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# PLA MULTIFILAMENT YARN OPTIMIZATION OF THE TEXTILE-PHYSICAL PROPERTY PROFILE

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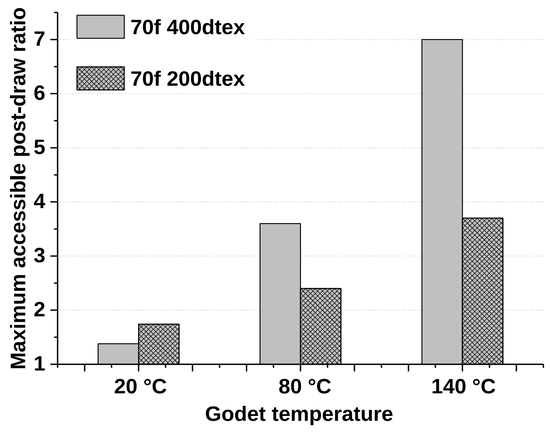
## Introduction

Commercially available multifilament yarns from the biobased thermoplastic PLA, which is biodegradable in industrial composting plants, have textile-physical property profile that's permits consideration in the textile sector.

A significant improvement of the tensile properties could positively influence the establishment process of PLA fibres on the world fibre market.

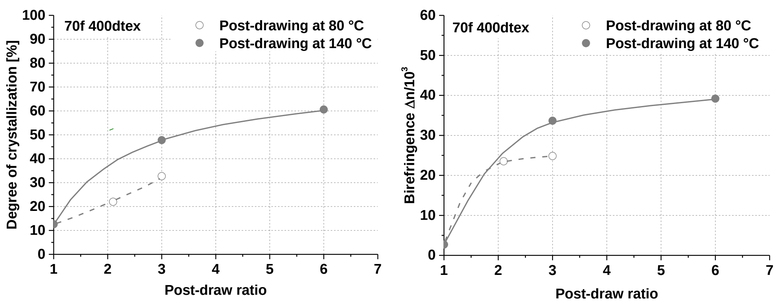
## Motivation

Improvement of the strength and modulus of elasticity of PLA fibres by post-drawing processes of melt spun multifilament yarns (70f400dtex and 70f200dtex) at godet temperatures above the glass transition, as well as identification of the supermolecular structural elements by accompanying methods of fiber characterization (WXAS, SEM, birefringence, tensile test) responsible for this.

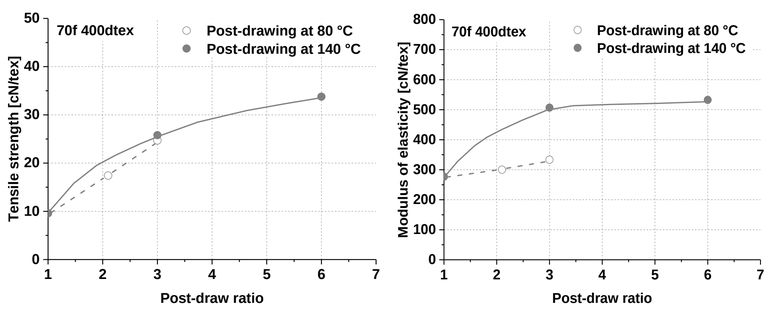



Maximum accessible post-draw ratios of the investigated melt spun PLA multifilament yarns 70f400dtex and 70f200dtex depending on the godet temperature.

# STRUCTURE DEVELOPMENT IN THE POST-DRAWING PROCESS



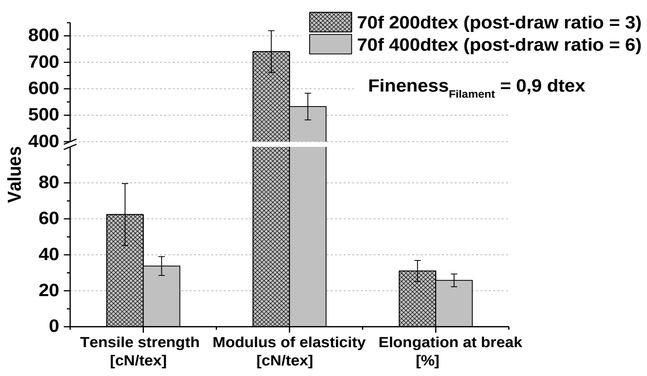

Degree of crystallization (left) and birefringence (right) of the post-drawn PLA fibers (70f400dtex) depending on the draw ratio for the applied godet temperatures of 80°C and 140 °C.



