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Annual Report 2023

#WeKnowWood



Annual Report 2023

Research for
sustainability
and quality of life



Greeting

Dear customers, colleagues, and friends,

This annual report summarizes the achievements of Fraunhofer WKI during 2023. The report is written in a concise form; detailed information can be found on our website. WKI further developed in 2023 and we were able, at least partially, to offset negative consequences resulting from the conflict in Ukraine and loss of customers in Russia. Despite these challenges, we were able to finish the year with positive numbers and belong to the top institutes within the Fraunhofer-Gesellschaft.

We have continued making investments and established a new area of structural adhesion, which is still under development. We are in the process of acquiring a special conditioning

chamber that will enhance our capabilities in testing structural adhesives.

The planning of our new pilot plant proceeded slowly, but surely, and we hope to start the construction of necessary parking spaces this year. We are in the process of building a particle and fiber analysis laboratory that will give us the capabilities of quantifying geometry parameters of materials. Our research portfolio is focused on renewable resources, and our decades of experience makes us unique not only within the Fraunhofer family of institutes but also worldwide. With great success, we have displayed our results at LIGNA, the largest wood technology show in the world.

Our departments develop in a sustainable manner and we were able to hire a number of talented young staff, many of whom are female. As a public institution, we are hindered by enormous bureaucracy that limits our ability to react quickly, invest timely, acquire equipment in a timely fashion, and serve our staff efficiently. It is my hope that this situation will change for the better.

We were able to secure significant projects within the European Community. The aim of the »Upgrade of the Centre of Excellence LignoSilva« project, funded by the European Union, is to strengthen both scientific excellence and international research contacts. We will provide support as a mentor in the coming years. Following the successful establishment of the InnoRenew CoE in Slovenia, we are now the first institute within the Fraunhofer-Gesellschaft whose director has been selected as a mentor for two major EU projects aimed at establishing research centers abroad. This significantly enhances the international reputation of the Fraunhofer WKI.

We have continued serving our industry partners and customers by delivering high quality solutions and services. This is of vital importance to our future and I would like to thank all of you for your continued support. Most of all, I would like to thank all my staff for their professionalism, dedication, and excellent performance, which is not only motivating but rewarding as well.

Sincerely,

Prof. Dr.-Ing. Bohumil Kasal
Director of the Fraunhofer WKI

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Tailor-made wood-fiber insulation materials for building construction

In keeping with the energy transition:
Sustainable beech-wood fiber insulation materials as filling for thermal-insulation bricks » Page 19.

Institute with Profile

Sustainability has formed the focus of the Fraunhofer WKI since its foundation in 1946.

The founder and eponym, Dr. Wilhelm Klauditz, sought solutions for the optimal exploitation of raw wood - a commodity which had become scarce as a result of the second world war - as well as for the technical utilization of waste wood and small-diameter wood. He is regarded as a co-founder of the modern wood-based materials industry.

Today, at the Fraunhofer WKI, we study a wide range of renewable raw materials and their holistic utilization from production through to recycling. One particular focus is thereby directed at sustainable lightweight construction solutions. Our holistic research approach also encompasses the development of material recycling processes, life cycle analyses, indoor air analysis, and other.

Virtually all the procedures and materials resulting from the research activities are applied industrially. Customers of the Fraunhofer WKI include companies from the wood and furniture industries, the construction industry, the chemical industry, the packaging industry and the automotive industry.

With its research and development activities, the Fraunhofer WKI makes an important contribution towards the development of a bio-based recycling economy (bioeconomy).

As an accredited testing body, the Fraunhofer WKI performs material-testing and quality monitoring tasks. It assesses cases of damage and provides advice on questions of damage remediation. The quality assurance of wood products and other materials by means of non-destructive procedures such as thermography, ultrasound or computer tomography enhance the institute's spectrum.

With the HOFZET® Application Center and the integration into the Open Hybrid LabFactory, the important and promising new field of fiber composites is currently being systematically augmented and expanded. In collaboration with the Technische Universität Braunschweig, the ZELUBA® Center for Light and Environmentally-Friendly Structures is reinforcing the subject areas of building construction and lignocellulose-containing materials.

Since October 2010, the Fraunhofer WKI has been headed by Professor Dr.-Ing. Bohumil Kasal. Professor Dr. Tunga Salthammer acts as his deputy. The institute was incorporated into the Fraunhofer-Gesellschaft in 1972 and, with currently around 160 permanent employees and an operating budget of ca. 18,2 million euros, is one of the largest institutions for applied wood research in Europe. Around 9,000 m² of offices, laboratories, technical center and workshops are available.

The Fraunhofer WKI is a member of the Fraunhofer Group MATERIALS, the Building Innovation Alliance, and the Fraunhofer networks "Sustainability" and "Science, Art and Design". Furthermore, the Fraunhofer WKI is a member of the Cultural Heritage Research Alliance, the Fraunhofer Research Field Lightweight Construction, the Research Area Technical Textiles, and the Business Unit Vision.



Facade area of the main building of the Fraunhofer WKI in Braunschweig.

