PRESENTATION

Session: **Cotton Quality And Testing**

Title: **Raw material classification of recycled fibers**

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Presentations are available in the conference archive: https://baumwollboerse.de/en/competencies/international-cotton-conference/speeches/

Conference Organization

Faserinstitut Bremen e.V., Bremen, Germany. E-Mail: conference@faserinstitut.de
Bremer Baumwollboerse, Bremen, Germany. E-Mail: info@baumwollboerse.de

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Raw material classification of recycled fibers

Stephan Baz, Johannes Leis, International Cotton Conference Bremen 2022, September 30th

Agenda

- Presentation of DITF and STFI
- Introduction and objective
- Mechanical processing of used textiles
- Characterization of recycled fibers
- Results of the investigations
- Yarn production
- Summary and outlook

Europe‘s Largest Textile Research Center

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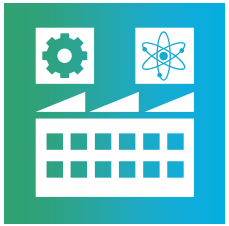
Key Figures 2021

Employees

approx. **250**

Turnover

13 m € public
15 m € industry



Area

25,000 m²

Research

159 public
589 industry

Partners

1196 enterprises
80 % SME

Services

109 test customers
5 small batch series

Textile Vertical Integration

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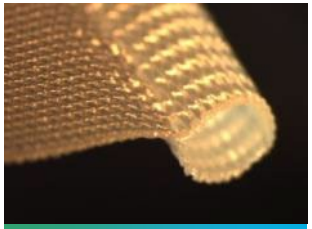
FROM MOLECULES TO PRODUCTS

