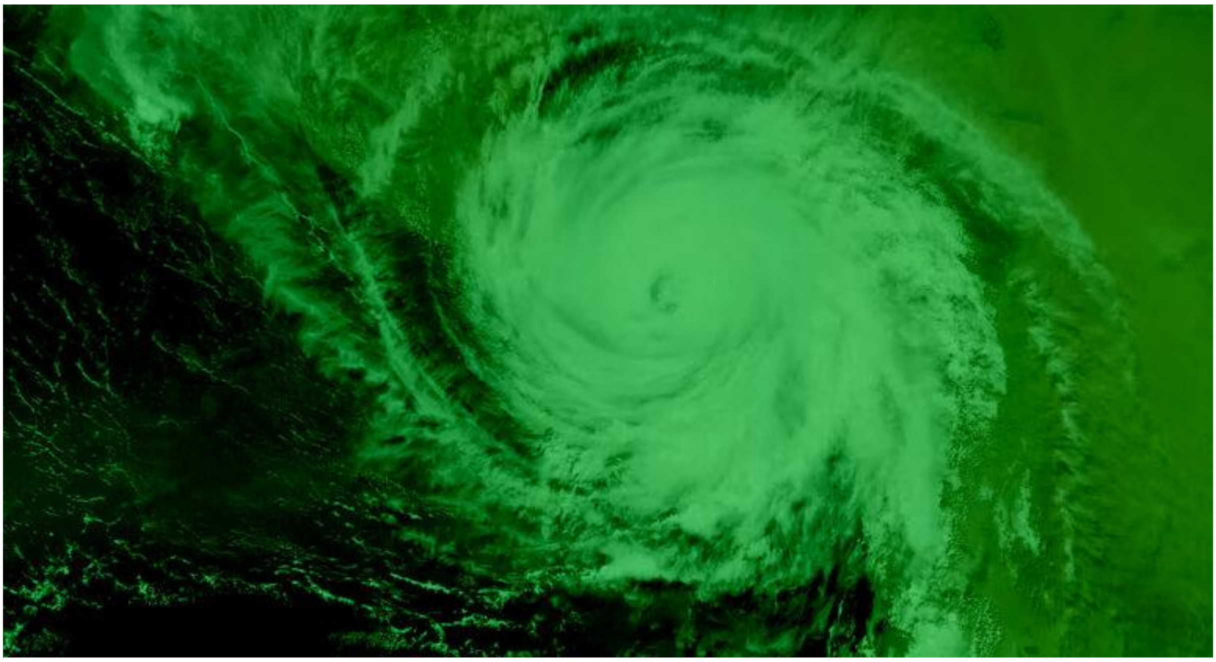

Project Overview: BioPEtex

Bio-based Polyethylene: From Packaging to the Clothing of the Future. A New Raw Material is Being Tested.

The objective of the project bioPEtex, part of the research initiative BIOTEXFUTURE at the leading textile institute ITA (Institut für Textiltechnik) of RWTH Aachen University, is to develop monomaterial garments made from bio-based polyethylene polymers. These garments will be spun-dyed, elastically finished, recyclable, cost-effective, energy-saving and environmentally friendly. It appears that the bioPEtex research team, in cooperation with industry partners, is well on its way to making PE a new, both bio-based and circular material for the textile industry of the future.

Our Motivation

In the multi-billion-dollar fiber market, fossil-based polyester (PES) dominates the apparel sector with a market share of 57%. The general public knows polyester as PET (polyethylene terephthalate), the same material used for making plastic bottles. However, PET has a major disadvantage on the path to a bio-based textile industry: unlike polyethylene (PE), it is currently impossible to produce fully bio-based PET on an industrial scale. PET is made from the monomers ethylene glycol and terephthalic acid and the latter cannot yet be produced bio-based. Thus, bio-PET always contains a non-biological component and is therefore considered „partially bio-based“ – at least for now.

In contrast, PE is composed of only one monomer – ethylene, which can already be entirely bio-based using today's technologies. Bio-PE can be derived from renewable resources like fermented starches or sugars and has the same properties as fossil-based PE. Until now, it has primarily been used for packaging, such as plastic bags for fruits and vegetables, shopping bags, and garbage bags. However, despite its many advantages, it has not yet been used in apparel manufacturing.

Bio-PE is cheaper than other biopolymers currently used for fiber production and can be processed at lower temperatures, thus saving energy. This potential for savings can be further increased if the coloring of bio-PE is done during the spinning process rather than later in fabric form. Dope or spun dyeing typically uses around 50 % less energy and water than conventional dyeing methods and emits 60 % less CO_2. As a result, there are fewer environmental impacts.