Self-Perfection

Vision

Our vision is a globally successful research institute which addresses current and future issues concerning renewable raw materials in a customer-oriented manner whilst taking into account the socio-economic and ecological challenges.

Mission

We develop technologies and products and provide services for the responsible use of renewable resources, taking into account environment-related interactions and a sustainable improvement in the quality of life.

Sustainability

Since its foundation in 1946, the Fraunhofer WKI has been conducting applied research, the results of which are then utilized to develop new materials, products, services and technologies in collaboration with industry. These developments are focused on renewable resources and their sustainable use. The aim is an improvement in product

quality and safety as well as an increase in the competitiveness of our industrial partners. We strive to establish a long-term cooperation based on partnership.

In addition to the most important renewable raw material wood, the institute investigates numerous other lignocellulosic materials. These are, in all facets, key materials for a sustainable development and the solution of ecological and socio-economic challenges - from chemical applications, through industrial use, and on to recycling.

The effective utilization of complex materials requires highly specialized knowledge, the scope of which encompasses many disciplines of natural and engineering sciences.

The Fraunhofer WKI is the research institution in which the complexity of renewable raw materials is systematically documented and processed in the most diverse facets and interactions. This is the fundament which enables the WKI to occupy a leading position in research and development today.

Since
1946
in the pursuit of
sustainability.

Organization Chart

Institute Management

Director	Prof. Dr.-Ing. Bohumil Kasal Phone +49 531 2155-211 bohumil.kasal@wki.fraunhofer.de
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Center for Light and Environmentally-Friendly Structures ZELUBA®	Prof. Libo Yan Ph. D. Phone +49 531 120496-14 libo.yan@wki.fraunhofer.de
Application Center HOFZET®	Prof. Dr.-Ing. Andrea Siebert-Raths Phone +49 511 353248-11 andrea.siebert-raths@wki.fraunhofer.de

Infrastructure Services

General Administration	Dipl.-Wirt.-Ing. Ulrike Holzhauer
Information Technology	Andreas Schlechtweg
Technical Services	Dipl.-Ing. (FH) Stephan Thiele

Board of Trustees

The Board of Trustees of the Fraunhofer WKI, which consists of qualified scientists and experts from industry, authorities and institutions, examines the research activities and advises the Institute's Management as well as the Executive Board of the Fraunhofer-Gesellschaft.

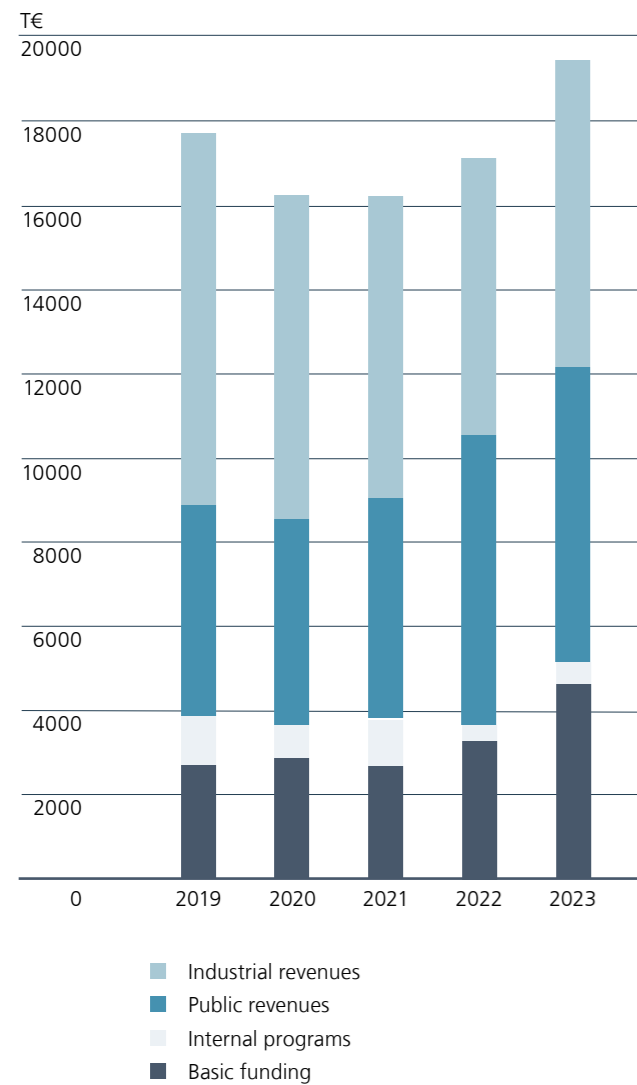
Dr. Markus Boos Remmers GmbH, Lönigen	Prof. Dr. Andreas Krause Thünen-Institut für Holzforschung, Hamburg
Christine Dübler ZwickRoell GmbH & Co. KG, Ulm	Karl-Robert Kuntz elka-Holzwerke GmbH, Morbach
Dorothee Flötotto Sauerländer Spanplatten GmbH & Co. KG, Arnberg	Larissa Kuntz, M. Sc. elka-Holzwerke GmbH, Morbach
Dipl.-Ing. Hubertus Flötotto (Deputy Chair) Sauerländer Spanplatten GmbH & Co. KG, Arnberg	Dr. Klaus Merker Niedersächsische Landesforsten, Braunschweig
Prof. Dr. Eva Frühwald Hansson Lund University, Faculty of Engineering, Sweden	Prof. Dr. Holger Militz Georg-August-Universität Göttingen, Wood Biology and Wood Products, Forest Sciences and Forest Ecology
Dipl.-Ing. Kai Greten (Chair) Gronau (Leine)	Prof. Dr. rer. nat. Klaus Richter Chair of Wood Science - Holzforschung München Technical University of Munich
Prof. Dr. Joachim Hasch SWISS KRONO Tec AG, Luzern, Switzerland	Anemon Strohmeier Verband der Deutschen Holzwerkstoffindustrie e. V., Berlin
Dr. Jörg Hasener Fagus-GreCon Greten GmbH & Co. KG, Alfeld (Leine)	Prof. Dr.-Ing. André Wagenführ TU Dresden, Institute of Natural Materials Technology, Chair of Wood Technology and Fibre Materials Technology
Dr. Frank Herrmann Pfleiderer Deutschland GmbH, Neumarkt i.d.OPf.	Dr. Stephan Weinkoetz BASF SE, Ludwigshafen
Dr. Sebastian Huster Ministry for Science and Culture of Lower Saxony, Hanover	MR'in a. D. Dr. jur. Birgit Wolz Bonn
Prof. Dr. Angela Ittel Technische Universität Braunschweig	Werner Zimmermann Rhenocoll-Werk e. K., Konken
Dr. Helge Kramberger Dr.-Robert-Murjahn-Institut GmbH, Ober-Ramstadt	

