RESEARCH HIGHLIGHTS

DEUTSCHE INSTITUTE FÜR TEXTIL- UND FASERFORSCHUNG DENKENDORF

DITF REPORT

April 2024 – No. 1

Techtextil – Beyond innovation.

Visit us at the Frankfurt trade fair – Hall 12.1 Stand D 50

Diversity, synergy, inspiration – that's what Techtextil 2024 promises its visitors. The DITF are looking forward to presenting its R&D project results at the trade fair event from April 23 to 26.

At Techtextil, the leading international trade fair for technical textiles and nonwovens, the DITF will be partners at the Baden-Württemberg joint stand for the fifth time, and participants will benefit from the intensive exchange with each other and the extended networking with new interested parties. Together with 17 textile companies from Baden-Württemberg and the AFBW, the DITF present their development work and new products here. The joint trade fair appearance has proven to be very successful in recent years. After all, everyone involved benefits from the intensive exchange with each other and the extended networking with new interested parties.

At the trade fair, the DITF will be providing information on new developments along the entire textile value chain. As in previous years, there will be a wide variety of topics. Projects from the following areas will be presented: smart cycles, health, pneumatic textiles, fabrics with integrated light guides and textile pressure sensors, ceramic fibers, self-cooling surfaces, lignin coatings for geotextiles and protective gloves, bio-based and biodegradable nonwovens and sound insulation. Selected exhibits represent the five research fields of the DITF, which have been redefined as part of Strategy Development 2026: New materials, lightweight construction, health, sustainability and digitalization. As was the case at last year's ITMA, the latter two research fields are the focus of many research projects due to the digital transformation process and he enormous challenges posed by climate change or are taken into account as an indispensable aspect of almost all developments. While technical innovations for higher productivity, greater effectiveness and flexibility have been the main focus for years, the thematic priorities have now shifted significantly. As part of the knowledge transfer at the trade fair, the DITF will also be presenting at the Techtextil Forum and holding four lectures on the topics of "Self-cooling textiles", "Lignin", "CO_2 Calculation" and "Biodegradable nonwovens".

The DITF will be exhibiting at Techtextil in Frankfurt from April 23 to 26

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Baden-Württemberg Lightweight Construction Alliance

At the beginning of 2024, the "Lightweight Construction Office for Baden-Württemberg" was set up on behalf of and with the support of the state. As the Lightweight Construction Alliance BW, it is the central point of contact for all stakeholders in the field of lightweight construction and represents their interests at national and international level. Professor Markus Milwich from the DITF represents the office. More information on page 7.

Professor Dr.-Ing. Markus Milwich

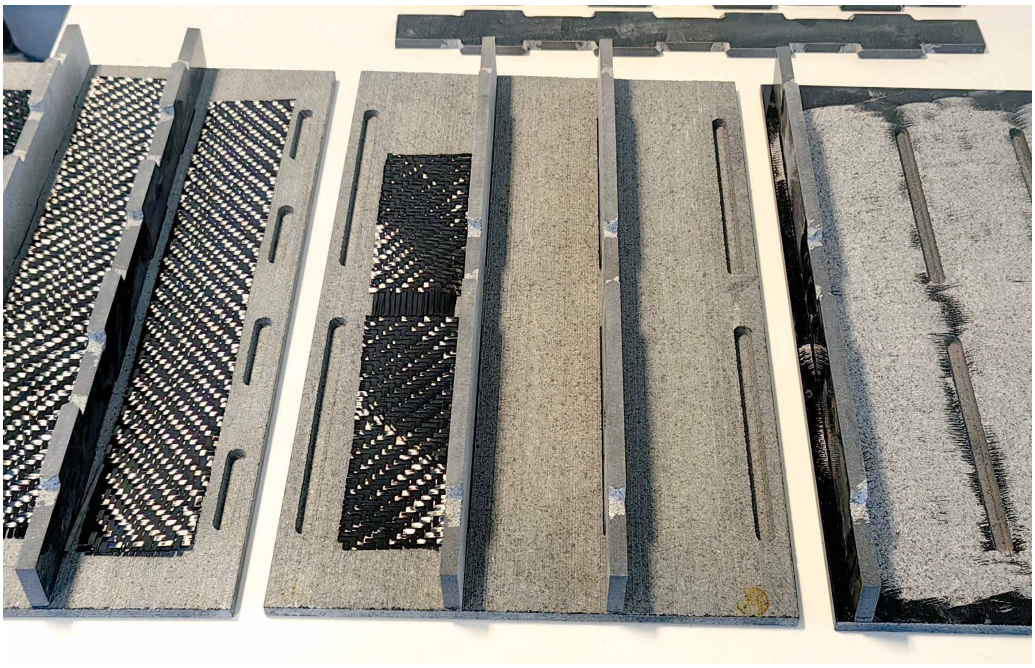
"DACCUS-Pre": CO_2-negative construction

