RESEARCH HIGHLIGHTS

DEUTSCHE INSTITUTE FÜR TEXTIL- UND FASERFORSCHUNG DENKENDORF

DITF REPORT

November 2025 – No. 2

DITF set an example for climate protection

Ceremonial commissioning of the photovoltaic systems

The DITF have invested heavily in a photovoltaic system at their site in Denkendorf, thereby taking an important step towards climate neutrality. In the presence of many guests, the system was officially put into operation on September 17, 2025.
The system is a central component of the state's strategy to make the state's own institutions and business-related research facilities greenhouse gas-neutral by 2030. The project, which was funded by the state of Baden-Württemberg with 1.4 million euros, has a total volume of 1.6 million euros.
The systems installed on the roofs of the buildings and covered parking lots have a total installed capacity of 840 kilowatt peak (kWp).
At the opening ceremony, DITF CEO Prof. Dr. Michael R. Buchmeiser emphasized the importance of the investment for the future energy supply of the institutes. In their welcoming speeches, Mayor Ralf Barth from Denkendorf and Ministerial Director Michael Kleiner from the BW Ministry of Economic Affairs also praised the project as an important contribution to advancing Baden-Württemberg in the area of climate-neutral research facilities nationwide. Following the commissioning of the solar plant, the guests were able to see for themselves that the topic of sustainability also plays a central role in research at the DITF. Scientists presented innovative fibers and composite materials made from renewable raw materials and showed how state-of-the-art analysis and testing methods contribute to the optimization of material properties.

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DITF Executive Board Member Peter Steiger, Mayor of Denkendorf Ralf Barth, DITF Executive Board Chairman Professor Michael R. Buchmeiser, Ministerial Director Michael Kleiner and DITF Executive Board Member Professor Götz T. Gresser (from left) at the official opening ceremony

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DITF focus topic: Textile recycling

Textile recycling is becoming an increasingly important topic worldwide. Reports of growing mountains of unused used textiles make it clear that solutions need to move forward more quickly. Companies are also increasingly recognizing the potential of circular value creation and investing in sustainable recycling technologies. The DITF are facing up to this challenge and are focusing their research on innovative recycling processes that should significantly alleviate the problem.
With two new projects with a total volume of over 4.2 million euros, the DITF are developing technologies that will make used textiles, high-performance fibers and fiber composites much more usable in the future and thus reduce the enormous environmental impact of textile production.

On page 2, we present the HiPerReF and CYCLOTEXUM projects – two impulses for a genuine circular economy.

Research into textile recycling

4.2 million euros for two current funding projects

Worldwide, used textiles are still rarely recycled and pile up into huge mountains of waste. A recent study by the Boston Consulting Group (BCG) drew attention to this problem. However, the low recycling rate is also due to the fact that only a small percentage of used textiles are suitable for recycling into high-quality material and for demanding applications. The DITF are tackling this problem with their research and have launched two research projects with a project volume of over 4.2 million euros.

In the HiPerReF project, a center for the development of high-performance fiber composite structures based on recycled high-performance fibers such as carbon and glass fibers will be established over the next two years in order to further develop their recycling. Scientists at the DITF are working on a complete process chain to produce highly oriented semi-finished products from recycled carbon and glass fibers on an industrial scale.

Tapes for high-performance applications made from recycled carbon fibers

In order to achieve maximum performance in the component, the interaction of all machines and devices is being optimized. The aim is to produce standard industrial semi-finished products such as prepreg and non-porous composite plastics with a fiber volume content of over 45 percent.

The CYCLOTEXUM project is about recycling classic textile waste into high-quality yarns. The aim is to intelligently combine existing mechanical, physical and chemical process steps so that fine, uniform yarns can be produced from the secondary raw material. Material Flow and Cost Accounting (MFCA) is used to check all technological developments for economic efficiency and sustainability.

With these two research projects, the DITF offer the national and global textile industry effective tools and solutions for an effective textile circular economy.