Status: December 2023

Germany, unless otherwise stated.

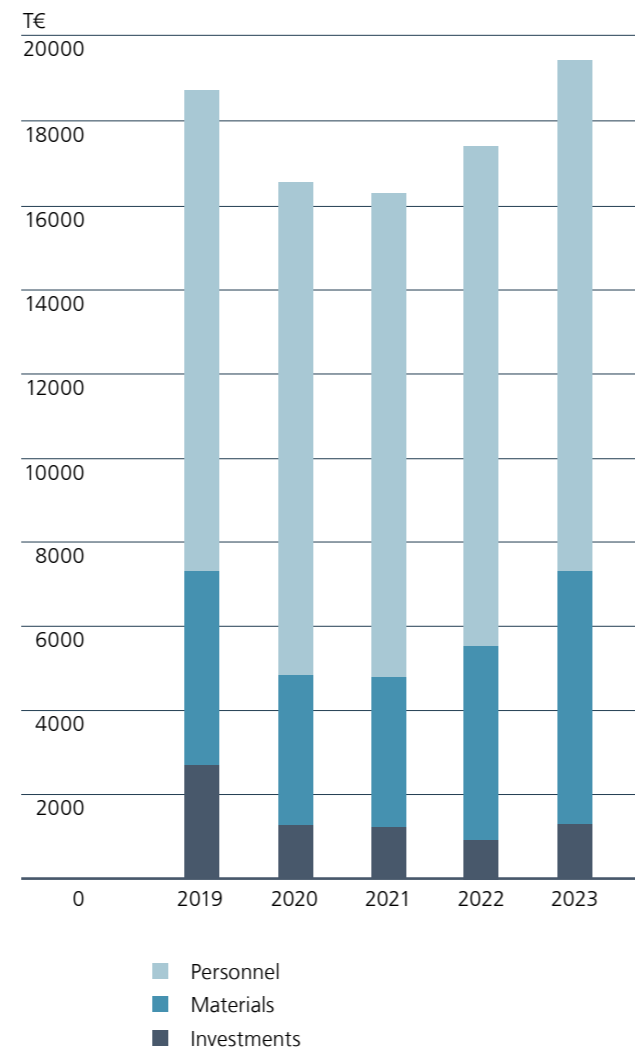
Figures | Data | Facts

Revenue Structure



In 2023, a total of € 14.3 million in external income was realized. Just over 50 % of the WKI's income is financed through industrial contracts; € 7 million was generated through public funding within our research projects.

Budget and Investments



In the reporting year 2023, the operating budget was just over € 18.2 million. Personnel expenses amounted to € 12.2 million, while material costs totaled € 6 million. The investment budget amounted to a total of € 1.3 million.



Locations

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Staff



In the reporting period, the Fraunhofer WKI employed around 160 staff, 30 percent of whom were scientists, engineers and doctoral students. 70 % of the employees come from the professional fields of technology, laboratory, administration and information technology. In addition, bachelor and master students and student assistants are employed to support the

research work carried out at the institute. The Fraunhofer WKI offers apprenticeships in the fields of IT specialist, office communication, and industrial and wood mechanics, as well as in the area of media and information services.

Innovative Fields of Research

Laminated-material bridge

Sustainable alternative to concrete bridge construction

- Free-form pedestrian bridge made of hybrid materials: hardwood veneers manufactured in combination with fibers in a special vacuum-drying and infusion process
- Lightweight wooden-bridge construction demonstrates possibilities for introducing renewable raw materials into future-oriented and durable applications



**The longest bridges are found
between words and deeds.«**

Ernst Ferstl

Fraunhofer
WKI

Technology for Wood and Natural Fiber-Based Materials

Composites made from wood and other lignocellulosic raw materials have a unique character: They are environmentally-friendly, degradable and exceptionally functional.