New composite material as an alternative to reinforced concrete

A new composite material is finding its way into the construction industry. Made from natural stone, carbon fibers and biochar, it is an alternative to reinforced concrete. It is characterized by a particularly good CO_2 balance.

The DITF are leading the joint project "DACCUS-Pre*". The basic idea of the project is to develop a new building material that stores carbon in the long term and removes even more CO_2 from the atmosphere than is released during its production. In collaboration with the company TechnoCarbon Technologies, the project is now well advanced – a first demonstrator has been realized as a house wall element. This consists of three materials: Natural stone, carbon fibers and biochar. Each individual component contributes to the negative CO_2 balance of the material in a different way:

Fully assembled wall element



Assembly of the wall element

1. Two slabs of natural stone form the visible walls of the wall element. The mechanical processing of the material, sawing in stone cutting machines, produces significant quantities of stone dust. This is very reactive due to its large specific surface area. Silicate weathering of the rock dust permanently binds a large amount of CO_2 from the atmosphere.
2. Carbon fibers in the form of technical fabric reinforce the side walls of the wall elements. They absorb tensile forces and are intended to stabilize the building material in the same way as reinforcing steel in concrete. The carbon fibers used are bio-based, made from biomass. Lignin-based carbon fibers, which have been technically optimized at the DITF for a long time, are particularly suitable for this application: they are inexpensive due to low raw material costs and have a high carbon yield. In addition, unlike reinforcing steel, they are not susceptible to oxidation and therefore are considerably more durable. Although carbon fibers are more energy-intensive to produce than steel, as used in reinforced concrete, only a small amount is required for use in construction materials. As a result, the energy and CO_2 balance is considerably better than for reinforced concrete. By using solar heat and biomass to produce the carbon fibers and the weathering of the stone dust, the CO_2 balance of the new building material is even negative overall, making CO_2-negative construction of buildings possible.
3. The third component of the new building material consists of biochar. This is used as a filling material between the two rock slabs. The coal acts as an effective insulating material. It is also a permanent source of CO_2 storage, which is included in the CO_2 balance of the entire wall construction.

From a technical point of view, the already realized demonstrator, a wall element for constructive building, is well developed. The natural stone used is a gabbro from India, which has a high-quality appearance and is suitable for high load-bearing capacities, as demonstrated in load tests. Bio-based carbon fibers serve as the top layers of the stone slabs. The biochar from Convoris GmbH is characterized by particularly good thermal insulation values. The CO_2 balance of a house wall made of the new material was calculated and compared with that of established reinforced concrete. This results in a difference in the CO_2 balance of 157 CO_2 equivalents per square meter of house wall. A significant saving!

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* (Methods for removing atmospheric carbon dioxide (Carbon Dioxide Removal) by Direct Air Carbon Capture, Utilization and Sustainable Storage after Use (DACCUS).