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DITF Sustainability Report 2024

On the way to climate neutrality in 2030

The DITF published a sustainability report for the first time this year. This includes key elements of reporting in accordance with the EU Sustainability Reporting Directive (CSRD). This includes a clear definition of targets that are based on the requirements of the country and the Energy Efficiency Act:

1. climate neutrality by 2030
2. energy efficiency increases of 2 % per year by 2045 (with the exception of operational facilities that are directly involved in solving scientific problems).

In accordance with the scope concept, the sustainability report documents direct, indirect and upstream emissions for key categories and shows the consumption of key resources such as energy and water from 2022 to 2024. A catalog of measures shows how CO_2 emissions are to be reduced in concrete terms. The focus here is on setting up an energy management system in accordance with ISO 50001 and implementing a comprehensive heat recovery concept in the context of heat pump technology.

The report is supplemented by an overview of current research projects at the DITF that address sustainability issues and develop forward-looking solutions in areas such as energy and resource efficiency, recycling, renewable raw materials and the circular economy. Finally, services offered by the DITF for external partners to promote sustainability in their products and processes are also presented. These include, for example, tests on the biodegradability of materials, time-accelerated ageing tests and MFCA analysis (Material Flow Cost Accounting) and life cycle assessment.

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EU project SOLSTICE:

5R Solutions for a Circular Textile Economy

M18 Consortium Meeting in Prato (Italy), November 2025

The DITF are part of the SOLSTICE project funded by the European Union since May 2024. The project addresses important social and technical challenges in the textile industry. In four European regions – Grenoble in France, Berlin in Germany, Prato in Italy and Catalonia in Spain – the project actively demonstrates the implementation of climate-neutral practices and the transition to a circular economy specifically for the textile sector. SOLSTICE is based on a holistic approach that encompasses all phases of waste prevention and management and is guided by a 5R strategy: Refuse/Reduce, Reuse, Repair, Repurpose and Recycle and are carrying out a life cycle assessment of the four polymer recycling processes under consideration as well as a technical and economic evaluation for these processes.
The focus of the scientific and technical work at the DITF is on polyamides, particularly aramids. These are used in flame-retardant protective textiles. The aim is to develop a solvent-based recycling process to recover high-quality aramids from pre- and post-consumer material. So-called 'green solvents' are the main focus as solvents. Current work shows that it is possible to separate meta- and para-aramid using selected solvents. The meta-aramid content can be extracted from the textiles without polymer degradation. The rheological profile of the meta-aramid solutions allows the production of easily processable spinning solutions. Meta-aramid fibers regenerated by coagulation in an aqueous medium can be produced using a wet spinning process. The process stability and the resulting mechanical properties of the fibers exceed expectations. The new technology is now being advanced in collaboration with an industrial partner to develop demonstrators. On the other hand, the DITF are leading the work package for integration and sustainability assessments. Three competence centers and the Center of Management Research at the DITF are involved in the project.

New aramid "regenerated fibers" from post-consumer textile waste

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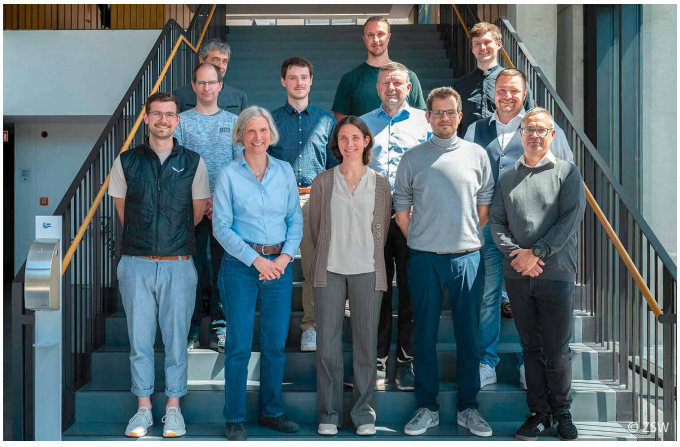
Development of rapid ageing methods

Shortening the development cycles of hydrogen electrolyzers

Together with the Center for Solar Energy and Hydrogen Research (ZSW), Oberland Mangold GmbH and McPhy Deutschland GmbH, the DITF have launched a joint project for the sustainable production of green hydrogen using alkaline water electrolysis.
The aim of the project is to use rapid ageing methods for cathodes, diaphragms and stacks to shorten the development and verification cycles of hydrogen electrolysers in order to significantly accelerate their new development. At the same time, a qualitative improvement in the service life and power density of the systems can be expected from the research results.
The project partners from research and industry are contributing extensive know-how and an outstanding technical center and laboratory infrastructure to the three-year project funded by the BMWE.



