Conversion of Post-Consumer Textile Waste into High-Purity Microcellulose

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Introduction:

Post-consumer cotton textiles represent a large and underused waste stream with significant environmental impact. Traditional recycling techniques often fail to recover pure cellulose due to complex fiber blends and contaminants.

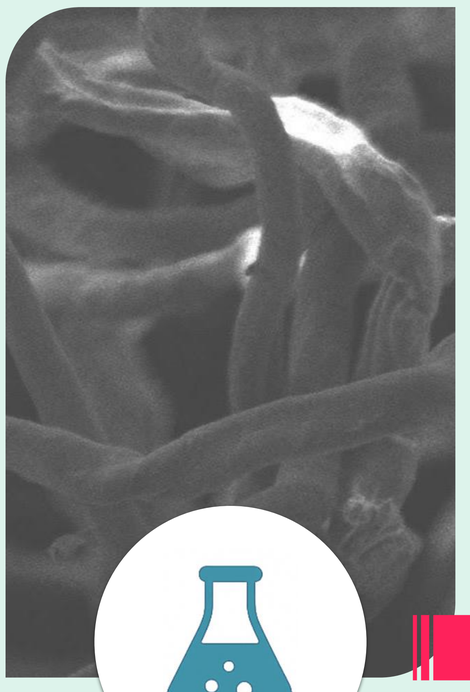
To address this challenge, we developed an **alkali-assisted enzymatic process** to convert cotton-rich textile waste into **microcellulose**.

During **alkali pre-treatment**, the solution penetrates amorphous cellulose regions, disrupts hydrogen bonds, and causes fiber swelling. This transformation changes the fiber morphology from flattened ribbons to more rounded forms and can induce a partial crystalline transition from **cellulose I to cellulose II**, improving enzyme accessibility.

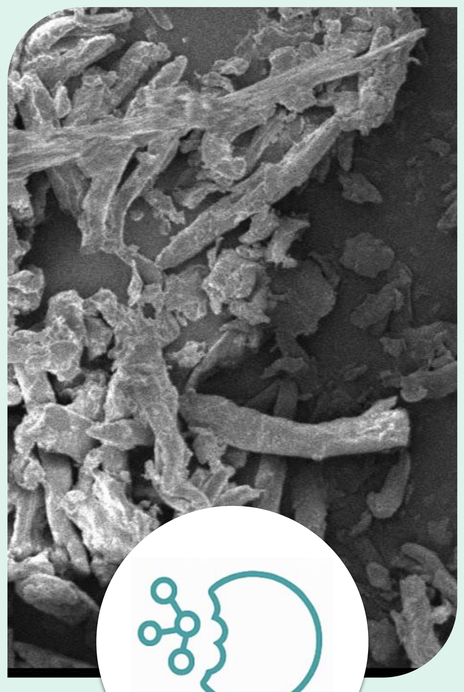
The following **enzymatic stage** hydrolyses the pre-treated fibers, converting around **90 % of the textile waste** into **micro- or nanocellulose**, while the remaining 10 % becomes light process residue.