Modernization of the melt spinning pilot plant

Spinning sustainable and functional fiber materials

With support from the state of Baden-Württemberg, the DITF have modernized and significantly expanded their melt spinning pilot plant. The new facility enables research into new spinning processes, fiber functionalization and sustainable fibers made from biodegradable and bio-based polymers.

In the field of melt spinning, the DITF are working on numerous pioneering research areas, for example the development of various fibers for medical implants or fibers made from polylactide, a sustainable bio-based polyester. Other focal points include the development of flame-retardant polyamides and their processing into fibers for carpet and automotive applications, as well as the development of carbon fibers from melt-spun precursors.

Also new is the development of a bio-based alternative to petroleum-based polyethylene terephthalate (PET) fibers into polyethylene furanoate (PEF) fibers. Bicomponent spinning technology, in which the fibers can be produced from two different components, plays a particularly important role here. In order to protect the environment and resources, more bio-based fibers should be used in the future and the fibers should be easier to recycle after use. For these future tasks, a bicomponent spinning plant from Oerlikon Neumag was set up and commissioned on an industrial scale at the DITF in January. The BCF process (bulk continuous filaments) allows special bundling, bulking and processing of the (multifilament) fibers. This process enables the large-scale synthesis of carpet yarns as well as staple fiber production, a unique feature in a public research institute. The system is supplemented by a so-called spinline rheometer. This allows a range of measurement-specific chemical and physical data to be recorded online and inline, which will contribute to a better understanding of fiber formation. In addition, a new compounder will be used for the development of functionalized polymers and for the energy-saving thermo-mechanical recycling of textile waste.

Bi-component BCF spinning system from Oerlikon Neumag

The new melt spinning pilot plant at the DITF offers a state-of-the-art and well-equipped environment for the development and application of new materials and man-made fibers.

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Cellulose Fibre Innovation of the Year

Award for the HEREWEAR project

At the "International Conference on Cellulose Fibres 2024" in Cologne, the Nova Institute for Ecology and Innovation awarded first place in the innovation prize to the project partners of the EU-funded HEREWEAR project. They presented a dress made from cellulose fibers that was produced entirely from straw pulp.

The DITF were important project partners and were responsible for the production of the HighPerCell® fibers, the design of the knitting pattern, the knitting production and the manufacture of the dress. In addition, computer scientists and engineers from the DITF created the "Value Chain" and "Digital Twins" for the digital traceability of the production processes. Other project partners were the TNO (Netherlands Organization for Applied Scientific Research), which produced the sustainably produced cellulose, and the fashion label Vretena, which created the design for the dress, which can be knitted without cutting waste.

HEREWEAR is an EU-wide research project in which partners from research and industry have come together. They are working on establishing a European circular economy for locally produced textiles and clothing made from bio-based raw materials.

The HEREWEAR approach includes technical and ecological innovations in the production of fibers, yarns, woven and knitted fabrics and clothing as well as the use of regional value creation structures and the circular development of fashion items. New technologies for the wet and melt spinning of cellulose and bio-based polyesters form the technical basis. In addition, new coating and dyeing processes have been developed and tested. In addition to reducing the product carbon footprint, the reduction of microfiber release within the entire textile manufacturing process and life cycle is a further goal.

