Forschungsnetzwerk Mittelstand

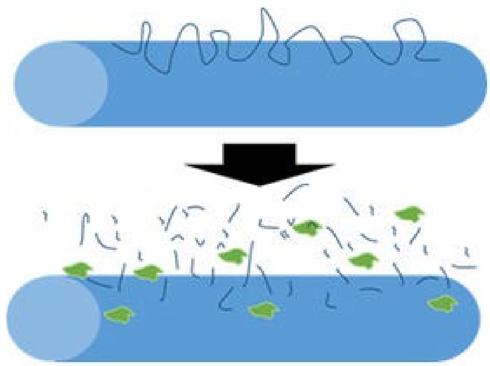

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Figure: Schematic representation of the enzymatic degradation of a fiber Top: Polyester filament with a schematically continuous polymer chain (dark blue); Bottom: Polyester filament with polymer chain degraded by enzymes (green) into short and long fragments

Improved surface functionality by enzymatic treatment of bio-based and conventional polyesters (IGF 259 EN)

The global fiber market is dominated by petroleum-based fibers. Textiles made from petroleum-based polyester are used in almost all end applications, from fashion and home textiles to technical products. The material is not biodegradable and therefore accumulation in nature is an unresolved problem. High toughness and E-modulus, good washing and wearing properties or high color fastness combined with a low price/kg paved the way for this material. The low wettability, which is unfavorable for the textile industry, and the tendency to electrostatic charging are usually overcome by non-permanent, hydrophilic or antistatic finishing agents. But there could also be another way.

Some new microorganisms and enzymes have been found that are able to attack Ester bonds in synthetic polyester fibers. This creates new hydrophilic functional groups on the fiber surface, which improves the wetting, antistatic and binding behavior. The control of the process kinetics enables the regulation of the degree of polymer degradation, so that fiber degradation up to the removal of pilling or even microparticles up to biochemical recycling concepts could become possible.
In addition, the expected efficiency of the process means that there is no need for large quantities of chemicals. The reactions are still too slow to be integrated into finishing processes, as most of the available enzymes come from the so-called first generation. Despite the promising scientific results, the industrial use of this approach has not yet begun and should therefore be the aim of this research project. "Second-generation polyesterases" should be developed and tested.

The aim of this research project was to develop enzymatic treatments for polyester fibers from conventional or bio-based raw material sources as well as for biodegradable polymers. In the research project, the latest results of enzyme research are investigated and transferred to textile applications in order to develop industry-relevant finishing processes for petroleum-based PET, but also for bio-based and biodegradable polyesters such as PLA.

In general, the results of all the experiments carried out as part of this project are as follows:

- Weight and pH reduction are not suitable for detecting small changes, so methylene blue absorbance was used as the main analytical method.
- After four hours of treatment, more functional groups or a higher methylene blue absorption could be detected than after 24 hours of treatment.
- After carrying out two different degradation processes, no difference could be detected between treated and untreated materials.
- The most suitable enzymes for the materials used were the enzymes HiC and the newly developed TfCut2.
- Commercially available enzymes were not as suitable for hydrophilization as the newly developed enzymes due to the high amount of crystalline areas in the fibres.
- In contrast to the previously commercially available enzymes, second-generation polyesterases were able to completely or almost completely degrade non-oriented polyester yarns. Nevertheless, oriented yarns with crystalline areas were partially functionalized.
- A copper coating on enzymatically treated PET fabric showed very good conductivity and abrasion resistance.
- Better adhesion of Cu particles on enzymatically treated PET fabric

In principle, the enzymatic functionalization of textile polyester is therefore possible. However, further adaptation of the polyesterases to the substrate is absolutely necessary for economical enzymatic functionalization.

Project partners

The research project is being conducted in cooperation with the University of Innsbruck, Research Institute for Textile Chemistry and Textile Physics (UIBK), Vorarlberg (Austria) and with the University of Environmental Biotechnology (BOKU), Vienna (Austria).

Duration

24 Month (01.01.2020 – 31.12.2021, extended until 30.09.2022)

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