Polymer

Fibers and Yarns



Fabrics

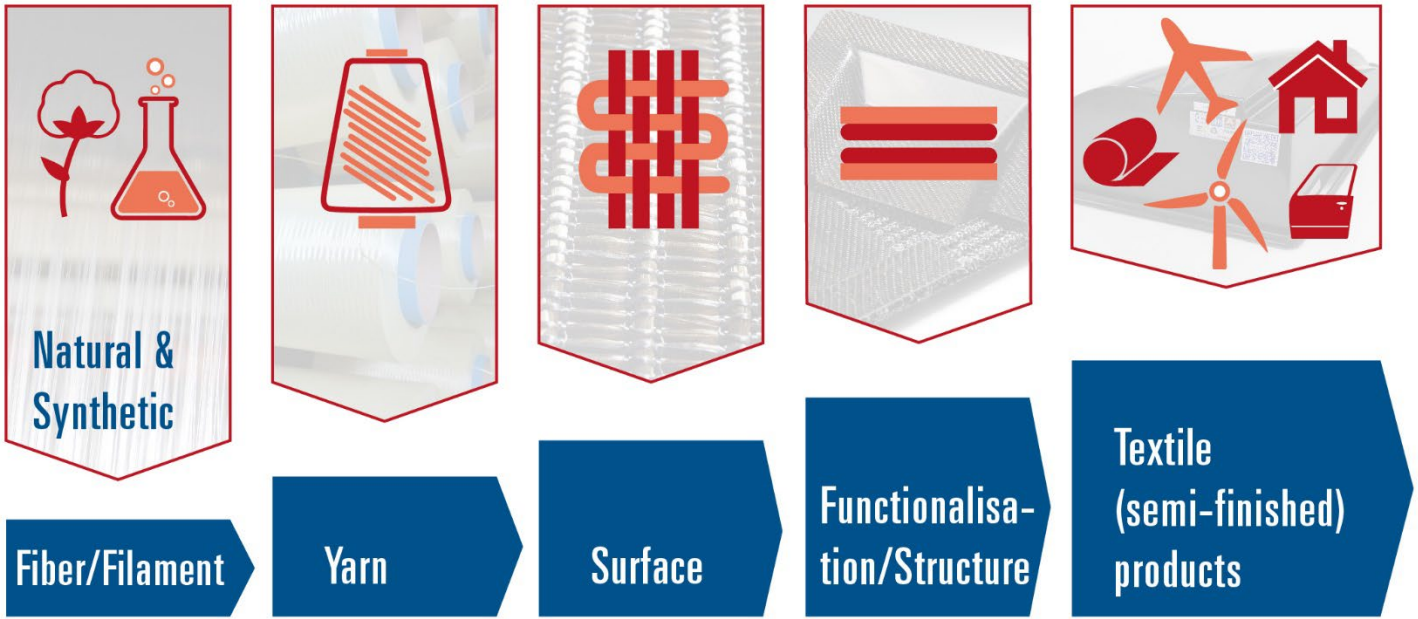
Functionality

Product

Some data about STFI

- STFI **was founded in 1992**, consolidation of Forschungsinstitut für Textiltechnologie GmbH (FIFT) and Institut für Technische Textilien GmbH (ITT)
- About **120 national research projects annually**
- Currently **4 projects in European research programs** with partners from a total of 15 countries
- Annually approx. **5 – 10 applications for property rights**
- Tests and certification procedures for **customers from more than 60 countries worldwide**