The award-winning Flexidress in its various forms

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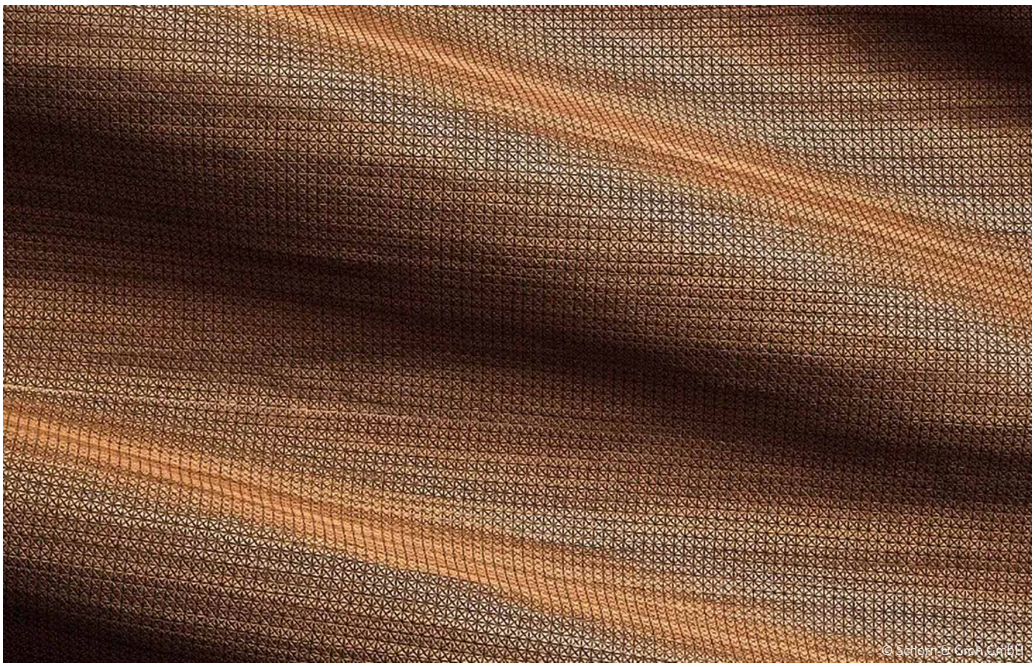
NUO. The world's first soft wood

FlexWood – a highly flexible composite material made from cellulose

Materials made from domestic, renewable raw materials are becoming increasingly attractive as they reduce CO_2 emissions, prevent microplastics from entering the environment and close the material cycle. Based on this market demand, a project consortium with the DITF and the companies Schorn & Groh Karlsruhe and Ribler Stuttgart developed a new decorative material made from natural components.

The composite material "Flexwood" consists of a decorative layer of wood from sustainable forestry in the form of a thin veneer layer and a textile based on cellulose-based natural fibre materials, which is laminated to the back of the wood veneer for stabilization. Previously, polyurethane films or polyurethane dispersions were used to bond the textile and wood veneer in comparable applications. In this project, a sustainable, new solution based on lignin was developed as an adhesive system for the required lamination. Lignin is a waste product of the paper industry.



NUO – a highly flexible composite material from project partner Schorn & Groh GmbH

After lamination, the thin veneer layer is cut into small segments with a laser beam, leaving the underlying textile intact. The fine engraving gives the wood surface its flexibility and pleasant feel. Due to the resulting extreme bending and draping properties, this composite material can be used as a decorative surface and sustainable leather alternative in automotive interiors, interior design, furniture construction, clothing and many other industries and sectors.

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DITF Sustainability Officer

PD Dr.-Ing. Thomas Stegmaier takes on new role

The EU directive on the further development of sustainability reporting (CSRD) poses major challenges for companies and the public sector. Until now, the regulations have only applied to large capital market-oriented companies. However, with the transposition of the CSRD into national law in 2024, far-reaching changes in sustainability reporting are to be expected. The DITF are facing up to this challenge of external reporting and at the same time the responsibility for sustainable and resource-conserving science. The Textile Research Center has therefore set up a staff unit reporting to the Executive Board. The DITF are reaffirming their commitment to sustainability with the appointment of the former Head of the Competence Center Textile Chemistry, Environment & Energy, Dr.-Ing. habil. Thomas Stegmaier, as Chief Sustainability Officer (CSO). In addition to this new role, Stegmaier will continue to provide his expertise to the Competence Center Textile Chemistry, Environment & Energy as Deputy Director.

Dr.-Ing. habil. Thomas Stegmaier

The task of the Chief Sustainability Officer is to develop solutions to reduce the DITF's energy and resource consumption, promote renewable energies and implement efficient energy use. In addition, Stegmaier will act as a driving force for sustainability issues, both for the Executive Board and for the research areas. The DITF management team, the operational organizational units and all employees will be involved in the process. The DITF see these tasks as an important step on the way to becoming an energy-efficient and climate-neutral research institution.