Participants of the kick-off meeting at ZSW Stuttgart

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Hemp profile project: sustainable travel

DITF develop walking stick made of natural fibers and bio-based matrix

In a joint project funded by the MRL_BW, the DITF and LEKI Lenhart GmbH have developed a walking stick that is largely made from renewable raw materials. The finished product shows that sustainable materials also offer high performance in the outdoor industry.

Consumer demand for environmentally friendly alternatives to conventional materials is increasing. Aluminum and carbon fibers, for example, require a lot of energy during production and are usually difficult to recycle. For this reason, the research project has set itself the goal of developing sustainable and durable sports poles made from hemp fibers and a bio-based matrix, which are manufactured using a pultrusion process.

The shaft of the walking stick is made from regionally harvested hemp fibers that are processed into rovings using the Kemafil process. This is a sheathing process that gives the hemp fibers a stable, rope-like structure through a special interweaving. The matrix used was developed with project partner Bio-Composites and More GmbH and is based on epoxidized linseed oil, which can be cured like a synthetic epoxy resin. The matrix is up to 42 percent of biological origin and is optimally adapted to the energy- and material-efficient pultrusion process.

Around 16 meters of pipe profile were successfully pultruded on a laboratory scale at the DITF. The resulting parts have a smooth surface and the natural fibers used are visible.

The suitability of the process for series production was demonstrated by manufacturing under industrial conditions at the industrial partner CG TEC GmbH.

The grip loop is made of natural fiber fabric and the attachments are made of bio-based materials

In addition to the shaft, the other components of the walking stick are also sustainable: the grip loop is made from a natural fiber fabric and the attachments are made from bio-based materials. This means that over 64 percent of the entire walking stick is made from renewable raw materials.

Initial market analyses indicate very good marketability and user satisfaction. While hemp fibers were previously used primarily in applications with low mechanical requirements, the developed product proves that this natural fiber material can do more. The hiking poles produced achieve a flexural strength that is comparable to poles made from aluminum and also offer improved damping properties. This also makes the material suitable for heavy-duty structures. Thanks to its reduced CO_2 footprint, the product is sustainable and environmentally friendly.

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Project completion "AI sensor"

Predicting the electrical properties of sensor yarns with AI

The IGF project "KI-Sensor" has been successfully completed. The aim of the research project was to investigate the potential of artificial intelligence for predicting the electrical properties of conductive yarns and embroidered pressure sensors.

In close cooperation between the Center of Management Research at the DITF and the Technology Center E-Textiles & Acoustics, it was shown that AI models can predict the electrical properties of conductive yarns and textile sensors with sufficient accuracy to effectively support development processes. This can save significant costs and time in the development process.

During the course of the project, it became clear that not only the static resistance behavior is relevant for the design. The changes in electrical resistance along the force-strain curve are just as crucial, as the functional behavior changes significantly under load. A key finding concerns the importance of high-quality and standardized data for the successful use of AI. The project partners found that the development of resilient AI models is currently still hampered by a lack of or non-application of standards. For example, the resistance specifications in data sheets for conductive yarns are given in different forms such as $5\,\Omega \pm 2\,\Omega$ or $< 100\,\Omega$, while force-elongation measurements are often carried out under different framework conditions (e.g. clamping length, test speed or pretension weight).

Harmonization and standardization measures for measurement methods and data documentation are of central importance in order to use the knowledge gained in the long term and to further advance the industrial use of AI in product development.

