

RESEARCH HIGHLIGHTS

DEUTSCHE INSTITUTE FÜR TEXTIL- UND FASERFORSCHUNG DENKENDORF



April 2026 – No. 1

Defense & Textiles

Innovation Potential for Security-Related Applications

In light of global uncertainties and growing geopolitical tensions, defense research is becoming increasingly important. The DITF are therefore specifically opening up its previously civilian research to military applications. With innovative materials, multifunctional high-performance textiles, and developments in lightweight construction, the DITF can make an important contribution to

automotive, aviation, and maritime industries, mobile infrastructure, medical applications, and protective clothing. These include, among other things, sensor-based clothing, integrated early-warning systems for hazardous materials, and flexible lighting and control systems for use under extreme conditions.

In early March, the DITF participated for the first time in

security-related applications at the Baden-Württemberg International joint booth. A demonstrated mannequin on display, showcasing a variety of innovative textile protective and functional solutions for emergency responders, attracted particular visitor interest. Overall, the response was tremendous. The first trade show appearance focused on defense yielded numerous contacts, new con-



DITF, along with other exhibitors and Dr. Patrick Rapp, State Secretary at the Baden-Württemberg Ministry of Economic Affairs, as a guest at the "The Länd" joint booth at Enforce Tac in Nuremberg

security and defense – while at the same time unlocking new potential for efficiency and innovation.

As Europe's largest textile research center, the DITF cover the entire textile value chain – from the molecule to the finished product. For the defense sector, this results in a wide range of applications for the

Enforce Tac in Nuremberg, the leading trade fair for security and defense under the patronage of the German Chancellor. With around 1,000 exhibitors from over 50 countries and 19,000 trade visitors from around the world, the fair is an important international industry gathering. The DITF presented its textile developments for

connections, and points of engagement.

By integrating the field of defense research, the DITF are strengthening their position as a partner for industry and public sector clients – and contributing to the development of high-performance, safe, and sustainable technologies.

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Techtextil Innovation Award

For many years, the Techtextil Innovation Award has recognized cutting-edge ideas in textile technology, sustainability, AI, and the development of technical textiles. This year, two DITF developments received the prestigious award. The decorative composite material NUO FlexHolz, developed by the DITF in collaboration with Schorn&Groh GmbH and NUO GmbH, won the award in the New Material category. The innovative material concept of "FormLig" for a biodegradable, virtually free-formable, three-dimensional material was honored in the New Recycled Materials & Recycling Technologies category – a development by the DITF in collaboration with the Spek DESIGN studio and the companies Buck and TECNARO. For more information, see page 2.

Two sustainable projects, two awards

NUO FlexHolz and FormLig receive Techtextil Innovation Award

Materials made from domestic, renewable raw materials are becoming increasingly attractive as they reduce CO₂ emissions, prevent microplastics from entering the environment, and close the material cycle. Against this backdrop, the DITF are working on a variety of research projects aimed at replacing synthetically produced, predominantly petroleum-based materials with nature-based alternatives. Two projects in this field, developed in close collaboration with industry, have now received the Techtextil Innovation Award.



The highly flexible composite material NUO

NUO FlexHolz

A project consortium comprising Schorn&Groh GmbH, NUO GmbH, and the DITF have developed the decorative composite material NUO FlexHolz – a highly flexible material made from real wood veneer, hemp or cellulose fabric, and a newly developed lignin-based adhesive layer. It consists entirely of renewable raw materials and is biodegradable. What makes this application particularly noteworthy is the material use of lignin, which until now has been primarily used for energy production. By eliminating synthetic adhesives, CO₂ emissions and microplastics are further reduced.

The material combines the natural look and feel of wood with the flexibility of textiles. It can be bent and shaped without losing its quality and is suitable for demanding design applications.

The technical basis is precise laser microsegmentation: After lamination, only the veneer layer is finely structured, while the textile substrate and lignin layer remain intact. This enables high flexibility, lasting dimensional stability, and – depending on

the design – acoustically effective surfaces. NUO FlexHolz can be used in a variety of applications, such as in automotive interiors, interior design, furniture manufacturing, or the apparel industry.