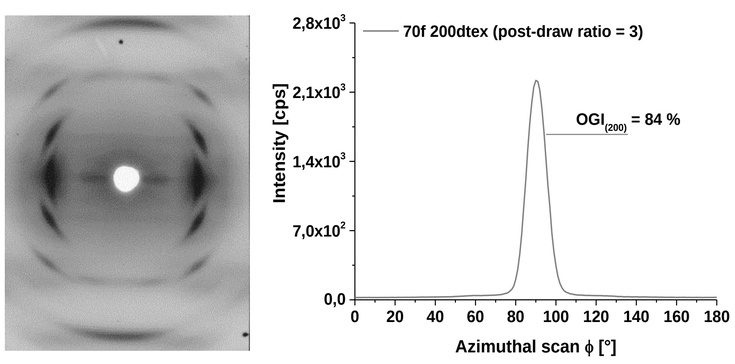

Tensile strength (left) and modulus of elasticity (right) of the post-drawn PLA fibers (70f400dtex) depending on the draw ratio for the applied godet temperatures of 80°C and 140 °C.

## Optimization of the supermolecular strucure

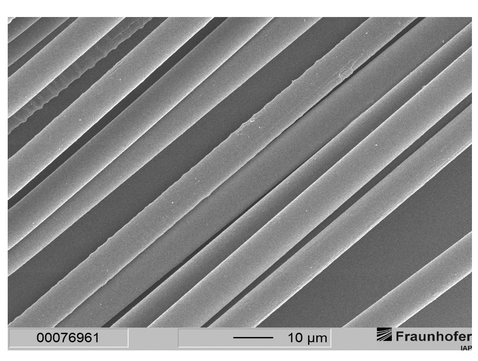
Strictly oriented crystallitte structures within the fibre substance can be reached by post-drawing with maximum accessible draw ratios at godet temperatures of 140 °C, whereby in combination with high degrees of crystallisation and a pronounced overall orientation of the polymer chains, an improvement of the tensile strength and modulus of elasticity is achieved.




Comparison of the textile-physical property profile of the post-drawn PLA fibres 70f200dtex (post-draw ratio 3) and 70f400dtex (post-draw ratio 6) which have been post-drawn with a maximum accessible post-draw ratio at godet temperature of 140 °C.




WXAS-analysis of the post-drawn PLA fiber 7020odtex (Post-draw ratio 3, $T_{godet}$=140°C): diffraction photograph (left) and diffractogram of the reflex of the 200-crystal plane (right).




REM image of the high-modulus and high-strength post-drawn PLA filaments (Post-draw ratio 3, $T_{godet}$ = 140 °C) with a single filament fineness of 0,9 dtex.

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## Conclusion

The best textile-physical property profile could be achieved by a post-drawing process of the PLA 70f200dtex yarn sample at a godet temperature of 140 °C and draw ratio of 3. The 0,9 dtex fine filaments reached a tensile strength of 62 cN/tex (0,5 GPa) and a modulus of elasticity of 740 cN/tex (6 GPa) with elongation at break of 31 %. A high degree of crystallization (58 %) with strictly oriented crystallites ($OGI_{(200)}$ = 84 %) and a high overall orientation of the polymer chains ($\Delta n = 35 \times 10^{-3}$) could be identified as the supermolecular structural aspects responsible for this.

The achieved textile-physical property profile lies within the range of technical PET fibers available on the fiber market and expands the potentials field of application for PLA fibers.