Feedstock Collecting

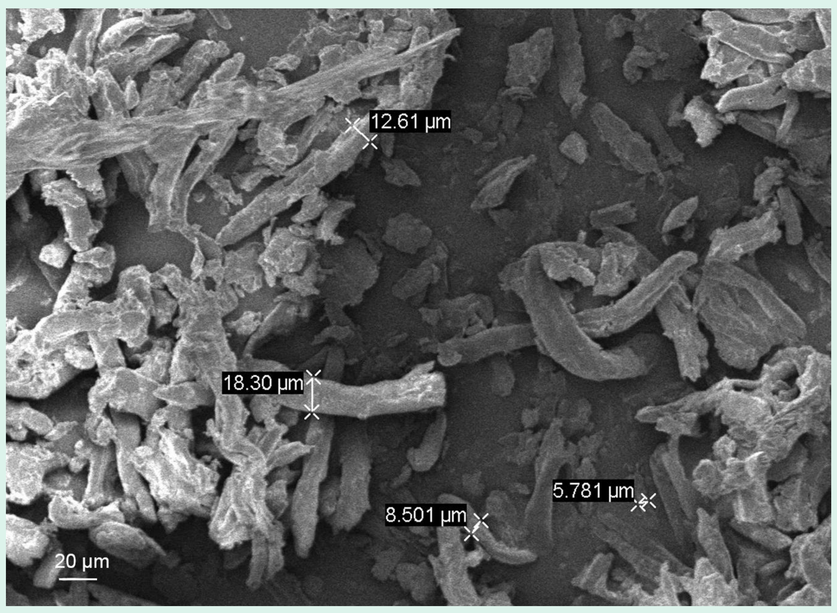
Mechanical Treatment

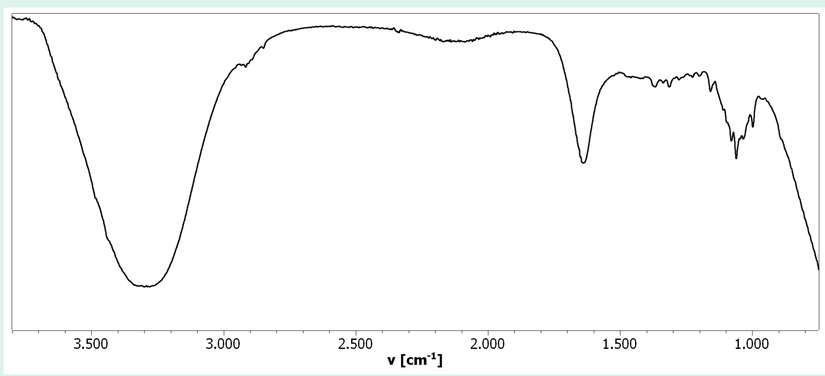


Alkali Pre-Treatment



Enzymatic Hydrolysis of Cellulose





IR spectra of homogenized microcellulose dispersed in water.

Characterization Results:

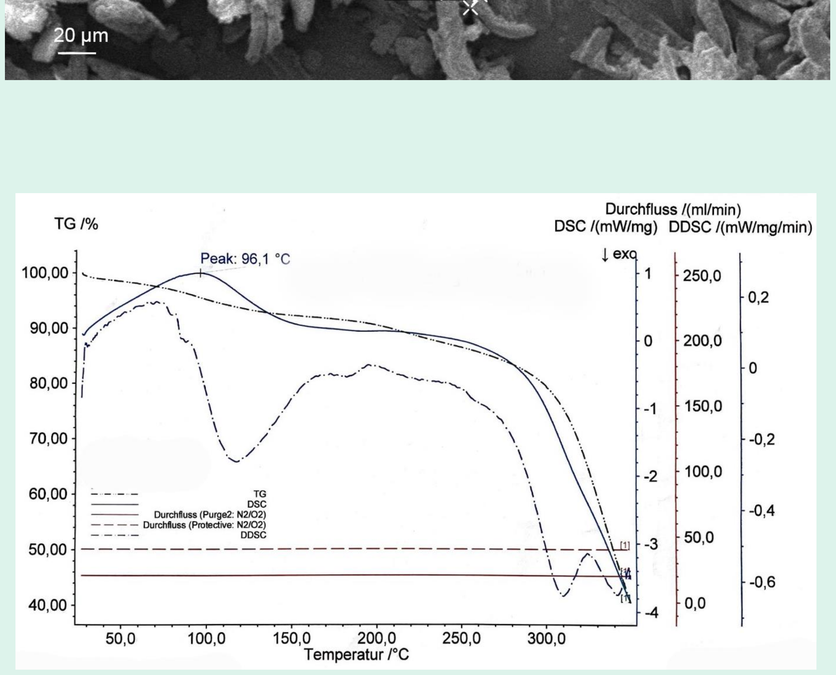
The produced material showed **high purity** and a preserved **cellulosic structure**.

DLS analysis indicated an average particle size (*dv(50)*) of **~20.5 µm**.

SEM revealed **microcrystals and shortened fibers**

FTIR spectra displayed only **characteristic cellulose peaks** (O–H, C–H, C–O–C), verifying the removal of impurities and non-cellulosic components.

TGA/DSC showed a single degradation step at **320–350 °C**, consistent with **high-purity cellulose** and no residual polymers or enzymes.



TG / DSC trace of homogenized microcellulose (synthetic air, heating rate 10 K/min).

Conclusion:

The developed process converts **over 90 % of post-consumer cotton and blended textile waste** into **high-purity microcellulose**.

Alkali pre-treatment increases cellulose accessibility and enhances enzymatic hydrolysis efficiency.

The method is **robust across various textile blends and contamination levels**.

The resulting **microcellulose shows high chemical purity** and a **uniform particle size distribution in the micro- to submicron range**.

This demonstrates a **reliable and scalable route** for recovering cellulose from complex textile waste streams for advanced material applications

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