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Project "PapierEvents"

Recyclable event and trade fair furniture made from paper

A lot of waste is generated in the trade fair and event industry. Furniture that can be quickly dismantled and stored to save space or simply disposed of and recycled makes sense. Paper is the ideal raw material here: locally available and renewable. It also has an established recycling process. The DITF and their project partners have jointly developed a recycling-friendly modular system for trade fair furniture. The "PapierEvents" project was funded by the German Federal Environmental Foundation (DBU). Once the paper has been brought into yarn form, it can be processed into a wide variety of basic elements using the structure winding process, enabling a completely new design language. The unusual look is created in the structure winding process. In this technology developed at the DITF, the yarn is deposited precisely on a rotating mandrel. This enables high process speeds and a high degree of automation. After the winding process, the individual yarns are fixed, creating a self-supporting component. A starch-based adhesive, which is also made from renewable and degradable raw materials, was used in the project for the fixation. The recyclability of all the basic elements developed in the project was investigated and confirmed. The research colleagues at the project partner from the Department of Paper Production and Mechanical Process Engineering at TU Darmstadt (PMV) used the CEPI method, a new standard test procedure from the Confederation of European Paper Industries, for this purpose. Sensor and lighting functions were also implemented in a recyclable manner. The paper sensor yarns are integrated into the components and detect contact. A modular system for trade fair and event furniture was developed as part of the project. The furniture is lightweight and modular. For example, the total weight of the counter shown is well under ten kilograms and individual parts can be easily shipped in standard packages. All parts can be used several times, making them suitable for campaigns lasting several weeks.

A counter, a customer highlight in DIN A1 format and a pyramid-shaped stand were used as demonstrators. The research work of the DITF (textile technology) and PMV (paper processing) was supplemented by other partners: GarnTec GmbH developed the paper yarns

Left: Structurally wound paper yarn element with green sensor yarn
Right: Pyramid-shaped display and illuminated counter

used, the industrial designers from quintessence design provided important suggestions for the visual and functional design of the elements and connectors and the event agency Rödig GmbH evaluated the ideas and concepts in terms of usability in practical use.

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Journey into the circular economy

A special tour of the SME Digital Center for Future Culture

In April and May 2024, the Mittelstand-Digital Zentrum Zukunftskultur is offering manufacturing companies from trade and industry a total of six events dedicated to the prospects of the circular economy. The topics range from strategy and design to new technologies such as sensor technology and remanufacturing to questions about energy management in the circular economy. As part of the events, participants will be able to

> get to know the basic principles of circular economy better,
> gain an overview of topics such as business models, innovation, product design and digital support
> try out relevant technologies and
> visit "circular" places and companies.

Workshop of the Mittelstand-Digital Zentrum Zukunftskultur in cooperation with the DITF

The DITF are involved as a cooperation partner in the event series via the Mittelstand-Digital Zentrum Smarte Kreisläufe and is organizing the third day of the event together with Hahn-Schickard. On April 25, 2024, they will provide information on the topic of circular production at ARENA 2036 and hold a workshop on value chain design to explain how design, business models and the positive effects of the circular economy are closely linked. Two presentations by DITF scientists will introduce the topic:

> Dr. Marcus Winkler: Design for circular economy
> Dr.-Ing. Jürgen Seibold: MFCA – Analysis tool for material and energy flows in companies

The target group is primarily specialists and managers from small and medium-sized companies in the manufacturing industry.

