A Data-Driven Analysis of Material Influences on Fiber Quality in Mechanical Textile Recycling

Amon Krichel*[1], Marco Benedetti*†[2], Prof. Dr. Stefan Schlichter[3], and Prof.dr. Mesut Cetin Mba[3]

[1]Technische Hochschule Augsburg, Institut für Textiltechnik Augsburg gGmbH – Germany
[2]Ommi Srl – Italy
[3]Technische Hochschule Augsburg, Institut für Textiltechnik Augsburg gGmbH – Germany

Abstract

The mechanical recycling of textiles is currently limited by a significant reduction in fiber length, which necessitates the addition of virgin fibers to maintain yarn quality. Against the backdrop of rapidly increasing textile waste volumes and the need for a functioning circular economy, this study investigates how material and product properties influence the resulting fiber quality.
The analysis is based on a comprehensive dataset of 357 samples from multiple research projects, covering a wide range of materials, product types, and processing conditions. Fiber length was measured at single-fiber level using Uster AFIS Pro 2, enabling high-resolution characterization of recycled fibers. Due to heterogeneous and non-normally distributed data, robust statistical methods were applied, including Welch-ANOVA, Games-Howell post-hoc tests, and nonparametric approaches, complemented by effect size analysis and exploratory visualization.

The results show that fiber material and position in the textile chain are the most influential factors. Synthetic fibers, particularly polyester, tend to retain longer fiber lengths compared to cellulosic fibers such as cotton or viscose. In addition, post-industrial textiles exhibit higher fiber quality than post-consumer materials, indicating the strong impact of prior use and wear. The analysis also shows that additional components on textiles require a higher intensity during the tearing process and therefore lower the quality of recycled fibers. Furthermore, the study evaluates the Omni Recomover, a novel defibering technology capable of removing contaminants without significantly reducing fiber length, addressing a major trade-off in current recycling processes.

A key innovation of this work is the integration of real industrial data with statistically robust methods to analyze multivariate dependencies, moving beyond the isolated factor analysis commonly found in existing literature. Furthermore, the study evaluates the Omni Recomover, a novel defibering technology capable of removing contaminants without significantly reducing fiber length, addressing a major trade-off in current recycling processes.
The findings provide a data-driven foundation for improved material selection, sorting strategies, and process optimization in fiber-to-fiber recycling. By enabling higher-quality recycled fibers and reducing reliance on virgin materials, this research contributes to advancing circularity in the textile industry and supports the development of scalable, sustainable recycling systems.

*Speaker
†Corresponding author: marco.benedetti@ommi.it

Keywords: textil recycling, data driven analysis, tearing, fiber quality