Bio-PE is easily recyclable because it can be effectively identified by existing waste-sorting technologies, especially as a monomaterial. Life cycle assessments (LCAs) systematic analyses of the environmental and energy impact of products over their entire life suggest that PE could significantly reduce the ecological footprint of the textile industry, especially when spun-dyed. Additionally, PE textiles are infrared-transparent, allowing body heat to escape and providing passive cooling. PE also absorbs virtually no moisture, so sweat evaporates directly on the skin for a cooling effect or is quickly transferred outward.

Despite these numerous advantages, bio-PE has not yet been used in apparel production. Preliminary research at ITA shows that it can be processed into spun-dyed textile fibers and knitted fabrics with promising properties. This is a research path that deserves dedicated pursuit and this is exactly the mission of the bioPEtex project.

Our Goal

The aim of the project is to produce a spun-dyed T-shirt with elastic finishing from bio-based materials within only 19 months. This timeframe is highly ambitious, requiring multiple research phases to run in parallel. The steps include creating polymer blends from bio-PE and bio-based additives. A colored masterbatch is developed from bio-based compounds for spun dyeing, offering a sustainable dyeing alternative.

A masterbatch is a highly concentrated colorant or additive pellet that's later blended into raw polymer to modify its properties or color. Within bioPEtex, textured yarns suitable for knitting are produced through melt spinning and false-twist texturing. This texturing process gives the yarn elasticity, heat retention properties and bulk. The textured yarns can be used for knitting and the final result is a demonstrator T-shirt with bio-based elastic finishing. All materials used are planned to originate from the same biological source, making the T-shirt thermomechanically recyclable.

Thermomechanical recycling is the standard method for synthetic textiles like polyester, polyamide, or polypropylene. Here, the plastic polymers are melted down while maintaining their chain integrity. New fibers can then be spun from the recovered material, typically with the addition of some virgin polymer.

Our Approach

Bio-based PE is compounded to improve the processability for melt spinning. The compounded polymer granulate is melted and extruded through spinnerets in the spinning process, which is iteratively optimized for quality. The resulting yarn is then false-twist textured to make it elastic and bulky for further processing. With this yarn, a knitted T-shirt is produced (seamless) and finished with bio-based materials to achieve the required performance properties. If necessary, the team fine-tunes the spinning, texturing and finishing steps.

"We are designing for recycling right from the start by considering future recyclability in material selection", says one of the researchers.

Current Status

The research team is making strong progress and already has tangible results – remarkable, considering that PE has not been used in textiles until now. Bio-PE is currently available in large quantities at low prices, often derived from sugarcane production waste. While PE recycling is already established, it has yet to enter the textile sector. This presents a real opportunity to make the drop-in polymer bio-PE scalable for sustainable fashion.

The industry partner TECNARO provided the bio-based PE granulate, which ITA spun on a semi-industrial melt spinning line and then textured on ITA's lab-scale machinery. BB Engineering conducted the industrial upscaling for false-twist texturing to ensure sufficient quantities of textured yarn for downstream processes. FALKE, a specialist in socks and performance apparel, who is also an industry partner in the project, conducted knitting trials and developed a very first T-shirt prototype using both bio-PE and commercial yarns. The process is now being scaled up for industrial production to create fabrics that can be further refined depending on the final textile application.

Currently, bio-PE has lower strength and elasticity than polyester, making it more suitable for lighter fabrics such as those used in T-shirts or performance underwear. Its low moisture absorption, good thermal radiation properties, and cool touch make it ideal for endurance sportswear. It could also be used in parts of garments where these properties matter but mechanical stress is low – like linings. An elastic finish is possible, and this is currently being explored by FALKE along with thermophysiological of the developed garments.

The bio-PE yarns used for the first T-shirt demonstrator were white, but researchers already develo-ped black spun-dyed alternatives. By the project's conclusion at the end of 2025, the team aims to present two T-shirt demonstrators: one in white and one spun-dyed black, both 100 % bio-based and elastic.

One standout feature: Bio-PE is certified CO_2-negative. Producing 1 kg of bio-PE binds 2.1 kg of CO_2. The researchers do not see the non-biodegradability of bio-PE as a disadvantage; rather, they believe it is more sustainable to keep bio-PE within a long-term textile cycle than to compost garments slowly after their useful life.

After the project concludes, partner TECNARO may continue developing the granulates and master-batches for industrial use and supply them to filament manufacturers. Partner BB Engineering could provide the necessary machinery and process adjustments. For large-scale textile production, the suitability of the polymer properties and processing parameters has not yet been fully assessed and may need further optimisation. These topics could be addressed in a follow-up project to bridge the gap between prototype development and industrial application.

For FALKE, further studies on user acceptance and product performance will be important before potential consumer products can be introduced. In addition, for bio-PE-based clothing in general, a proof of concept for circular recycling must still be demonstrated to confirm the material's long-term sustainability in a closed-loop system.

BioPEtex at ISPO 2025






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