- Employees of STFI participate in **23 standardisation committees**
- Turnover of approx. **18 Mill. €**, workforce of **153 employees**

STFI - We completely cover the textile chain



Ways of recycling to gain recycled fibers

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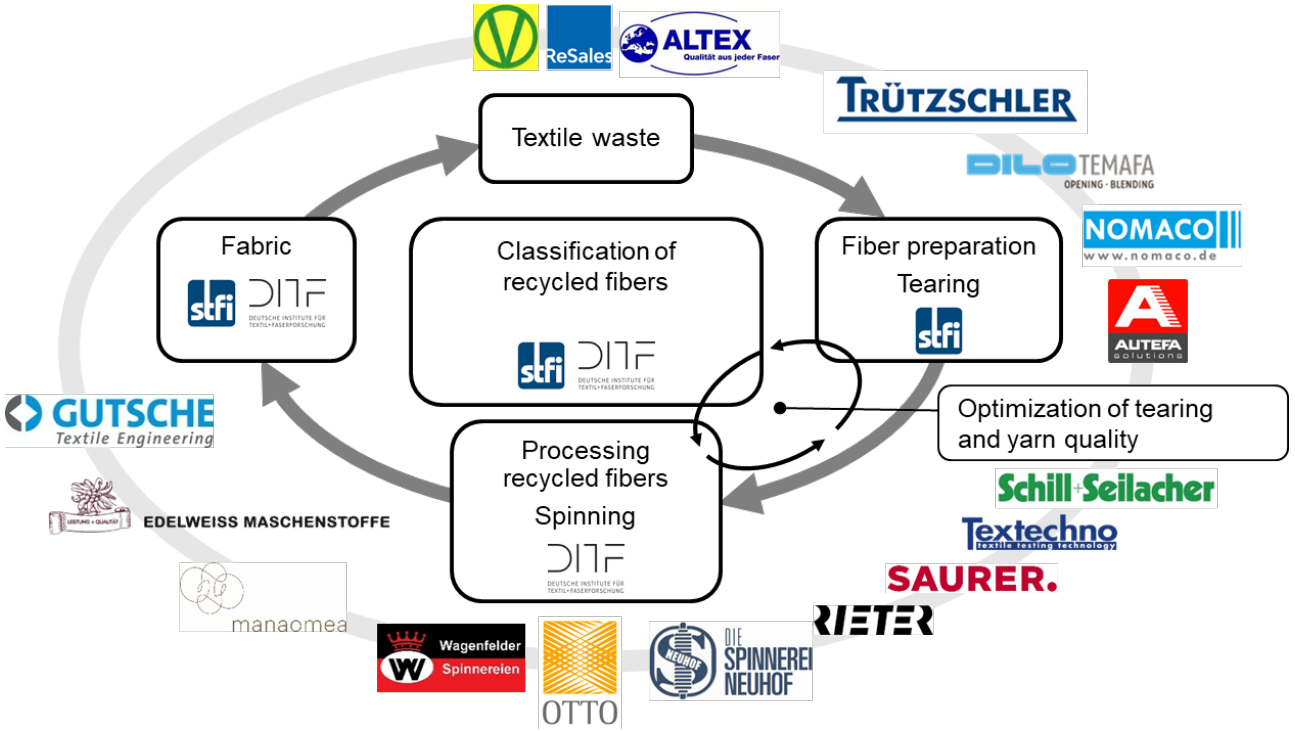
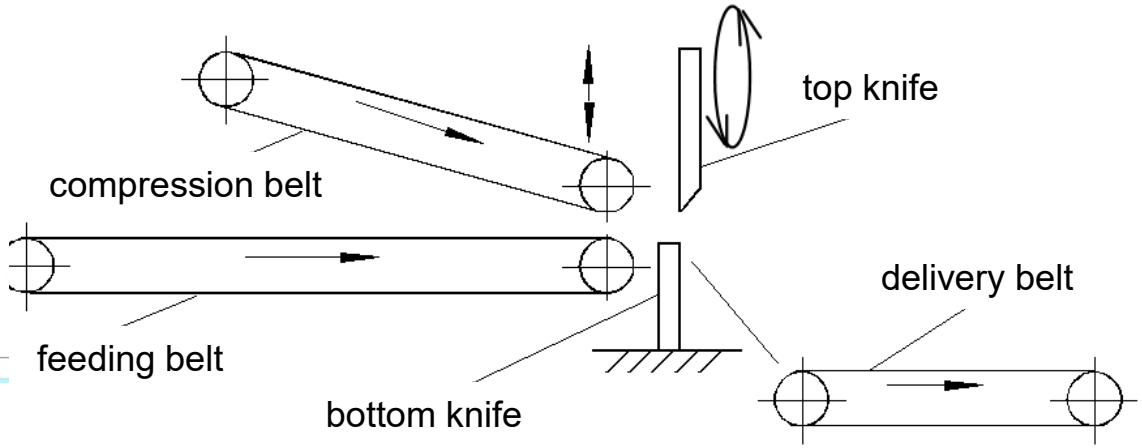
Chemical recycled	Mechanical recycled		
Pre- and postconsumer waste	Preconsumer waste		Postconsumer waste
	Yarn preparation waste	Yarn and garment production waste	Used textiles
 [1]  [2]		 [3]	 [4]
New man made staple fiber	Loose fibers	Teared fibers or yarns, fabrics, garments	

