is of great importance also for these recycling technologies.

This project aims at increasing knowledge of the current situation in regard to chemical content in textiles for material recycling. The project also focuses on developing a tool, or a model, for categorization / classification of textile materials intended for material recycling. This specifically regarding risk assessment based on chemical content and the possible restrictions this places on the possible applications for recycled textile material. The categorization of textile material is linked to a number of different analysis packages for assessment of textile material.

Slutrapporter

Project report
Results of chemical analysis

Summary

PROJECT NAME
Classification of textile

STATUS
Completed

RISE ROLE IN PROJECT
Project coordinator with expertise in areas textile management and textile recycling, as well as textile chemica and analysismikaliesanalys och återvinningsmetoder

PROJECT START
2017-10-01

DURATION
2 år

TOTAL BUDGET
2 195 000

PARTNER
Innovatum, The Chemicals Group at RIS Swedish Society for Nature Conservati (SSNC) , Vänersborgs kommun, Göteborg Stad, Renova, Avfall Sverige, Myrorna TEXAID, SIS Swedish Standard Institut The Swedish Environmental Protection Agency

FUNDERS
Vinnova

PROJECT MEMBERS
Christina Jönsson, Lisa Schwarz Bour, Camilla Nilsson, Jehona Sjöberg, Reb Landin

Supports the UN sustainability g

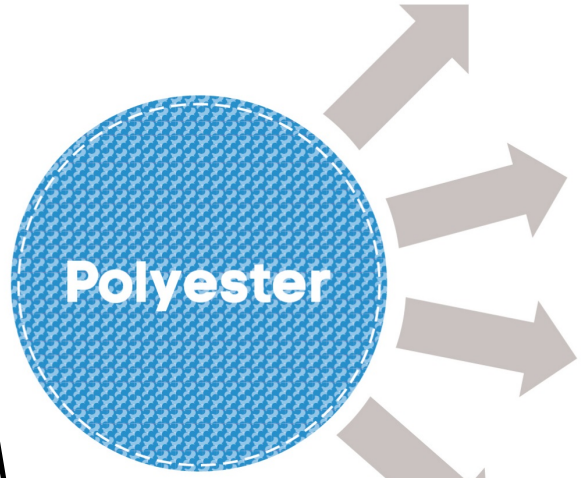
Chemical analyses on textile materials

- Available here:

https://www.ri.se/en/what-we-do/projects/classification-and-risk-assessment-of-textile-for-material-recycling

Chemicals in recycling

·Azo-based dyes
·Optical brighteners
·Per- and polyfluorinated substances
·Toxic metals
·Chlorinated organics
·Non-halogenated flame retardants
·Alkyl phenols and their etoxylates
·Silikoner
·Biocider
·Bi-products from degradation



Azo baserade färgämnen
Optiska vitmedel
Per- and polyflourerande ämnen
Toxiska metaller
Klororganiska ämnen
Icke halogenerade flamskyddsmeddel
Alkylfenoler och deras etoxylater
Silikoner
Nedbrytningsprodukter
Biocider

	Kvar i material	Emission till miljön
Mekanisk behandling	Azo baserade färgämnen Metallkomplex färgämnen Optiska vitmedel Per- and polyflourerande ämnen Toxiska metaller Alkylfenoler och deras etoxylater Silikoner Nedbrytningsprodukter Biocider	
Termisk behandling	Azo baserade färgämnen Metallkomplex färgämnen Optiska vitmedel Toxiska metaller Icke halogenerade Flamskyddsmedel Nedbrytningsprodukter Biocider	
Kemisk behandling	Nedbrytningsprodukter	Azo baserade färgämnen Optiska vitmedel Per- and polyflourerande ämnen Toxiska metaller Icke halogenerade Alkylfenoler Silikoner Nedbrytningsprodukter Biocider
Förbränning	Inga	Emission via aska av metalloxider, oorganisk fosfor och stabila organiska ämnen till vatten/jord

What does it take to succeed?

- Efficient sorting
- Control of chemical content
- Recycling technologies - chemical and mechanical
- Continuous access to large volumes
- Labelling system for recycled raw materials
- Willingness to use textiles as a secondary raw material

BIO INNOVATION

What can I do today?

- Ask vendors for recycled materials.
- Demand recycled yarn, low levels of recycled fiber may be possible without affecting the quality.
- Consider what is a requirements and what is a wish, certain requirements that are placed on the product may not be absolutely necessary.
- Consider how new products are designed to make it easier for future recycling.

BIO INNOVATION

Access to information is key

Transparency and requirements

+

Material handling - reuse or recycling

→

Digital information-systems

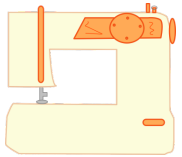
Complexity of the textile value chain

Spinning/ Yarn

Weaving/ knitting

Chemical treatments

Manufacturing



Sales

User phase

Reuse & Recycling

Fiber composition, origin, factory

Textile composition, construction, origin, factory

Surface treatments, dyestuffs …

Brand information, article number …

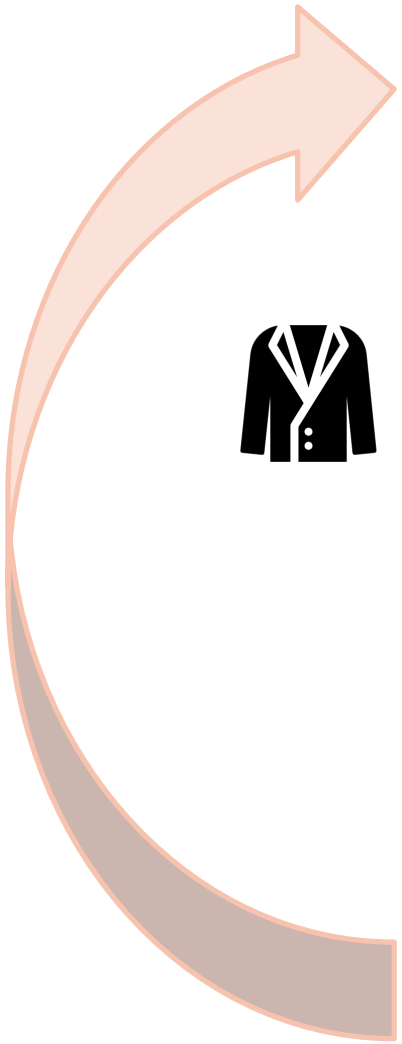
Inventory, anti-theft, consumer info. …

Care instruction, producer, origin, etc

Fiber content, construction, chemical profile …

RFID

A well organised RFID strategy creates opportunities...



- Traceability in the logistics chain
- •Faster inventory/stock-taking
- •Consumer information
- •Sorting at “end-of-life”
- •Chemical content
- •Material recycling

Questions ?