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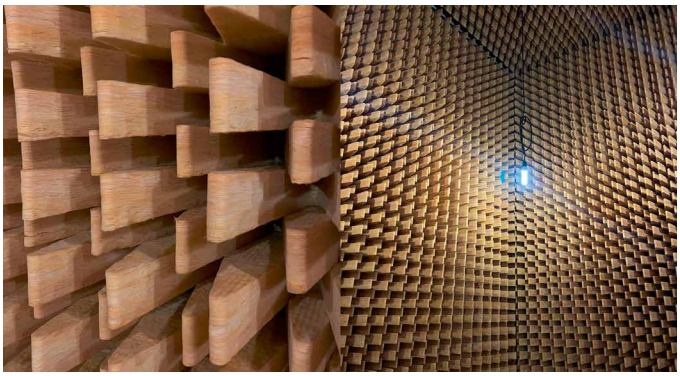
Measuring device for determining the electrical resistance along the force-strain curves

Successful Invest BW-Praxissprint

MetAkusTex: New measurement methods for soundproof textiles

The DITF is implementing a comprehensive system for measuring and predicting the acoustic properties of a wide variety of textiles. This research enables the development of a wide range of sound-absorbing or acoustically effective materials.

Currently, nonwovens are used as sound absorbers alongside foams. However, these are relatively thick and have poor elasticity. Textile surfaces, such as woven and knitted fabrics, also offer potential for sound insulation applications, but have been little researched to date. They are generally thinner and more flexible, which means that the measurement methods and simulation models used for nonwovens are not readily applicable to these other types of textiles.



Sound-absorbing ceiling and walls in the sound measurement room at the DITF

This is where the MetAkusTex research project, funded by the Invest BW-Praxissprints program of the BW Ministry of Economic Affairs, comes in. In this project, the DITF are developing new acoustic measurement procedures and prediction methods that can be used to evaluate how different textiles interact with sound, whether they absorb, reflect, or scatter it. With the help of mathematical models, textile materials can be tested, adapted, and optimized for their acoustic effect as early as the design phase. The project results will help companies make their product development processes more efficient and design materials in a more targeted manner.

In addition to the development of new measurement methods, the acoustics laboratory at the DITF has been expanded. The measuring room with sound-absorbing walls and sound-reflecting floor (semi-anechoic chamber) has been equipped with a modern data acquisition system. The new acoustics laboratory will be used for research at the institute and will also be made available to industry for testing.

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Development of an energy-saving nozzle

Novel main nozzle for multi-colored weft insertion in air-jet weaving

Air-jet weaving is a productive technology with up to 1,200 wefts per minute. However, one disadvantage compared to rapier and projectile weaving machines is the high energy costs for compressed air. The weft yarn is usually inserted via four to eight main nozzles, whereby only one nozzle can be ideally arranged parallel to the reed channel. The other nozzles blow the compressed air at an angle to the reed channel, causing a lot of air to escape unused, creating air turbulence in the reed channel and promoting weft insertion errors. The yarn transport properties are different for each nozzle and therefore require higher pressure. This requires a special, expensive reed with a funnel-shaped inlet. Productivity could be almost doubled with a double weft insertion, which is not possible with the current main nozzle system. A new, energy-saving main nozzle was therefore developed at the DITF. Several main nozzles, fixed or movable, were replaced by a single energy-saving nozzle, which is optimally positioned in relation to the reed channel and enables multi-color weft insertion. Flow simulations (CFD) were used to develop solution concepts, layout and optimize nozzle designs. The velocities, flow profiles and pressure losses for the different nozzle designs were analyzed, flow phenomena explained and the concept solutions evaluated in detail. This led to a nozzle design with reliable shot entry and optimum utilization of compressed air. Demonstrators were produced using 3D printing, the dimensional accuracy was checked using µCT, the simulation models were verified using air flow measurements (Particle Image Velocimetry System, PIV) and the firing processes were documented using high-speed cameras. The demonstrators and also the double weft insertion were successfully tested on various DORNIER air-jet weaving machines.