Source: 1: Aleksandro LOBNIK, IOS Ltd, http://www.resyntex.eu/; 2: Staple Fiber Production – the Right Solution for Every Need, www.oerlikon.com, Nov. 2015; 3: Intro to Textile Waste : Pre-Consumer, Jul. 2018, www.ethelstudio.com; 4: Simon Glover, Textile recycling project 'close to success', Jan. 2020, www.ecotextile.com

Aim of the research project

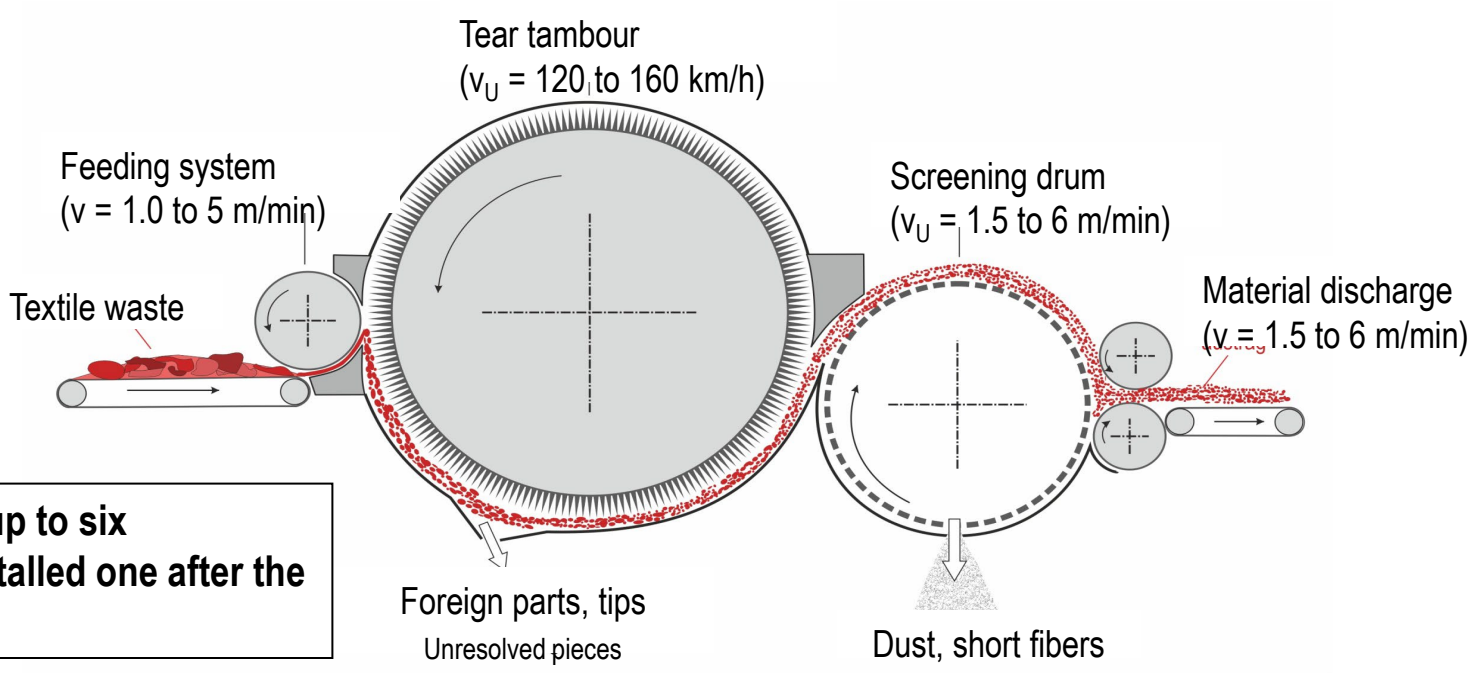


Processing textile waste - the preliminary shredding



Cutting lengths: **3 to 180 mm (special machines up to <1 mm cutting length)**
Working widths: **200 to 800 mm**
Throughput rates: **up to 5000 kg/hour**

Processing textile waste - the tearing principle



In practice, up to six units are installed one after the other!

Optimization of the preparation via tearing process

1 Internal forces and their distribution

2 Homogeneity of the template

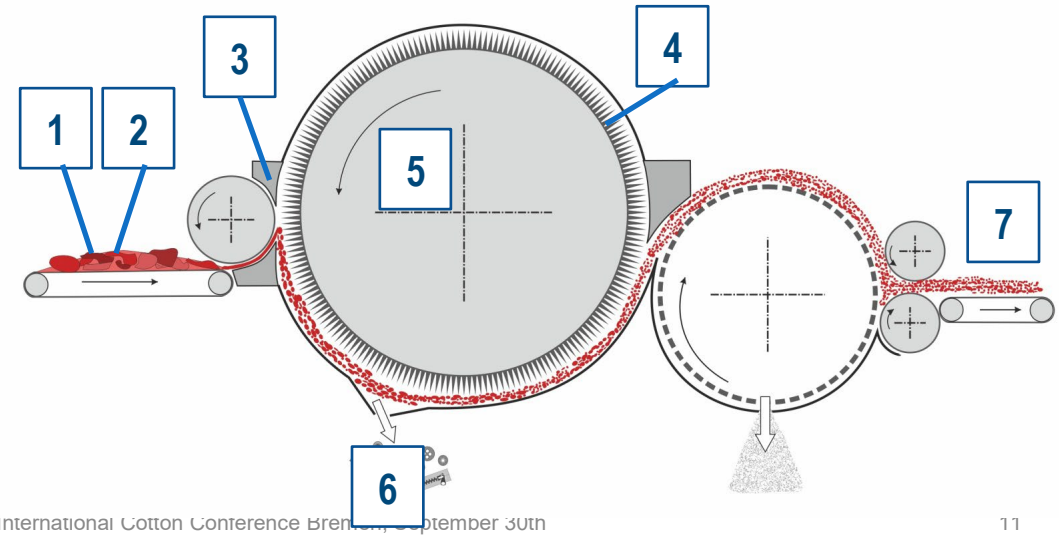
3 Feeding systems and clamping point topography