FormLig

The material concept behind "FormLig" is based on coating cellulose yarns with lignin-containing compounds, followed by knitting into a semi-finished product and thermal shaping. The knitting process produces a semi-flexible knit fabric that fuses into an open-cell composite material through the targeted melting of the lignin coating. Shape and stiffness can be adjusted over a wide range. The material can be shaped almost freely in three dimensions and allows for a variety of geometries.

FormLig consists exclusively of biodegradable raw materials. Cellulose and lignin can be sourced from regional value chains. Lignin is a byproduct of the paper industry and has previously been used primarily for energy. Its material application opens up new sustainable potential.

In light of growing environmental impacts from fossil-based plastics, FormLig offers an innovative alternative. The composite combines renewable resources with functional material properties, providing a fully biodegradable substitute for synthetic polymers. This process generates neither microplastics nor landfill waste. The material is currently in the prototype phase but shows great market potential. FormLig

combines ecological responsibility with technical performance and opens up new design and application possibilities. In addition to the DITF, project partners include the Spek DESIGN studio and the companies Buck and TECNARO.

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Self-supporting lampshade made of FormLig

Vegan and recyclable leather alternatives

Use of biotechnologically produced cellulose

In the Fabulose project, 11 European partners are developing new scalable and sustainable bio-based, vegan production routes for leather alternatives, utilizing efficient biotechnological processes for the production of bacterial cellulose, cyanophycin, and bacterial pigments. The DITF are coordinating the 3.5-year project, which is funded by the EU through the Horizon Europe program, JU Circular Biobased Europe, with 3.5 million euros. Resource-efficient production of the raw materials is achieved through fermentation, the use of waste streams and CO₂ as raw materials, and AI-supported process optimization. By combining the materials in a coating formulation, the durability



Bacterial cellulose film manufactured by Sumatrix

and aesthetics of leather are replicated. DITF's HighPerCell® technology enables the spinning of (recycled) cellulose into filaments, which are processed into textile substrates with high tensile strength.

Overview of Project Innovations

- > Use of fermentation products for the rapid and cost-effective production of raw materials

- > Use of waste streams and CO₂ to cultivate microorganisms in order to lower production costs and reduce environmental impact
- > Recycling of bacterial cellulose into filaments via spinning processes to produce textiles of consistent, high quality
- > Development of production processes for cyanophycin to produce durable coatings and finishes
- > Development of a roll-to-roll production process to simplify future scaling

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Sustainable, recyclable, compostable

Biopolymer Innovation Award for a new artificial leather design

Fiber- or textile-reinforced composite materials are usually constructed from different components. Artificial leather is a good example of this. Many types of artificial leather consist of a textile backing, often polyethylene terephthalate, polyamide, or cotton, and a coating of polyurethane, polyvinyl chloride, or silicone. This material diversity between the textile backing and the polymer coating makes recycling difficult, if not impossible. In line with sustainable product design principles, a team of researchers at DITF, in cooperation with the FILK Freiberg Institute, has succeeded in developing an artificial leather that consists essentially of one single component, namely the bio-based aliphatic polyester poly(butylene succinate) (PBS).

The main challenges were to realize a melt spinning process for PBS, to manufacture the PBS textile substrate in the form of woven and nonwoven fabrics, and then, above all, to adapt the subsequent coating of the textile substrate via melt extrusion of PBS. Numerous process optimizations were necessary to ultimately obtain artificial leather with satisfactory performance

and handle. The final PBS synthetic leather products are characterized by their recyclability, which is made possible by simple remelting. In addition, in the event of an end-of-life scenario, the compostability of the biologically degradable PBS is an important ecological criterion. The development was awarded the Biopolymer Innovation Award 2025 (1st prize).