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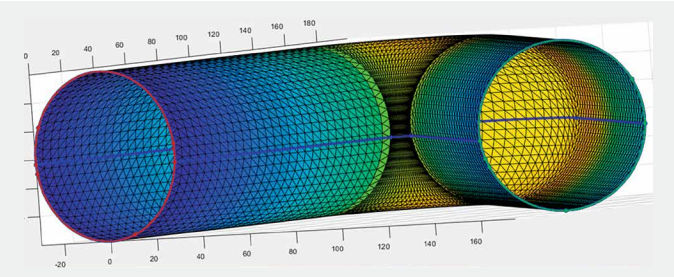
AiF-project AddKnit

3D knitting as an additive manufacturing process for the textile industry

As part of the Addknit research project, the DITF have created a process model for the development of individualized knitted fabrics. This covers all steps from the definition of requirements to the knitted product using the Addknit knitting algorithm. The requirements profile includes all the properties necessary to characterize the finished product. For implementation, a division is made into physical properties of the surface and properties of the 3D model (geometry). The surface properties are taken into account by selecting the material mix and weave. The mesh size depends on the material and weave and is determined in the process model by material tests. To convert the 3D model into a knitted jacquard, a Matlab



3D model visualized in the Addknit software

algorithm was developed in the project for which the stitch size is the essential parameter. The 3D models can be CAD-generated or scanned and must be reduced to the surface to be knitted and adjusted if necessary. Parameters such as elongation, thickness and strength are taken into account via the 3D model. In the Addknit software, the 3D model of the body to be knitted is loaded in the graphical user interface and the boundary conditions are set. The knitting algorithm generates a knitting jacquard, which can be converted into knitting programs using software interpreters from various machine manufacturers. For this purpose, a symbol or color is defined once for each knitting operation in the knitting algorithm and created accordingly in the interpreter.

The knitting program is loaded onto the flat knitting machine and knitted with the appropriate yarn configuration. The knitted product is equipped according to the specifications in the requirement profile and checked for systematic errors such as holes or stitch accumulations. The accuracy of fit of the product to the original 3D model is also checked. Optical methods such as comparative 3D scans can be used for this purpose. The results of the project will be presented at the SME Innovation Day of the Federal Ministry for Economic Affairs and Climate Protection on June 13 in Berlin.

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JEC Composites Innovation Award

Hermann Finckh honored for "Extreme-Lightweight" development

Hermann Finckh received the prestigious JEC Composites Innovation Award in the Equipment Machinery & Heavy Industries category. The Deputy Head of the Competence Center Staple Fibers, Weaving & Simulation at the DITF and his team in the field of simulation were honored for their innovation for maximum mass reduction of cutting tools. Specifically, the project involves the development of a modular planer head made of carbon fiber-reinforced plastic (CFRP) for woodworking machines. A valuable industrial partner in the development was the company Leitz from Oberkochen, which manufactured the tool from the DITF's CFRP parts and successfully tested it.

Award-winning planer cutter in extremely lightweight design

Instead of "just" replacing as much metal (high-strength aluminum) as possible with CFRP, the new planer head is based on a completely new, modular design principle that makes the "extremely lightweight construction" possible in the first place. Here, CFRP triangular elements on the inside bear the high centrifugal load and the CFRP outer shell absorbs the bending and torsional moments. High-precision CFRP rods from CG-TEC in Spalt connect the components. This best possible use of the potential of the carbon fibers leads to maximum rigidity and strength of the tool. It weighs at least 50 % less than conventional tools and enables at least 50 % higher operating speeds with up to a 1.5-fold increase in production.

The development of the "Extreme-Lightweight" solution principle was carried out with the help of numerical simulation. Each development step was tested virtually for its suitability and limits. A patent application was filed for the principle. The basis for the award-winning prototype was provided by the joint IGF project 20128N (DITF/IfW, University of Stuttgart), which was submitted via the FKM, Forschungsplattform Holzbearbeitung e.V. (FPH) and funded by the BMWK.