4 Design, shape and number/density of the tearing elements

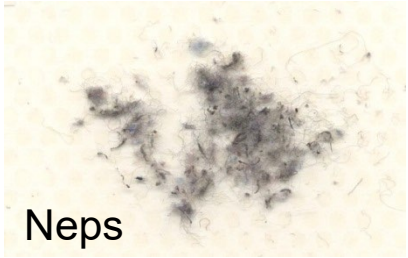
5 Energy input, reel speed

6 Influence of deflashing

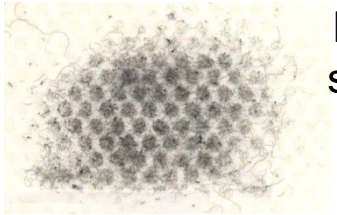
7 Number of tear passages



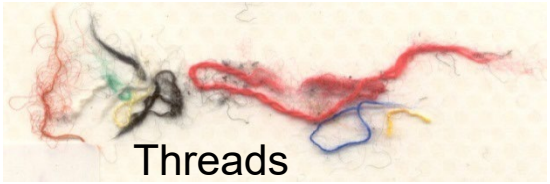
The products of the tearing process



Neps



Fibre dust,
short fibres



Threads

Reclaimed fibres
as a blend of:

Unopened
pieces

Fibres with
different lengths

Tear tests at STFI

Methodical procedure for the studies on the individual parameters:

- Basic investigations concerning the energy input (tambour speed) during the tearing process, the cut length in the pre-shredding (CO) as well as for the introduction of an agent to reduce fiber-fiber friction.
- After selecting the favored setting, the following test parameters were varied in further test series:
- the feeding and nip point topography (textured wafer & largely smooth rubber roll),
- Geometry of the trough edge to influence the take off point,
- Shape, arrangement and density of the tearing elements, use of different tearing tambour (SS4, SS8, SG12, SZ),
- Number of tear passages performed, minimum two to maximum 6 passages.

Tear tests as an iterative process

Post-consumer waste, CO shirts:

- Generation of 19 material batches in 3 test loops by tear tests at STFI.
- Great support from the industry in the committee accompanying the project!
  - ➢ Generation of 7 further batches of material by trials at Temafa Maschinenfabrik GmbH and Nomaco GmbH & Co. KG

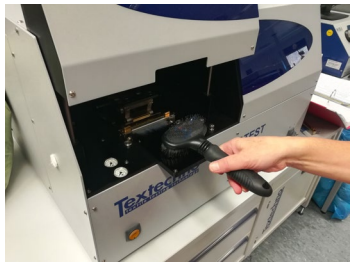
Aramid production waste:

- Generation of 20 material batches in 3 test loops by tear tests at STFI.

Characterization of recycled fibers
Measurement technology

- Textchno MDTA-4
  - Analysis of the trash content and other components in the fiber material
  - Determination of the energy required to open the fiber material
  - Rotor ring for yarn production

- Textchno Fibrotest
  - Optical detection of the fiber length distribution



- Uster Almeter
  - Capacitive detection of fiber length distribution

Characterization of recycled fibers
Procedure for fiber length measurement

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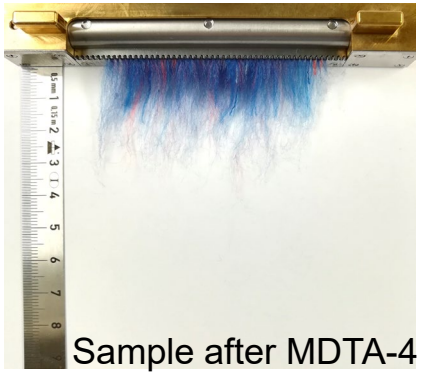
Problem with torn textiles:

- There are still many not opened pieces of yarn in the recycled material
- Yarn pieces are longer than fibers and falsify the measurement result (fiber length, fiber strength)