The basic principle of a single-component structure is currently being further developed with a view to transferring it to other interesting textile composites. In a BMBF project, for example, attempts are being made to design so-called bellows, which are used as connecting elements in public transport vehicles such as trains or buses, as a single-component composite. The requirements are set high here. Only by selecting a polymer compound with an optimal composition and through sophisticated process optimizations will it be possible to achieve the required flame-retardant and mechanical properties of the composites.



Pure PBS synthetic leather

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Flat speaker with textile membrane

A subtle loudspeaker for Smart Home applications

In the world of Smart Homes and Internet-of-Things, the flat speaker technology is experiencing an upswing. Due to its slim design, it can be used as unobtrusive decor element or integrated almost invisibly into other components. In the ZIM cooperation project "SchallFELT", the DITF, together with a speaker manufacturer and the circular knitting company roma Strickstoff Fabrik Rolf Mayer GmbH & Co. KG, created a loudspeaker equipped with a knitted membrane. In combination with a correspondingly designed exciter, a proof-of-concept for a robust flat speaker for reproducing high frequencies – a so-called tweeter – was developed. The traditional foil magnetostatic speaker uses a foil membrane



Left: The textile speaker can be hung on the wall like a picture frame and subtly fill the room with sound. Right: Developed speaker.

with conductive tracks to create sound. The conductive tracks, applied using vapor deposition, however, are a known weak spot of the speaker. The membrane and the tracks are subject to high forces from the membrane swinging movement when run-

ning the speaker. As a result, the conductive tracks tend to detach from the membrane after rather short running times. By using circular knitting, conductive yarns can be integrated permanently in the membrane and function as the conductive

tracks for the speaker. Hence, risks of the tracks detaching are eliminated and the lifetime of the speaker is extended. Together with the excitation unit, the developed speaker can create sound waves. After having completed the transition from the proof-of-concept stage to the prototyping phase, the speaker will be able to play notifications, melodies or other sounds and can be hung on a wall or ceiling. In the long run, the development can be extended to address mid-to-high-frequencies to broaden applications scenarios. The proof-of-concept demonstrator will be exhibited at TechTextil 2026 in Frankfurt.

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Greater Safety and Comfort for Protective Clothing

Utilizing the properties of auxetic woven structures

When everyday materials are pulled, they stretch or elongate in the direction of the pull and become narrower in cross-section – a behavior that is also typical of flat textiles. Auxetic structures exhibit different behavior: they do not change under tensile stress or even increase in width or thickness. This property is advantageous, for example, in protective textiles or textile filter media.

Previous research in the field of auxetic fabrics has focused on fiber composites. These structures naturally exhibit high stiffness. This makes them suitable for applications where the material needs to deform only once. Other research approaches have achieved auxetic properties at the yarn level. Negative transverse contraction can



Tensioned auxetic fabric with a single direction of action

be quantified using the Poisson's ratio; for auxetic structures, it takes on values of ± 0 but also significantly negative values. The effect is superimposed by other structural influences in the textile fabric and

is thus limited. For this reason, the DITF are researching a textile, flexurally compliant fabric-based structure that possesses reversible auxetic properties. To this end, special multilayer fabrics have been developed

whose thickness profile resembles an hourglass geometry in both the weft and warp directions. Under pressure, the material compresses, effectively dampening impacts – an advantage for protective applications. At the same time, the fabric adapts well to different shapes. Under tension, however, its width or thickness increases, which is of interest for filtration processes, for example.

The fabric structures developed in the "Auxetic Woven Structures" project achieve an adjustable Poisson's ratio of up to -2 . The auxetic effect is not only unique but also demonstrable under repeated loading.

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Sustainable coloring for denim products

Convincing denim look with digital printing

The production of denim fabrics consumes an extremely large amount of water and energy and causes a very high wastewater load due to chemicals and unfixed dyes. It is not uncommon for up to 4,000 liters of water to be consumed in the production of 1 kg of dyed denim fabric. Water consumption for dyeing alone often exceeds 150 liters. Added to this are significant emissions from laser treatment and stonewashed effects used to achieve a fashionable vintage look.