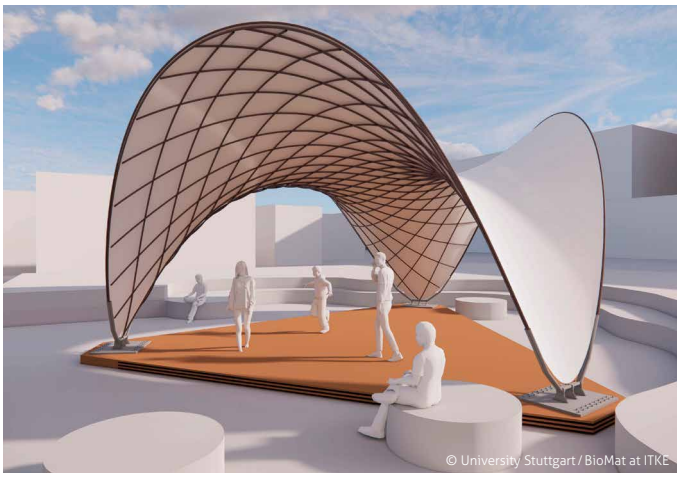
Hermann Finckh (DITF) and Andreas Kisselbach (Leitz GmbH & Co. KG)

Lightweight Construction Office for BW

Markus Milwich represents the "new contact point"

Lightweight construction is a key technology for the energy transition and for sustainable business. Following the dissolution of the state agency Leichtbau GmbH, a consortium consisting of the Alliance of Fiber-Based Materials (AFBW), the Lightweight Construction Center Baden-Württemberg (LBZ e.V.-BW) and Composites United Baden-Württemberg (CU BW) now represents the interests of the lightweight construction community in the state. The "Lightweight Construction Office for Baden-Württemberg" was set up for this purpose on behalf of and with the support of the state. As the Lightweight Construction Alliance BW, it is the central point of contact for all stakeholders in the field of lightweight construction and represents their interests at national and international level. Professor Markus Milwich from the DITF represents the office.

The use of lighter materials in combination with new production technologies significantly reduces energy consumption in transportation, the manufacturing industry and the construction sector. As a cross-sectional technology, lightweight construction covers everything from production and use to recycling and reuse. The aim of the state government is to establish Baden-Württemberg as a leading provider of innovative lightweight construction technologies in order to strengthen the local economy and secure high-quality jobs. Among other things, the "Lightweight Construction Alliance Baden-Württemberg" will continue the nationally renowned "Lightweight Construction Day", which acts as an important source of inspiration for a wide range of lightweight construction topics in business and science. Professor Milwich is a long-standing expert in the field of lightweight construction with an excellent network beyond the state's borders. In his role, Milwich also represents the state of Baden-Württemberg on the Strategy Advisory Board of the Lightweight Construction Initiative of the Federal Ministry of Economics and Climate Protection, which supports the cross-technology and efficient transfer of knowledge between the various nationwide players in lightweight construction and serves as a central point of contact for entrepreneurs nationwide for all relevant questions. From 2005 to 2020, Milwich headed the Fiber Composite Technology research department at the DITF, which was integrated into the Competence Center Polymers and Fiber Composites in 2020. He is also an honorary professor at Reutlingen University, where he teaches hybrid materials and composites. "Lightweight construction is essential for sustainability, environmental protection and resource conservation. I want to make this clear in research and teaching and now also as a representative of the lightweight construction community in Baden-Württemberg," emphasizes Milwich.



LeichtPRO research project: Future-oriented, sustainable architecture

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Important voice in R&D for ceramic fibers

Dr. Stephanie Pfeifer elected to the board of CU Ceramic Composites

"Ceramic Composites" is an association of companies and research institutions in the field of ceramic composites. The network is a sub-organization of Composites United e.V. (CU). The mission of the "Ceramic Composites" department is to promote the industrial use of fiber-reinforced ceramics in mechanical and plant engineering and in the mobility and energy sectors and to support their sustainable use. Representatives of the DITF Competence Center for High-Performance Fibers have been active in "Ceramic Composites" for many years and contribute their expertise in the field of oxide ceramic fibers. At the general meeting on 14 March 2024, Dr. Stephanie Pfeifer, Project Manager R&D at the Competence Center High-Performance Fibers Ceramic Fibers, was elected to the five-member board. This means that the DITF now have an important voice in the association and can help shape the strategic direction and networking of "Ceramic Composites" even more effectively than before. Stephanie Pfeifer's many years of successful commitment to the research and development of ceramic fibers are honored by her election to this group of experts. The DITF's expertise in lightweight construction is also reflected in this news item in addition to the article above.