Sample from recyclate



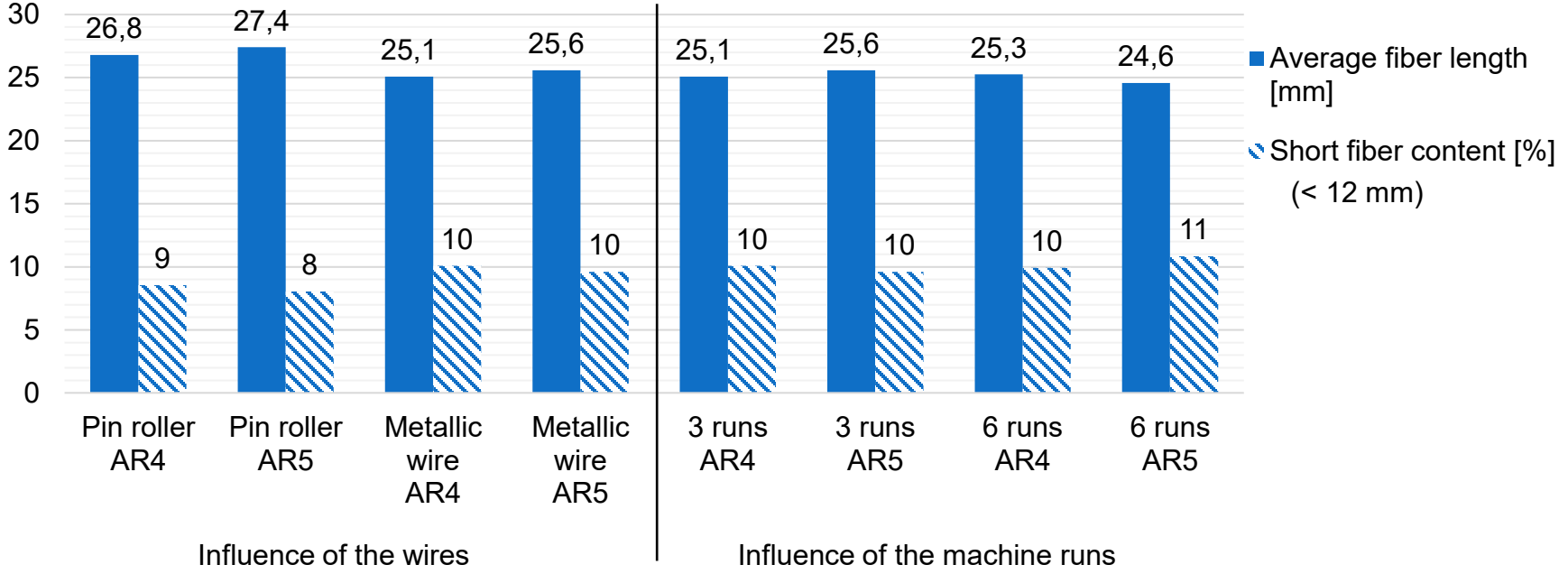
Sample after MDTA-4

Developed test routine:

- Opening the fiber sample on the MDTA-4 without extraction point
- Removal of the fiber material after passage from the collecting box
- Sample preparation from the taken fibers for the measuring devices Almeter and Fibrotest
- If necessary, individual pieces of yarn in the sample are removed by hand