In the "Technology for Wood and Natural Fiber-Based Materials" department, we address the development of composite materials, the recycling of waste wood and biocomposites (WPC), and image-processing methods for process and quality control. The spectrum of our material developments ranges from classic wood-based materials (particle board, fiberboard, insulation board, OSB, plywood, LVL) through hybrid materials and on to biocomposites, 3D molded parts and material composites.

For the preparation and production of the materials and for the application of the binders, technical facilities are available which offer a direct industrial orientation. This allows us to map the complete process chains from raw commodity through to material.

In addition to the further development and optimization of existing process technologies and the combination of positive properties in the material production, we also perform testing on formaldehyde-free binders, bonding and modification processes. Our portfolio is completed through new sorting processes and utilization methods for an efficient recycling of waste wood, WPC and their coatings and constituents as well as non-destructive measuring and testing methods.

Head of Department

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Material Analysis and Indoor Chemistry

In the department "Material Analysis and Indoor Chemistry", we comprehensively address the measurement and evaluation of indoor air contaminants and consumer-related products. The spectrum of materials investigated ranges from classic wood-based materials, through plastics and building products, and on to products from the automotive, consumer goods, electronics, aircraft and food industries.

The development of new analysis and sampling techniques, olfactory examination methods and the construction of emission test chambers and cells are further important areas of our work. We address questions concerning indoor hygiene and room climate with respect to the environment, health and consumer protection. We investigate and evaluate real indoor environments in private and public buildings, educational and recreational facilities, and modes of transportation, including consideration of the air quality in display cases and in museum collection rooms. We measure and model the size and distribution of particles and bio/aerosols in indoor air and investigate the efficiency of air-purification devices. Furthermore, we develop model systems with the help of which the complexity of indoor areas and the resulting air hygiene can be calculated in dependence on widely differing parameters (climate, materials installed, chemical-physical reactions).

Current main topics concern the influences of short- and long-term climatic changes on indoor air quality for the Central European region, and the correlation between building-product emissions and indoor air quality. We contribute our expertise to the relevant bodies. Furthermore, we cooperate with numerous research institutions – both in Germany and abroad – within the framework of scientific exchange programs.

Head of Department

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Binders and Coatings

With a commitment to the environment, in our “Binders and Coatings” department we develop bio-based coatings, adhesives, printing inks and 3D-printing materials derived from vegetable oils, sugars, lignin and other vegetable residues. From binder synthesis, through formulation and on to processing, we are at your side as a competent research partner.

Wood hereby also forms the focal point for us. In addition to the development of wood coatings which protect wood from environmental influences, wear and fire, we also develop binders for adhesives used in the bonding of wood and other materials as well as in the production of wood-based materials. Connected to this is damage analysis, which involves rapid and unequivocal clarification of damage cases in coated woods, wood adhesives, wood-based materials and solid woods.

Our bio-based binders are also deployed in the field of printing inks and additive-manufacturing processes. In the printing-ink sector, we primarily substitute health-endangering ink constituents for diverse printing processes. For additive manufacturing, we develop novel polymeric materials for UV-curing and thermoplastic processes.

Standardized tests, damage analyses and the development of methods for the assessment and optimization of the weathering resistance of materials round off our profile.

Head of Department

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Quality Assessment

With its three core areas of “Testing, Monitoring, Certification”, “Research and Development” and “Knowledge Transfer”, the QA department expresses its versatility. The focus is thereby directed towards the topics of “Structural Bonding”, “Wood-based Materials” and “Formaldehyde”.

The QA department is a nationally and internationally recognized testing, monitoring and certification body. In addition to the certification and monitoring bodies “Wood-based materials and solid wood”, “Timber construction” and “Elements”, the focus of the testing bodies is on all adhesives for load-bearing timber construction, mechanical properties and the determination of formaldehyde in wood and wood-based materials. In addition to this, we offer our customers the possibility of proof of suitability for the bonding of load-bearing timber components, which includes operational testing and construction-site monitoring in accordance with DIN 1052-10 and which is supplemented by damage analyses, tests and expert reports.

The expertise of our scientists creates the basis for the R&D activities in the department regarding “Structural bonding and mechanics” and “Formaldehyde testing methods”. The focus here is on the assessment and evaluation of bonding and bonding processes in load-bearing timber construction, as well as the optimization and new development of hybrid materials with wood or on the basis of wood.

The **WKI | AKADEMIE**® offers courses on “Bonding in wooden construction” and “Repair of bonded load-bearing timber components”. Participants are thereby able to prove their professional suitability or the special expertise required in order to perform the relevant activities. The portfolio furthermore includes established training courses on topics such as “Grading of sawn timber” and “Formaldehyde testing methods”. Individual training requests can also be accommodated.