As part of the "DENIMPRINT" development project, entirely new approaches were explored, and the digital pigment printing process was applied for the first time to color denim fabrics. Instead of the labor-intensive and wastewater-intensive warp-dyeing process, followed by



Left: Printed back pocket of a pair of jeans; right: Printed image of a laser-treated pair of jeans



fabric formation through the weaving process and the resulting typical coloration, the final denim look is simply printed onto the textile substrate using inkjet technology. Stonewashed effects or laser bleaching can also be achieved using this printing technology. Since the

color pigments are bonded to the fabric surface by the binder, no post-washing is required, making the process completely water-free.

The project identified suitable pigment printing inks and developed the corresponding fabric preparations and necessary

printing parameters for producing color-accurate print patterns with high colorfastness. In this way, a fantastic denim look with impeccable colorfastness properties in the final product was achieved. The investigations were conducted on a variety of cellulosic substrates of different weights and finishes.

The sustainability of the new process was quantified and substantiated with numerical values. This makes it possible to manufacture denim fabrics sustainably, regionally, and in an extremely resource-efficient manner in Germany once again, while adhering to high social standards, avoiding child labor, and preventing the unprotected handling of chemicals.

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BRIEF NOTE

JEC World 2026

JEC World in Paris, as the world's leading trade fair for composite materials and an important meeting place for users from many different industries,

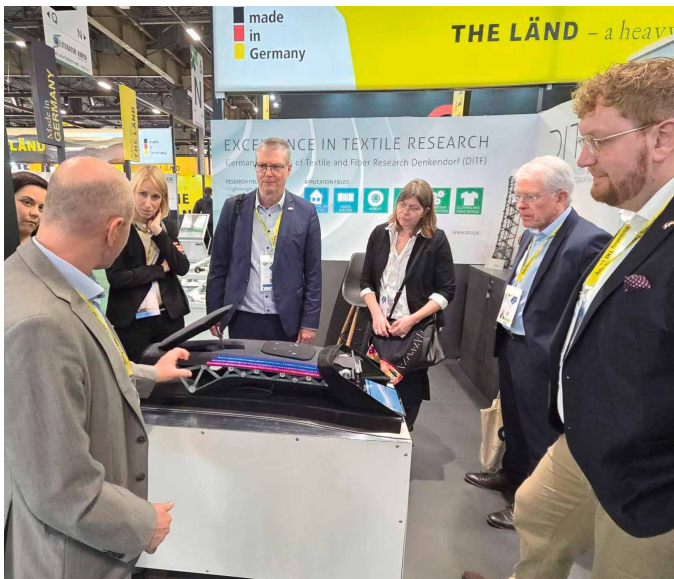
is a fixture on the DITF's trade fair calendar. As in previous years, the DITF were represented at the joint booth of Baden-Württemberg International (bw_i) and presented current research

results on bio-based fiber composites, CO₂-negative construction methods (DACCUS project), and lightweight components for the automotive and aerospace industries and other high-performance applications.

An innovative lightweight center console served as a demonstrator and attracted significant interest. In addition to numerous company representatives, the DITF booth also welcomed Thomas Schwara from the Baden-Württemberg Ministry of Economic Affairs.

projects and research findings. Following the theoretical presentations, participants also experienced the practical side of things during a tour, visiting the High Performance Fiber Center, the Spinning and Polymer Technology Center, and the Smart Textiles Technology Center.

In his welcoming remarks, DITF Chairman Prof. Dr. Michael R. Buchmeiser emphasized the importance of recycling as a research topic. For the past two years, the DITF have expanded this focus with support from the Ministry of Economic Affairs and the Ministry of the Environment of Baden-Württemberg. At the Denkendorf Research Center, research is thus conducted not only from the molecular level to the finished product – but also from the material back to the polymer.