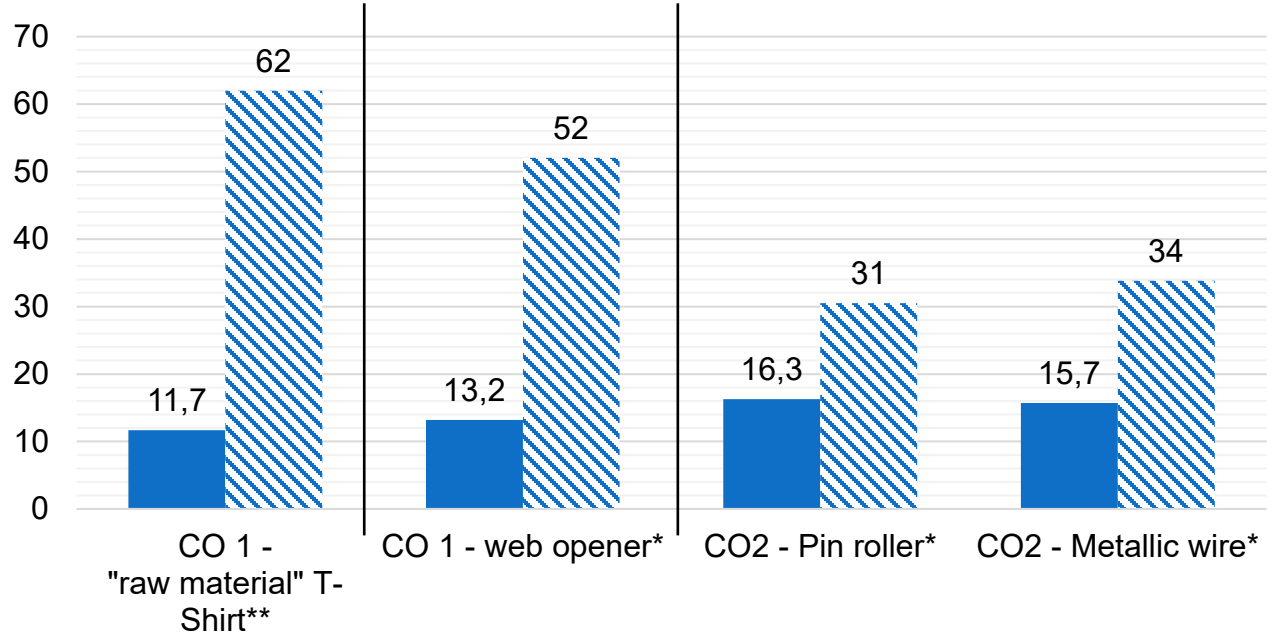
Characterization recycled fibers

- Average fiber length after preparation of aramid fibers



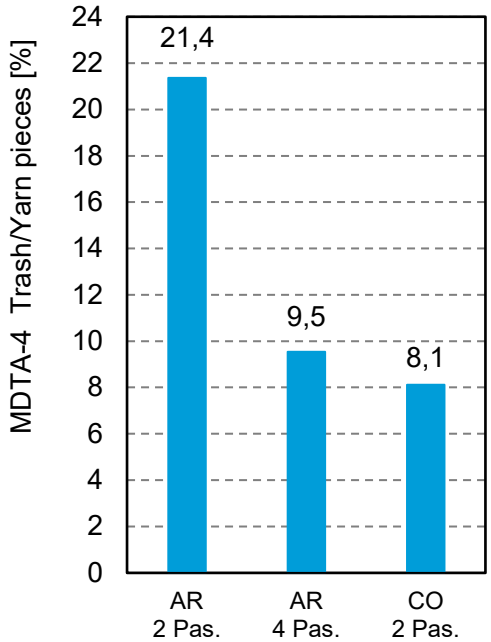
Characterization recycled fibers

- Average fiber length after preparation of cotton fibers

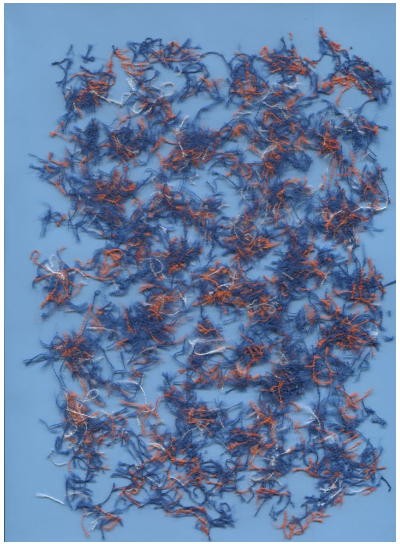


Characterization recycled fibers

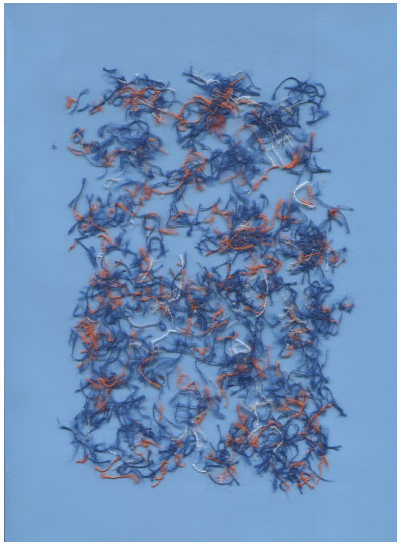
Discarded components on MDTA-4



Aramid 2 runs



Aramid 4 runs



Cotton 2 runs

Yarn production

Open End (OE) yarn, 100% recycled aramid

Opening 2 tambours

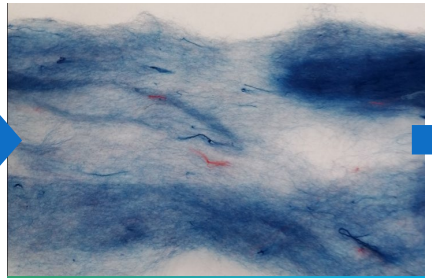
Card web

Card sliver

Fiber wastage: 63 %

OE yarn

Opening 3 tambours



Card web

Card sliver

Fiber wastage: 29 %

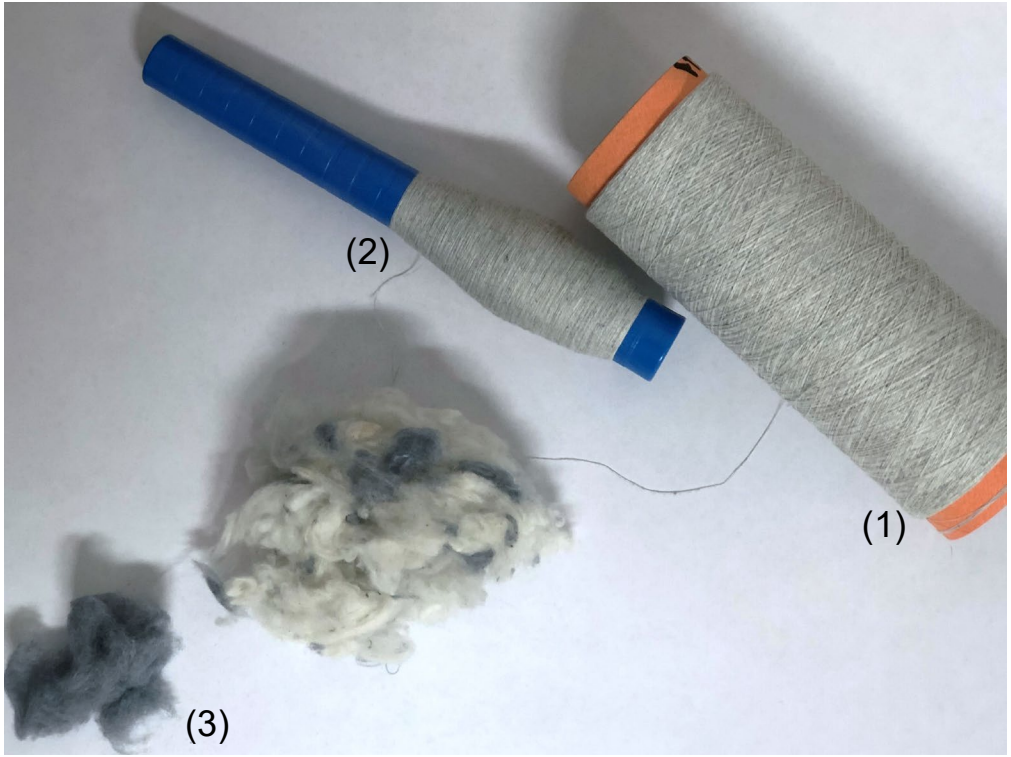
Yarn production

OE (1) and ring yarn (2),

20% recycled cotton (3),

80% new cotton.

Yarn count: Nm 40



Summary

- Mechanical processing is strongly dependent on the quality of the input material (fast fashion!).
- Procedure defined for measuring recyclate with yarn pieces.
- The sample preparation allowed the fiber length distributions to be measured.
- MDTA 4 is suitable for analyzing the carding properties - determining the type and amount of waste.
- Depending on the break fiber quality (length distribution), yarns can be made from 100% recycled material (aramid) or blended with virgin fibers (cotton).
- Tearing process must be adapted to raw material - aggressiveness vs. fiber length vs. amount of waste.
- Degree of (textile) opening has an influence on the fiber loss in the carding process.

Outlook

- Continuous collection of fiber data and classification of recycled fibers is expected to optimize the tearing process and the spinning process.
- Further analysis of rotor and ring yarn production.

Acknowledgement

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Thank you for your attention!