Head of Department

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Center for Light and Environmentally-Friendly Structures ZELUBA®

At the “Center for Light and Environmentally-Friendly Structures ZELUBA®”, we develop sustainable solutions for the construction industry. We provide industrial partners from the wood-based materials, construction and manufacturing industries, as well as companies from the skilled trades, with support in the development of new building materials and components.

One of our major competences is the transfer, within the construction industry, of fundamental research, through to applied research, and on to the finished product.

With the addition of building physics and mechanical-constructive research methods as well as the consideration of the complete life cycle of a product, our spectrum ranges from the development of innovative materials, through the complex issues of individual details, and on to entire building-material systems and their recycling.

A further research focus is the development of reactive fire-protection systems for the improvement of building-material behavior and the fire resistance of building elements and structures, as well as the development of hybrid building-material systems.

Furthermore, we also focus on advanced computer modeling, structural dynamics and vibrations.

Wood and other renewable raw materials form the primary focus of our activities.

Head of Department

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Application Center HOFZET®

The aim of the “Application Center HOFZET®” is, in collaboration with industrial partners, to identify new applications for sustainable composite materials and to develop pioneering products and technologies.

Our research fields extend from simple material developments through to complex complete solutions for products, components and semi-finished products. We develop sustainable solutions ranging from the selection of raw materials, material production and processing, through material-appropriate designs and simulations, and on to ecological evaluation and production maturity.

The emphasis is placed on the development of thermoplastic, extrusion-produced, short-fiber-reinforced compounds as well as the production of textile semi-finished products and their processing into thermoset and also thermoplastic composites. The focus in materials development is thereby directed at the utilization of cellulose-based fibers, yarns and fabrics as well as the incorporation of biopolymers and recycles.

With a particular awareness of the need for an efficient recycling economy, current research activities are increasingly being oriented towards issues relating to the utilization of recycled and residual materials, as well as their extraction, characterization and definition for potential areas of application.

Our developments are always carried out under consideration of the corresponding impact categories of a life-cycle assessment, with the result that the topic of sustainability is taken into account from the selection of the raw materials, through component production and the life cycle, and on to recycling.

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Research Highlights

Wooden crash-barrier system

Highly stress-resistant sustainable alternative

- Sustainable alternative for crash-barrier systems - made from domestic wood species - compatible with existing systems, equally durable and financially competitive
- The current project is the next step on the way to series production




What you now consider an obstacle will later be an effective remedy.«

Vinzenz Ferrer



Bulky waste - A source of waste wood with exploitable potential

Approximately half of bulky waste is comprised of wood. Currently, only around half of this is utilized materially, whilst the rest is incinerated. A project in which the Fraunhofer WKI is participating aims to make use of the untapped potential of this waste wood through a combination of modern sensor technology and artificial intelligence.

Bulky waste is generally sorted manually using pre-crushed material. On the one hand, manual sorting creates employment opportunities for low-skilled personnel, but on the other hand, it can be cost-intensive. The aim of the ASKIVIT project (Waste-wood recovery from bulky waste using artificial intelligence and image processing in the VIS, IR and terahertz range) is therefore to increase the material recycling of wood from bulky waste by means of automated sorting in order to increase the proportion of positively sorted wood and, simultaneously, to reduce the sorting outlay. In view of the wide variety of bulky waste that accumulates, manual sorting is simulated using an image-processing system with artificial intelligence that uses neural networks to learn the properties of wood from sample materials. In addition to normal color cameras, the sensor system incorporates additional imaging processes in order to increase the success rate. These are near-infrared imaging spectroscopy, active thermography and terahertz technology. The optimum combination of these detection methods will be investigated and determined over the course of the project. In addition, the utilized process will also be employed in an attempt to detect and separate non-ferrous metals in order to further increase the economic efficiency. Research partners are the Fraunhofer IOSB, the Fraunhofer ITWM and the Karlsruhe Institute of Technology.

Funding: German Federal Ministry of Food and Agriculture (BMEL) via the specialist agency Fachagentur Nachwachsende Rohstoffe e. V. (FNR)

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Development of a testing standard for the efficacy of air purifiers

A test procedure that we developed allows the standardized efficacy testing of air purifiers in order to enable a comparative evaluation of the technologies available on the market. In addition to the reduction of particles and infectious agents, the new testing standard also takes into account important parameters of occupational health and safety.

In closed rooms, airborne pathogens spread easily and remain in the indoor air for a very long time as a result of their generally small size. Studies have shown this to be particularly applicable to respiratory viruses, which are released during breathing, speaking, coughing or sneezing. Air-purification devices are considered a means of reducing the risk of infection indoors, particularly if ventilation is inadequate. The efficacy testing of air purifiers is currently anchored in various international standards. Different approaches are, however, thereby applied and only a small number of air pollutants are taken into account. A comparative evaluation of the technologies available on the market and a substantiated decision for or against the use of a particular air purifier is therefore difficult to achieve.

In a research project, we have therefore developed a low-threshold procedure for the efficacy testing of air purifiers. On this basis, a comparative evaluation of all devices and technologies available on the market is facilitated, thereby also taking into account other parameters relevant to occupational health and safety. In addition to the cleaning efficiency with respect to airborne pathogens, the testing standard also encompasses important air pollutants, such as ozone or nitrogen oxides, which may be produced as undesirable reaction products during operation of the device. Furthermore, the operating sound level and possible UV radiation or draughts are also taken into account in order to eliminate any negative effects on health.

