

# Advancing the Recycling of Textiles via Mixed Fiber Classification and Separation

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*Primary topic: Emerging Textile Recovery & Recycling Technologies*

*Secondary topic: Mechanical Recycling Technologies*

## *Abstract:*

Global fiber production reached an all-time high of 132 million tonnes in 2024.[1] Waste management of textiles has been rather ineffective. 75% of materials used in clothing are landfilled or incinerated, and 23% of discarded clothes are collected for recycling, however, less than 1% of the recovered fibers are used to produce new fabric.[2]

Spurred by the urgency of reducing the environmental footprint of textiles and recovering value from used textiles, this paper highlights challenges and recent advances to (i) classify textiles at the macroscopic level (i.e., garment) and (ii) separate blended textiles at the molecular scale (i.e., cotton and polyester fibers). The former is a key component of mechanical recycling, while the latter falls under chemical or molecular recycling.[3]

The recycling of textiles is impeded largely by a lack of actionable information about the content of the fabric, in turn, caused by insufficient capabilities of current spectroscopic identification techniques. High-throughput, automated sorting is developed through the utilization of visible and infrared spectroscopy, including hyperspectral methods, combined with machine learning (ML) [4] for rapid identification of textile composition. This will enable the subsequent separation of higher and lower value textile grades, and identify “disruptors” for fiber-to-fiber textile recycling, such as flame retardants and water repellent finishes, that are typically difficult to detect.

Blended or mixed textiles pose challenges for mechanical recycling which cannot separate fibers from the blend. However, separation of fiber blends can be achieved by selectively dissolving or depolymerizing specific types of fibers in the blend.[3] The separation of cotton and polyester through dissolution or hydrolysis is discussed.

The developments presented here can promote sustainable practices in the textile and waste management sectors, hence facilitating the shift towards a circular economy.

## *Acknowledgements:*

The textile classification material is based upon work supported by the U.S. Department of Energy’s Office of Energy Efficiency and Renewable Energy (EERE) under the Advanced Manufacturing Office Award Number DE-EE0007897 awarded to the REMADE Institute, a division of Sustainable Manufacturing Innovation Alliance Corp. This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

The chemical recycling material is based upon work supported by the National Science Foundation (NSF) under Grant No. EFMA-2029375 “EFRI E3P: Valorization of Plastic Waste via Advanced Separation and Processing”.



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