

BioTexCirc

Research into chemical recycling of bio-based polyamides with the aim to close the loop for functional apparel and to drive forward the textile industry's phase-out of crude-oil based raw materials

Our motivation

BioTexCirc is a project in the BIOTEXFUTURE innovation space, funded by the German Federal Ministry of Education and Research dedicated to drive forward the conversion of the textile industry from petroleum-based to bio-based. The BioTexCirc project is taking up the challenge of transforming linear production methods into circular ones and thus ensuring their sustainability. In this project, the team of scientists at the ITA at RWTH Aachen University and its partners adidas AG and Fraunhofer Institute IAP focus on a chemical recycling process of bio-polyamides, to be later on used to produce high-tech textiles. These materials and their inherent properties for the industrial implementation have already been investigated in the BIOTEXFUTURE projects ALGAETEX and BIOBASE. Therefore, BioTexCirc can now draw on the results and further examine bio-based polyamide 6.9 and bio-based polyamide 4.10 as promising replacement or supplementary materials for the application in the textile industry. Due to their unique properties, these high-performance polymers have a great chance of competing with established materials and are therefore now being analysed in terms of their recyclability.

This project is based on the idea, that the overall aim of BIOTEXFUTURE innovation space is not only the conversion of the textile value chain from petroleum-based to bio-based, but also the keep material as long as possible in a closed loop in order to save resources and to reduce the use of virgin substances.

What we intend to achieve

The objective of BioTexCirc is to develop a sustainable value chain in the textile industry through the chemical recycling of bio-based polymers. This main objective is covered by three areas:

1. The investigation of the technical feasibility and effectiveness of chemical recycling processes for bio-based polymers, focusing on the chemical recycling of three bio-based polyamides, namely PA11, PA 4.10 and PA 6.9, previously investigated in the BIOTEXFUTURE projects ALGAETEX and BIOBASE respectively.
2. Analysing the cleaning process of the textile waste in order to increase its quality and efficiency for the chemical recycling.
3. Implementation of an accompanying life cycle assessment (LCA) and techno-economic evaluation (TEE) to understand the potential environmental impact of chemical recycling of bio-based polyamides in order to formulate guidelines for various stakeholders in the textile industry.

This is how we proceed

BioTexCirc aims to close the recycling loop by covering the entire path from "polymer to polymer", i.e. from the end product to the new raw material. In this context, the scientists are investigating the chemical recycling of bio-based polyamides, which may later potentially be used for the production of high-performance textile fibres.

Various textile recycling approaches are currently being scientifically researched to be able to technically close the textile cycle in the future. One of these processes is 'chemical recycling', which generally enables the conversion of used synthetic fibres into new raw material. In this framework, fibres, such as polyamides, are being broken down from their polymer into their monomer structure. This procedure is carried out under aqueous conditions at elevated temperature and pressure with the aid of a depolymerization catalyst. The monomers are further separated and purified by means of extraction, distillation and crystallization. Once these processes have been established, the recycled and purified building blocks are re-polymerized into polyamides so that their properties can then be compared with the original polyamides having been used as the starting material for the recycling process.

In the course of chemical textile recycling process, it is particularly important to remove additives, originally been added to the textile during polymer or yarn production proceeding or when subsequently having been finished or dyed. This activity is executed in the best possible way through pre-treatment and purification to improve the quality of the recycled material. In the framework of BioTexCirc the scientists currently investigate various down-streaming conditions to determine the most suitable cleaning method for each polymer, afterwards they transfer the individual pre-treatment steps into an empirical model. This allows us to identify and evaluate the best possible removal options for the individual impurities in relation to the different polyamides investigated in the project.

Furthermore, the project pays particular attention to ecological factors as part of a sustainability analysis. Thus, an accompanying life cycle assessment (LCA) and a techno-economic evaluation (TEE) to understand the potential environmental impact and economic aspects of the products and processes developed in the project, are also being carried out within the scope of the project.

The status

A lot is currently still „work in progress“ as the project is just halfway through. From the management's point of view, the biggest challenge is to combine the two approaches, namely a theoretical and a technical one, into a coherent conclusion at the end of the project. From a technical perspective, the objective is to find the most efficient way to chemically recycle the three selected bio-based polyamides. The respective iteration loops (i.e. the processes for investigating the possible steps in the recycling processes of the different polyamides) generally take around a month, therefore, the development of new approaches is limited in the two-year project, thus they must be selected carefully. Nevertheless, the work has already progressed to the scaling phase for PA 4.10, having the additional advantage that this methodology can be transferred directly to PA 6.9. However, a new approach is required for PA 11, which will begin once the scaling of the recycling of PA 4.10 and PA 6.9 has been completed.

Overall, BioTexCirc strives to contribute to sustainable economic growth and a structured transfer of cooperation and knowledge between science and industry to strengthen the textile industry. In addition, the effects of industry-wide chemical recycling on society and the environment are to be considered. This overall approach emphasizes the project's commitment to promoting environmental sustainability and resource efficiency in the textile industry.

Project partner

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About BIOTEXFUTURE

BIOTEXFUTURE is an innovation space for research on bio-based textiles funded by the Federal Ministry of Education and Research (BMBF). It is implemented in cooperation between RWTH Aachen University (ITA, Institute of Textile Technology and STO, Chair of Sociology of Technology and Organization) and adidas AG. The industry and research partners are working together on the conversion of textile value chain from petroleum-based to bio-based.

Website: www.biotexfuture.info

November 2024



This research and development project is funded by the Federal Ministry of Education and Research (BMBF) as part of the 'Bioeconomy Innovation Spaces' funding programme (funding code: 031B0454) and supervised by Project Management Jülich (PTJ). Responsibility for the content of this publication lies with the author.