Funding: German Social Accident Insurance (DGUV)

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Formaldehyde-free condensation resins made from lignin and HMF

The aim of the “AdLigno” project was the development of bio-based and formaldehyde-free condensation resins made from lignin and hydroxymethylfurfural (HMF) for the production of wood-based materials.

Hydroxymethylfurfural (HMF) is a promising alternative to formaldehyde in condensation resins. A significant advantage of HMF over other formaldehyde alternatives such as glyoxal or glutaraldehyde is its physiological harmlessness.

In 2011, the German Federal Institute for Risk Assessment classified HMF as harmless to health. The quantity of hydroxymethylfurfural must be adjusted to the lignin used in each case. The curing behavior was investigated using the model-free kinetics (MFK) approach. Taking the MFK results into account, pressing and tensile tests were subsequently conducted on an automated bonding evaluation system (ABES). These tests showed that at temperatures of 130-150 °C and pressing times of 30-90 s, tensile shear strengths of > 5 MPa could be achieved.

Using the resins, an initial batch of particle boards was successfully produced in the Fraunhofer WKI Technical Center. The particle boards were characterized according to surface soundness, screw pull-out resistance, transverse tensile strength, bending strength and modulus of elasticity as well as bulk density. The results were positive.

The lignin-HMF resins developed in the project are also a promising alternative to PMDI binders, and will therefore enable the wood-based materials industry to become less dependent on fossil raw materials.

Funding: German Federal Ministry of Education and Research (BMBF) via Project Management Jülich (PTJ)

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Wind of Change – Modular wooden tower for conventional wind turbines

The start-up company Modvion built the first wooden tower for commercial wind turbines in 2023. The Fraunhofer WKI assisted with the bonding on the construction site and supported the company with regard to the implementation.

The company Modvion AB, in Gothenburg, Sweden, has developed a modular wooden tower on the basis of veneer materials that can replace all conventional wind-power towers made from concrete or steel and that has the potential to reduce CO₂ emissions by up to 90 percent compared to conventional products. The current project, the so-called “Wind of Change Tower”, was completed in 2023. Including a V90-2.0MW turbine from Vestas Wind Systems A/S, it has a total height of 150 meters (pure tower height 105 m), which makes it the tallest wooden wind-turbine tower in the world. The individual building blocks used to construct the tower are specially manufactured quarter shells, each with a length of 14 meters, which are produced in the factory and then bonded together on the construction site to form four tapered sections. In a second step, the individual sections are placed on top of one another and connected using steel sheets. In addition to a more positive CO₂ balance, the construction method described here offers further advantages over conventional steel or concrete towers, which either require time-consuming maintenance of nuts and bolts or which are limited in their transport size as a result of fully prefabricated components. This becomes clear when the tower height is increased, which inevitably leads to an increase in the diameter of the truncated cone. Here, the modular timber-construction method enables incomparably larger dimensions. The towers are no longer limited in height, as a result of which higher air flows can be achieved and additional areas can be made usable for wind energy. The accredited and recognized testing body “Structural Bonding” at the Fraunhofer WKI provided Modvion with advice on all bonding-related issues and inspected the bonds on the construction site.

Funding: Industry

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Non-combustible foams and insulation shells for the construction sector

In this research project, a non-combustible foam was developed for utilization in buildings with increased fire-protection requirements, which is used both for the filling of door frames, window frames and openings and for the insulation of heating systems.

The initial basis for this was formed by PU-based construction foams, which were classified as having maximum flame retardancy. Furthermore, no prefabricated, non-combustible insulation shells for fittings and valves were known. During development, the challenge was therefore to firstly adapt the formulation in such a way that construction-material class A1 in accordance with DIN EN 13501-1 could be achieved and, secondly, to ensure low thermal conductivity. Through the application of the statistical test planning method, it was possible to limit the number of formulations to be tested to 74. Based on these formulations, test specimens measuring 35x35x5 cm³ were produced and subsequently characterized with regard to the heat of combustion in the bomb calorimeter, the thermal conductivity and the bulk density. From this, five formulations were identified which achieved a heat of combustion of less than 2000 J/g, the limit value for the achievement of the construction-material class non-combustible (A1), and which had a thermal conductivity of less than 90 mW/mK. The test series was then statistically evaluated in order to model the effects of individual and combined mixture components. The model was subsequently utilized in order to optimize the formulation.

Since November 2023, a follow-up project has been developing a process that makes it possible to produce insulation boxes semi-continuously or continuously on an industrial scale.

Funding: German Federal Ministry for Housing, Urban Development and Building (BMWSB) via the German Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR)

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Eco2Floor - Development of CO₂-optimized vehicle underbodies

Within the framework of the Eco2Floor project, underbody components for electric vehicles were developed that consist of natural fibers and recycled plastics. Compared to series components, the innovation has a CO₂ footprint that is around 40% lower.

