From Fibre Recycling to a Market-Ready Collection – Technology Transfer in the SustainTex Project

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MOTIVATION AND CONTEXT

Textile circularity requires more than the technical processing of individual fibres:
real-world material streams, processing, product design, colour, use, take-back and assessment must be considered jointly.

Real-world material streams
vary in composition, use history, contamination and fibre quality

Mechanical recycling
shortens fibres, increases the short-fibre content and alters downstream processing

Industrial circular systems
require reproducible quality, sufficient volumes and integrated value creation

RESEARCH QUESTION

How must material streams, processing conditions and product requirements be aligned to achieve reproducible recycle quality and industrially scalable recycling pathways?

Hypothesis:

Reproducible and scalable recycling pathways can be established when material characteristics, processing parameters and product requirements are integrated and tailored to the specific application.

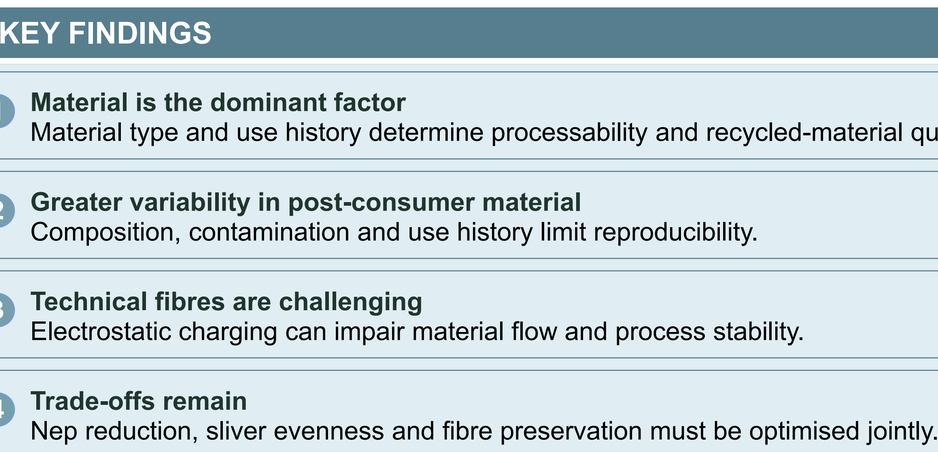
METHODOLOGICAL APPROACH

1 Material groups

- **Rental textiles / workwear** — PES/CO
- **Fine and flat linen** — CO
- **Protective underwear** — Aramid / Viscose / Belltron

2 Experimental route

Sorting › Tearing › Carding › Blending › Yarn › Product



3 Experimental logic

Input	Process	Quality metrics	Output
Material type and use history	Variation of carding parameters	Opening, damage, short-fibre content, nep formation	Sliver quality, spinnability, yarn / product

4 Experimental design
- 30 systematic carding trials
- Mixed-level factorial design
- Material, process and interaction effects

5 Factors (variation parameters)
- Material (PI / PC)
- Main cylinder speed
- Flat speed
- Carding-element spacing

6 Evaluated metrics
- Nep count (TotalNepCnt)
- Sliver irregularity (Uster CVm)
- Mean fibre length (L(n))
- Short-fibre content (SFC(n))

7 Blending and scale-up approach (supplementary)
- Rec.-fibre content: 30%, 50% and 70% | • Scale-up of selected variants to batches

KEY FINDINGS

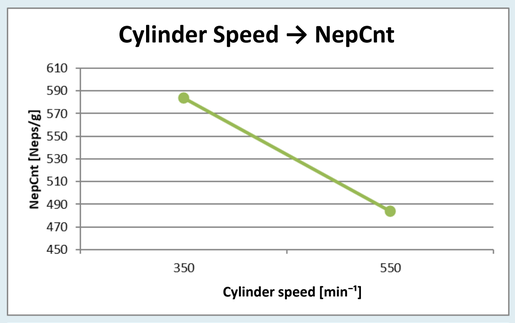
1. **Material is the dominant factor**
   Material type and use history determine processability and recycled-material quality.
2. **Greater variability in post-consumer material**
   Composition, contamination and use history limit reproducibility.
3. **Technical fibres are challenging**
   Electrostatic charging can impair material flow and process stability.
4. **Trade-offs remain**
   Nep reduction, sliver evenness and fibre preservation must be optimised jointly.
5. **No one-size-fits-all process**
   Parameters and target products must be specified for each material and application.