Denkendorf Innovation Day

Full house at the DITF: The Denkendorf Innovation Day, where researchers provide insights into their current work, was once again very well received this year. Eleven scientists presented their current

Osteosynthesis implants

Load-bearing and patient-specific design via 3D printing

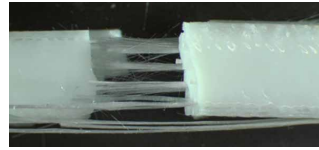
The number of bone fractures in Germany is steadily rising, posing economic challenges for healthcare systems. Osteosynthesis is often necessary to stabilize complex fractures. To date, metal implants (steel, titanium) have been the primary choice. However, these have significant drawbacks: they cause artifacts in imaging (CT/MRI) and usually require a risky second surgery to remove the material.

A current research project, funded by the Industrial Joint Research (IGF), addresses this issue and is developing novel, resorbable fiber-reinforced implants at the DITF's Biomedical



Left: Test samples with and without integrated yarn; right: Test sample, matrix brittle and broken in liquid nitrogen

Engineering Technology Center (BMT). Unlike previous biodegradable polymers, which lacked the strength required for load-bearing bones, these systems utilize highly stretched fibers. Through additive manufacturing (3D printing), the implants can be designed to withstand specific loads and tailored to individual patients. This reduces the amount of



material required and prevents growth disturbances in children. The goal is stable, temporary fixation that completely dissolves in the body after healing. For the first time, the project combines resorbable polymers with resorbable highly stretched yarns that are incorporated into implants via additive manufacturing. Initial investigations have shown that

even with a low yarn content, an increase in tensile strength and a significantly increased stiffness – which is also desired – can be achieved.

As the project progresses, the yarn content in the implant will be maximized and optimized for specific loads to ensure suitability for load-bearing applications. By the end of the project, prototype components – defined in collaboration with an expert committee – will be designed and manufactured into demonstrators using the newly developed production process.

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CirclE Project

Supporting companies in the development and implementation of circular strategies

Resource scarcity, climate targets, and new EU regulations are increasing the pressure on SMEs in the technical textiles and textile machinery sectors. The "CirclE" research project (IGF Project 01|F23239N) demonstrates in a practical way how to successfully transition to a circular economy. The goal is to support companies in developing and implementing circular strategies.

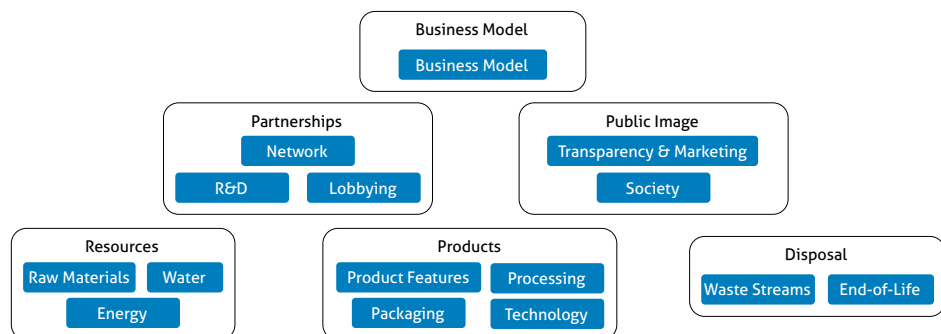
To date, the industry has been strongly characterized by linear value creation: high resource consumption, short product lifespans, and low recycling rates. At the same time, the pressure to act is growing due to regulatory requirements and rising customer expectations. A transition to the circular economy offers significant potential for reducing CO₂ emissions and increasing competitiveness.

CirclE, conducted by the DITF and the International Performance Research Institute (IPRI), addresses precisely this issue. It is based on a structured approach aligned with the 10R strategies, supplemented by an analysis of relevant influencing factors. From this, industry-specific measures were derived for manufacturers, recyclers, and the textile machinery sector.

The key result is the CirclE Circularity Index, which quantifies a company's circularity. Building on this, the free online tool "Circletool" was developed. Through a self-assessment covering resources, products, business models, collaboration, waste management, and public perception, companies receive a comprehensive evaluation of their current status.