The energy-saving jet offers new opportunities for competitive textile production in Germany with energy savings of over 12.1 percent, stable weft insertion, double weft capability and low-cost reeds. An additional plus point: the nozzle can also be used for existing weaving machines without major conversion.

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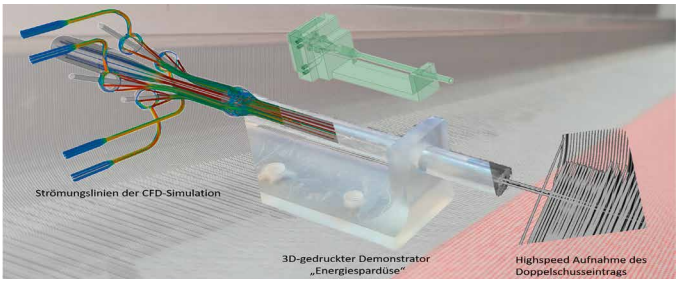

Prevention of bacterial vaginosis

Invest BW-Praxissprint: panty liners with active ingredient release

Around a third of all women in the fertile phase of life worldwide suffer from bacterial vaginosis – caused by a disturbed vaginal microbiome in the vagina. The consequences range from infections and an increased risk of infertility to premature births. As part of an Invest BW-Praxissprint, funded by the Baden-Württemberg Ministry of Economic Affairs, the DITF have now developed the basis for a panty liner that can stabilize the healthy vaginal environment and prevent vaginosis. As therapies to date have often caused relapses, this approach opens up new perspectives for women's health.

A research team at the DITF has laid the foundations for the development of a panty liner loaded with lactide. Lactide is the cyclic diester of lactic acid. It can be incorporated into a textile carrier in various ways. One effective method is to spin a solution of polymer and active ingredient into fibers. The application of an active ingredient-laden coating to a cellulose textile was also tested. When the panty liner is worn, lactic acid (lactate) is produced from the released lactide in the physiological environment. The pH value in the vaginal environment can be reduced to a "healthy", slightly acidic level. This can make a decisive contribution to prevention and prevent a flare-up of bacterial vaginosis.

Equipment of a tissue on a laboratory padder

The release of the active ingredient must take into account the actual duration of use of panty liners. To achieve this, an active ingredient had to be found that is released within a few minutes for a few hours in a temperature- and moisture-controlled manner. Another requirement is to use resource-saving and environmentally friendly materials.

Initial model tests with artificial vaginal secretions have shown that it is possible to reduce the pH value of lactide-loaded fibers and lactide-coated fabrics from an "unhealthy" value of over 4.6 to a "healthy" value of 3.8 within a short period of time. A realistic vaginal test model is to be developed in further research projects.

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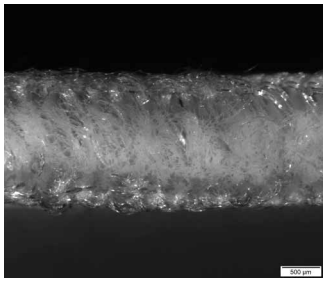
Vacuum insulation elements rethought

Demand-based adjustment of the heat transfer for building envelopes

Adjustable insulating elements can ensure that the heat transfer through the building envelope can be adapted as required. This saves energy for heating or cooling and therefore costs. The heat transfer can be regulated by intelligent systems – depending on the outside temperature and heating or cooling requirements in the interior rooms. The DITF and its partners are developing adaptive building envelopes that can also use concrete components as structural thermal energy storage units for temperature control in buildings.

In the IGF project ReVaD, controllable insulation elements are being developed that utilize the Knudsen effect: The lower the gas pressure in porous structures, the lower the thermal conductivity – if the pressure rises, it increases. A high switching factor between the two states is crucial for a functioning insulating element. To achieve this, the pore system and gas pressure must be precisely matched. The pore system is formed by spacer textiles developed at the DITF. A major challenge is the high compressive rigidity of the filling core, which must hardly give way even at 10 N/cm² in a fine vacuum. The team at the Technology Center Knitting Technique has developed suitable pressure-resistant structures for this purpose. By introducing textured yarns, the pore size is now optimized without significantly increasing the thermal conductivity. A switching factor of 5 has already been achieved and the researchers are currently working on further optimizing the spacer structures and setting up a demonstrator.