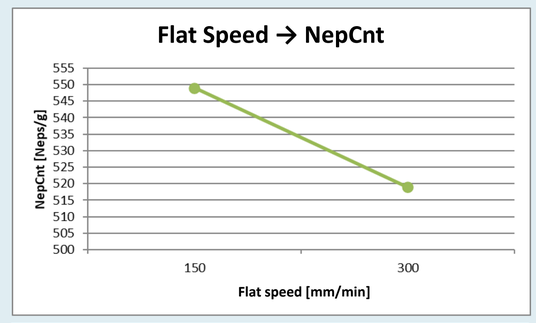
Process implication: material, carding parameters and downstream product must be designed as an integrated system.

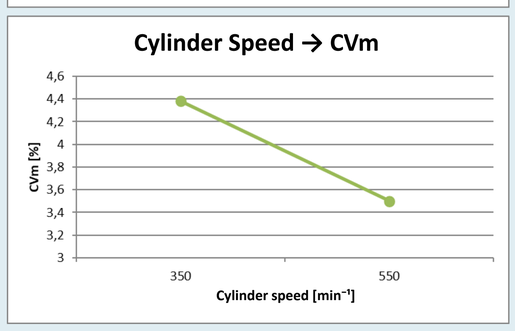
RESEARCH FINDINGS

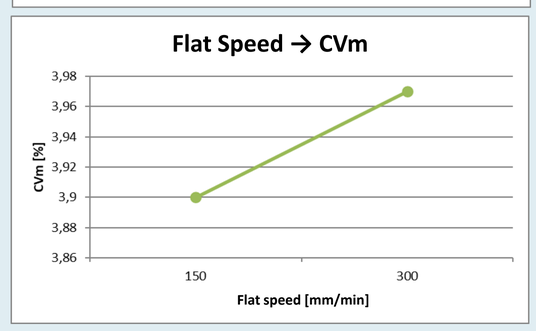
Selected main effects from the carding trials

	TotalNepCnt	CVm Uster	L(n)	SFC(n)
Material	highly significant	weak	highly significant	highly significant
Cylinder speed	highly significant	highly significant	significant	significant
Flat speed	significant	weak	weak	weak
Carding-element spacing	weak	weak	weak	weak









HYPOTHESIS EVALUATION & OUTLOOK

Hypothesis evaluation
The findings support the working hypothesis: material-related differences and processing-induced changes directly affect downstream processing. Robust circular systems therefore require material- and product-specific recycling pathways rather than a uniform process configuration.

Design for Recycling
- Reduction of material diversity and non-separable material combinations
- Recyclability-oriented design of labels, seams and elastic components
- Consideration of target-product requirements during product development

Colour strategies
- Colour-homogeneous material streams
- Graduated colour cascades
- Decolourisation only where necessary

Scale-up requirements
- Reproducible material quality
- Consolidated material streams at industrially relevant volumes
- Integration of value-chain stages
- Availability of use-phase and LCA data for robust scenario comparisons

Outlook
- Validation of yarn and product quality
- Industrial scale-up of selected recycling pathways

SustainTex demonstrates:
Textile circularity is a systems-level challenge, not an isolated recycling process.

CONSORTIUM

SustainTex demonstrates: Robust textile circular systems are enabled by material- and product-specific recycling pathways. Mechanical processing, Design for Recycling, colour strategies, use and take-back must be coordinated. Consistent material quality, sufficient material-stream volumes and integrated value chains enable industrial implementation.

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Acknowledgements:
The consortium gratefully acknowledges financial support from the Federal Ministry of Research, Technology and Space (BMFTR) within the collaborative project "Circular Textiles" (grant no. 033R410), funded under the "Circular Sustainable Textiles" initiative and the "Research for Sustainability" (FONA) strategy.

Bundesministerium für Forschung, Technologie und Raumfahrt
FONA Forschung für Nachhaltigkeit
ptj Projektträger Jülich Forschungszentrum Jülich