Based on this, individually tailored measures, concrete implementation steps, and training content are provided. These facilitate the initial steps and promote the integration of the topic within the company. CirclE thus provides important impetus for the transformation of the industry and supports SMEs in becoming more sustainable, innovative, and competitive.

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Areas of Action to Improve the Circular Economy

Successful knowledge transfer

Goals of the long-standing industrial partnership with Saint-Gobain have been achieved



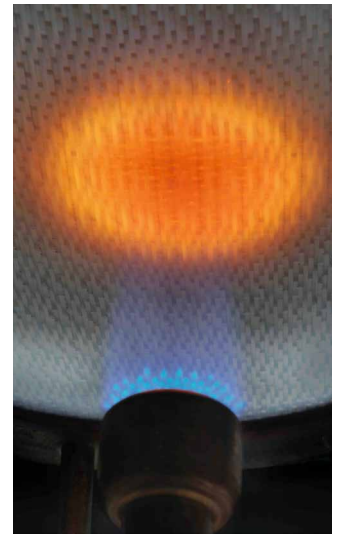
Four years ago, the DITF launched a comprehensive industrial partnership with the French company Saint-Gobain. The goal of the partnership was to advance joint development in the field of oxide ceramic fibers and to create the conditions for industrial production. Oxide ceramic fibers are a component of fiber-reinforced ceramic materials (CMCs), which do not exhibit catastrophic brittle frac-

ture under mechanical loads and in high-temperature applications.

DITF's expertise in this collaboration was based on decades of experience in the manufacture of ceramic fibers. This made them an ideal partner for the transfer of know-how. The agreed-upon goals have been achieved, and the joint work is largely complete. Through close on-site cooperation at the DITF, a French team was able to familiarize itself not only with the scientific background and the process technology. In recent years, groundbreaking advances

in manufacturing technology have also been developed, benefiting both parties.

Saint-Gobain's commitment aims to establish production of oxide ceramic fibers in Europe. The successful technology transfer helps strengthen Europe's competitive position in a high-tech segment. The DITF will continue to expand its research activities in ceramic fiber development in the future to create high-performance new materials.



Fabric made of ceramic fibers

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innBW Position Paper

The Baden-Württemberg Innovation Alliance (innBW), whose 11 member institutions include the DITF, has issued a position paper with proposals for a forward-looking innovation policy in light of the current government formation process in Baden-Württemberg. The paper makes it clear: Declining investment in research and development and a slowing pace of innovation are jeopardizing the state's current leading position. At the same time, international competitive pres-

sure is growing, particularly in key technologies. This makes it all the more important to strengthen the state's innovative capacity in a targeted manner.

The innBW institutes make a decisive contribution to this. They combine scientific excellence with applied research and ensure rapid transfer to the business sector – especially for small and medium-sized enterprises. This makes them a central component of the state's innovation ecosystem.

To continue fulfilling this role successfully in the future, the innBW has formulated clear demands. These include:

1. Strengthening the innBW's industry-oriented research
2. Expanding collaborative research in the state
3. Securing and modernizing the research infrastructure

The position paper is thus a clear appeal: Anyone who wants to secure Baden-Württemberg's future viability must invest decisively in innovation and technology transfer now.



Fairs & Events

April 21 – 24	Techtextil, Frankfurt – DITF booth
May 19 – 22	Index, Geneva – DITF booth
June 27	Science Day, University of Stuttgart – DITF booth
June 11	BMW SME Innovation Day, Berlin – DITF Demonstrators Exhibition
June 24 – 25	Textiles Recycling Expo, Brussels – DITF booth
September 16 – 18	DORNBIRN GFC 2026, Dornbirn, Austria – DITF presentations and booth
November 04 – 05	39 th Nonwovens Days, Hof – DITF presentations and booth
November 10	GoTex, Reutlingen – DITF booth
November 16 – 19	Medica/Compamed, Düsseldorf – DITF and ITVP at the bw-i joint booth
November 26 – 27	ADD International Textile Conference 2026, Dresden – DITF booth

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