In parallel, the DLR is developing a thermochemical reactor component that enables precise and energy-efficient gas pressure control in the panel using metal hydride-hydrogen systems. The IGTE at the University of Stuttgart is conducting simulations and experiments to investigate how the insulating elements can be integrated into wall constructions. Finally, the performance of the controllable thermal insulation will be tested under real conditions using a demonstrator.



Pressure-stable spacer fabrics as textile filling cores for vacuum insulation elements

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Carbowave research consortium

Energy efficiency in carbon fiber production

A new technology uses microwaves and plasma heating for the energy-saving production of carbon fibers. This means that high-strength composite materials can be produced more cheaply and with fewer resources. The DITF are part of the "Carbowave" research consortium, which will improve microwave and plasma-induced carbonization and make it marketable.

The combination of high strength and low weight makes carbon fibers almost irreplaceable in the manufacture of modern lightweight products. As advantageous as the material is, it is complex and energy-intensive to produce: The stabilization and carbonization of the fibers requires slow processing in high-temperature furnaces. Despite the considerable energy input, only a low material yield can be achieved due to the long dwell time in the ovens.

Energy-reduced low-pressure furnace

A completely new process uses microwave and plasma heating to replace the established process of stabilization and carbonization with an energy-saving technology. With this technology, the energy input into the fibers is only localized, thus minimizing energy loss.

A European research consortium has joined forces under the name "Carbowave" to optimize the process. The specific research objectives are the development of an optimal coating for Polyacrilnitril (PAN)-fibers that improves microwave adsorption, the development of a plasma heating system for the oxidative stabilization of the PAN fibers and the development of microwave and plasma technology for the continuous process.

The DITF are responsible for the implementation in continuous production processes and for the implementation on pilot lines on a pilot plant scale. The stabilization of the precursor fibers with plasma technology is the central task of the DITF in the joint project. The combination of plasma and low-pressure technology is also being implemented in order to reduce energy consumption in the stabilization process.

In terms of the circular economy, the Carbowave project includes the recycling of carbon fibers: The new process technologies should also allow microwave-assisted decomposition of carbon fiber composites (CFRP). "Carbowave" thus provides a holistic approach that includes both the production and recycling of modern lightweight materials.

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DITF successfully evaluated

Experts praise scientific excellence and proximity to industry

A commission of experts from science and industry has evaluated the Innovation Alliance Baden-Württemberg (innBW) with its 12 institutes – including the DITF – on behalf of the state government. The evaluation focused on assessing the quality and success of the research and transfer work of innBW as a network and the individual member institutes. Among other things, the technology portfolio, organizational structure, performance, financing model and orientation towards future markets were examined.

In the final report for the DITF, the experts emphasized the outstanding scientific performance and high relevance of the DITF for the innovative strength of Baden-Württemberg's companies. The uniqueness of the DITF's ability to map the entire process chain of textile production and development was explicitly acknowledged.

The institute's strategy is excellently aligned with the needs of the industry. With its research focus, the DITF not only address traditional textile markets, but also to a large extent markets for technical textiles, in which the use of fiber-based materials can be seen as an "enabling technology".

A particular strength of the DITF is its transfer competence and proximity to industry, which is impressively demonstrated by numerous key figures such as the number of business contracts and the number of partners in public collaborative projects: 81 percent of direct business contracts are awarded to small and medium-sized enterprises (SMEs), 52 percent of which come from Baden-Württemberg. In public funding programs, the majority of project participants from industry are SMEs.

In order to significantly increase the impact of research and development activities, the expert commission recommends, among other things, an increase in basic funding of around one third, similar to the Fraunhofer model.