The large-area components in the vehicle underbody investigated within the project are subject to high demands in terms of bending and impact behavior. During the development of the underbody, glass fibers – a high-performance material – were replaced by natural materials such as flax, hemp and cellulose fibers. In addition, on the polymer side, virgin polypropylene was completely dispensed with and only recycled materials were used. Up until now, natural-fiber injection-molded compounds have been known primarily for their increased strength and stiffness compared to non-reinforced polymers. During development of the vehicle underbody, it was possible to fulfill the high requirements for low-temperature impact strength – without compromising the required stiffness and strength – by utilizing a combination of selected post-consumer matrices and natural fibers of various purity grades. The prototype components produced were then tested by project partner Audi, both at component level and in road tests with vehicles from the VW Group’s Premium Platform Electric (PPE). The new materials thereby fulfilled all standard requirements for underbody components and proved to be suitable for series production. The significantly improved CO₂ footprint also plays a large part in the degree of innovation. For example, 10.5 kg of virgin material (PP/glass fiber) can be replaced by 4.2 kg of natural fibers and 6.3 kg of post-consumer recyclates. As a result, CO₂ emissions during production, use and product end-of-life could be reduced by up to 40%. In collaboration with the partners Audi, BBP, Röchling and TITK, an innovative holistic overall concept for vehicle underbodies, including recycling with cascaded re-use of the components, was developed.

Funding: Federal Ministry for Economic Affairs and Climate Action (BMWK) via TÜV Rheinland Consulting GmbH

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Public funding sources

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public
funding
projects 2023

AiF	German Federation of Industrial Research Associations "Otto von Guericke"
BBSR	Federal Institute for Research on Building, Urban Affairs and Spatial Development
BBR	The Federal Office for Building and Regional Planning
BLE	Federal Office for Agriculture and Food
BMBF	Federal Ministry of Education and Research
BMEL	Federal Ministry of Food and Agriculture
BMUV	Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection
BMDV	Federal Ministry for Digital and Transport
BMWK	Federal Ministry for Economic Affairs and Climate Action
BÖLN	German Federal program for organic farming and other forms of sustainable agriculture
DBU	German Federal Environmental Foundation
DFG	German Research Foundation
DGUV	Deutsche Gesetzliche Unfallversicherung e. V.
DLR	German Aerospace Center
EBA	Federal Railway Authority
EU	Commission of the European Union
FNR	Agency of Renewable Resources
FZJ	Forschungszentrum Jülich GmbH
IVTH	International Association for Technical Issues related to Wood
KIT	Karlsruher Institute of Technology
Land NRW	State Government of North Rhine-Westphalia
MWK	Ministry of Science and Culture of Lower Saxony
PTJ	Project Management Jülich
UBA	German Environment Agency
VDI/VDE	VDI/VDE Innovation + Technik GmbH
WKF	Waldklimafonds

Scientific excellence





**Good presentations
are presents and
require presence.«**

Georg-Wilhelm Exler



Events

Internationale Grüne Woche 2023

20th - 29th January 2023 | Berlin

The Internationale Grüne Woche (International Green Week) is the world's largest trade fair for food, agriculture and horticulture. The Fraunhofer WKI demonstrated a sustainable crash-barrier system made from highly durable wood-composite elements on the joint stand of the Fraunhofer-Gesellschaft.

Hannover Messe 2023

17th - 23rd April 2023 | Hanover

The Fraunhofer WKI presented innovative products and processes relating to the utilization of wood and other renewable raw resources in materials. At the joint stand "Showcase Bioeconomy" of the German Federal Ministry of Education and Research (BMBF) and the German Federal Ministry of Food and Agriculture (BMEL), the Fraunhofer WKI provided information on two current research projects.

"Salon der Wissenschaft"

10th May 2023 | Braunschweig

For the second time, the "Salon der Wissenschaft" (Science Salon) extended an invitation to engage in conversation with researchers from the Braunschweig region. In a personal dialog, participants were able to discuss the topic "Will buildings be primarily bonded in the future?" with Malte Mérono, a scientist from the Fraunhofer WKI.

LIGNA 2023

15th - 19th May 2023 | Hanover

LIGNA is the world's leading trade fair for machines, systems and tools for woodworking and wood processing. With the highlight "Multi-material model Wall | Ceiling | Roof", the researchers from the Fraunhofer WKI presented no fewer than eight innovations for the construction industry. Furthermore, they demonstrated additional ways in which renewable raw materials – such as balsa wood, hardwood or natural fibers – can be incorporated into future-oriented applications. These included a bicycle and pedestrian bridge made from plywood, and a bio-based stand-up paddleboard.

Meet the scientist: Green water – Sustainable floating islands for the greening of canals

25th October 2023 | phaeno Wolfsburg

How can we provide more space for nature in our cities? Interested parties were able to discuss this with Christoph Pöhler, a scientist from the Fraunhofer WKI, at "Meet the scientist" in the phaeno.

27th Internationales Holzbau-Forum (IHf 2023)

29th November - 1st Dezember 2023 | Innsbruck

The "Internationales Holzbau-Forum" (International timber-construction forum) offered experts from the timber-construction sector a platform where they could obtain and exchange comprehensive information regarding building timber-framed structures and wooden constructions. In the accompanying exhibition, manufacturers and research institutes from the timber-construction sector presented new application examples. The Fraunhofer WKI had its own stand where it presented current research results and developments.