Dr. Stephanie Pfeifer

DITF at drupa

Together with international partners from industry and research, the DITF will be presenting the Digital Textile Micro Factory at the touchpoint textilederdrupa. A fully networked on-demand production of sports products will be presented – from virtual design to the finished product. As a special highlight, production takes place in a continuous process with a material buffer and robot-assisted sorting for minimal manual interaction. During production, the carbon footprint of the manufactured products is determined and illustrated in the process shown. The Micro Factory serves as a source of inspiration for the printing and textile industry to manufacture sustainable products in a more targeted and faster way in future, tailored to customer requirements and trends. drupa is the world's leading trade fair for the printing industry and the meeting place for the international print & packaging community. In this community, digital textile printing is becoming increasingly important.
It will take place from May 28 to June 7, 2024 in the Düsseldorf exhibition halls.

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AACHEN DRESDEN DENKENDORF
INTERNATIONAL **TEXTILE** CONFERENCE

ADD ITC in Stuttgart

The Aachen-Dresden-Denkendorf International Textile Conference will take place in Stuttgart again this year. On November 21 and 22, 2024, the DITF and their partners from Aachen and Dresden are inviting you to the Kultur- und Kongresszentrum Liederhalle. With parallel lecture sessions, the conference will focus on current research projects and developments in a broad range of topics and of industrial relevance. Experts from the fields of textile chemistry, finishing and functionalization, textile mechanical engineering and composites will give presentations on topics such as the circular economy and recycling, fibre composites and lightweight constructions, medicine and health. Under the title "From the idea to practice", a Transfer session Innovations that have been successfully transferred from research collaborations to industry. The call for papers runs until April 30, 2024, so please send in your proposals! This year's partner countries are Belgium, the Netherlands and Luxembourg.

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Open day

Research up close – visitors can experience this at the Open Day on July 14, 2024 in Denkendorf. For the fourth time, the DITF will be opening their laboratories and pilot plants and inviting visitors on a voyage of discovery through the world of textile research. From 10:00–16:00, anyone interested can look over the shoulders of the scientists at work. In short lectures, guided tours through the research center and hands-on stations for children, the DITF will provide information about their main areas of work and the highlights of their research. A variety of exhibits and demonstrations invite visitors to try out, study and marvel. Textiles have long been much more than just clothing. Modern fibers play an important role in all future topics such as medicine, mobility, architecture, the environment and energy. This will be clearly demonstrated at the open day.

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Fairs & Events

April 22 – 26	Hannover Messe – DITF presentation
April 23 – 26	Techtextil Frankfurt a.M. – DITF at the BW_i joint stand
April 25	Journey into the circular economy (part 3) from the series of the Mittelstand-Digital Zentrum Zukunftskultur, Arena 2036 Stuttgart or digital – DITF organization and presentations
May 16	CRC1333 Minisymposium on „Catalysis under Confinement", Stuttgart – University of Stuttgart
May 28 – June 07	drupa, Düsseldorf – DITF Digital Textile Micro Factory
June 05 – 06	Week of the Environment, Berlin – DITF Exhibition
June 08	Science Day, University of Stuttgart – DITF stand
June 13	Innovation Day for SMEs of the BMWK, DITF Demonstrators exhibition
June 18 – 20	MedtecLIVE with T4M, Stuttgart – DITF at the VDMA joint stand
July 14	Open Day – DITF Denkendorf
September 12 – 13	DORNBIRN GFC 2024 – DITF DITF booth and presentations

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