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Fiber chart in the webshop

The completely revised Denkendorf fiber chart has been available in the DITF webshop since July – as a poster and for digital use. The fiber chart provides an overview of all important fibers of natural and synthetic origin in SEM, microscope and fiber array images as well as a force-elongation diagram for each. It covers a total of 40 fibers and provides information on 80 properties for each. It describes the chemical properties with key characteristic values such as specific strength, elongation or hysteresis. Relevant brand names complete the picture and enable reliable orientation when selecting materials for various products.

The Denkendorf fiber chart has a long tradition and has been a household name in the textile world for decades. It is well known to a large number of textile professionals from studies or practical application. The first edition was published back in 1970, compiled by Denkendorf laboratory heads and scientists in close cooperation with manufacturers and users. The selection and compilation of the fiber data was based on their many years of testing experience, their involvement in standards committees and their practical knowledge from many industry contacts.

In 2024, the laboratory heads and scientists at the DITF created a complete update of the Denkendorf fiber chart. As before, the fiber chart is available as a 140 x 120 cm poster.

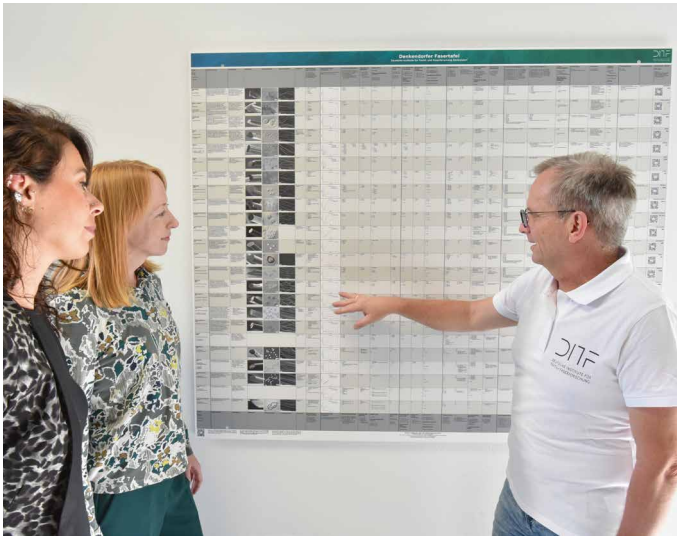
In addition to the chart, publications on research results and tickets for specialist events can be purchased in the DITF webshop. Please feel free to take a look: store.ditf.de.

Functionalization Forum

On 28 January 2026, Hohenstein, DITF and AFBW will host the annual Functionalization Forum, this time in Hohenstein. The event deals with current developments in the functionalization of textiles and is aimed at developers and managers from management, product and quality management and marketing. The focus of the Forum 2026 is on innovative materials, sustainable technologies and the functionalization of textiles for personal and military protective equipment. Current research results, test systems, trend analyses and new areas of application will be presented.

Denkendorf Innovation Day

The annual Denkendorf Innovation Day will take place on February 26, 2026, offering inspiration for textile product developments and new manufacturing processes. With presentations on current research projects and a tour of the pilot plants and laboratories, DITF scientists provide information on a wide range of topics from molecules to materials and from raw materials to finished products. They will provide an insight into their work and invite visitors to transfer knowledge and research. Registration via the website ditf.de.



Fairs & Events

January 28	Forum Functionalization, Hohenstein – Cooperation DITF, Hohenstein, AFBW
February 09 – 12	World Health Expo, Dubai – DITF and ITVP at the bw-i joint stand
February 23 – 25	EnforceTac 2026, Nuremberg – DITF at the bw-i joint stand
February 26	Denkendorf Innovation Day, Denkendorf – DITF event
March 04 – 05	SMART TEXTILES user forum, Zeulenroda – DITF stand and presentations
March 10 – 12	JEC World, Paris – DITF at the bw-i joint booth
March 25 – 27	38th Cotton Exchange, Bremen – DITF presentation
April 21 – 24	TechTextil, Frankfurt – DITF at the bw-i joint booth
May 19 – 22	Index, Geneva – DITF stand
June 27	Science Day, University of Stuttgart – DITF stand

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