Awards for Dr.-Ing. Juan Li

For her dissertation "Aging of wood as a construction material measured by atomic force microscopy", Juan Li has been awarded the PhD Award of the International Academy of Wood Science, the Karl Kordina Prize of the TU Braunschweig and, together with Professor Bo Kasal, the George G. Marra Award for excellence in research and writing of the International Society of Wood Science and Technology.

Mentoring program »LignoSilva CoE« in Slovakia

The aim of the "Upgrade of the Centre of Excellence LignoSilva" project, funded by the European Union, is the strengthening both of scientific excellence and of international research contacts. The Fraunhofer WKI will provide support as a mentor in the coming years. Following on from the successful establishment of the InnoRenew CoE in Slovenia, Professor Kasal has now become the first Institute Director within the Fraunhofer-Gesellschaft to be selected as a mentor for two major EU projects whose aim is the establishment of research centers abroad.

Webinars

Eschig, Steven: Bonding on Demand – Switchable adhesives for the adhesion of cement-bonded wood-based panels
ABhoff, Carsten: PET fiber reinforcement in polypropylene for transport containers
Zhao, Jiangyue: Influence of climate change on indoor air quality
Pöhler, Christoph: Bio-lightweight material for stand-up paddleboards and other applications



Groups, Alliances and Networks

Institutes with different areas of expertise cooperate within Fraunhofer Groups, Alliances, Research Fields and Networks in order to collaboratively work on and market a business area.

The Fraunhofer WKI is a member of the Fraunhofer Group MATERIALS, the Building Innovation Alliance, and the Fraunhofer networks "Sustainability" and "Science, Art and Design". Furthermore, the Fraunhofer WKI is a member of the Cultural Heritage Research Alliance, the Fraunhofer Research Field Lightweight Construction, the Research Area Technical Textiles, and the Business Unit Vision.

Fraunhofer Group MATERIALS

At Fraunhofer, materials science and materials engineering encompass the entire value chain, from the development of new and the improvement of existing materials and substances, through the suitable manufacturing processes on a quasi-industrial scale and the characterization of properties, and on to the evaluation of the application behavior. This also applies to the components and products manufactured from the materials and their system behavior in the respective applications. In addition to experimental investigations in laboratories, technical centers and pilot plants, methods of numerical simulation and modeling are used in equal measure; this applies across all scales, from the molecule, through the component, and on to the complex system as well as process simulation. In terms of materials, the Fraunhofer Group MATERIALS covers the entire range of metallic, inorganic-non-metallic, and polymeric materials as well as materials created from renewable raw resources and semiconductor materials. In recent years, hybrid materials and composites have gained considerably

in importance. The scientists at the group research institutes apply their knowledge and expertise on behalf of customers, particularly in the business areas of energy & environment, mobility, health, mechanical and plant engineering, construction & housing, microsystems technology, and security. They are nationally and internationally networked and provide a wide range of contributions towards material-relevant innovations and innovation processes

www.materials.fraunhofer.de

Fraunhofer Network Science, Art and Design

How can science be inspired by art and design - and vice versa? What do researchers, artists and designers have in common? How can they enter into a creative dialog and take a stand, side by side, on overarching issues? The Fraunhofer Network "Science, Art and Design", which was founded in early 2018, addresses these and other questions

www.art-design.fraunhofer.de

Fraunhofer Building Innovation Alliance

The aim of the Fraunhofer Building Innovation Alliance is to be able to map and process all scientific and research-relevant issues relating to construction - completely and "from a single source" within the Fraunhofer Gesellschaft. This provides the construction industry with a central point of contact for integral system solutions.

www.bau.fraunhofer.de

Fraunhofer Research Field Lightweight Construction

The partner institutes in the research field of lightweight construction contribute to conceptual and technical solutions along the entire value chain by researching and developing manufacturing processes as well as analysis and evaluation methods. Customer-specific issues are thereby addressed, taking ecological and economic aspects into account. The pooling of the expertise of 14 Fraunhofer institutes means that solutions can be offered from a single source. The portfolio is rounded off by a comprehensive range of further-training courses consisting of specifically tailored modules.

www.leichtbau.fraunhofer.de

Fraunhofer Research Area Technical Textiles

The Fraunhofer institutes of the Research Area Technical Textiles have joined forces to bundle their individual competencies in order to map the entire textile value chain from textile machinery, through fiber production, preform/semi-finished product manufacturing, textile functionalization, smart textiles, process and product simulation, sustainability, Life Cycle Assessment and recycling and on to fiber-composite components. The Research Area Technical Textiles provides companies and partners with a team that works on an interdisciplinary basis in order to generate optimal, application-oriented, product-specific developments of textile-based technologies and plant systems.

www.textil.fraunhofer.de

Fraunhofer Business Unit Vision

The Business Unit Vision at Fraunhofer is an association of specialist departments from several Fraunhofer institutes that work together and pool their expertise in the fields of industrial image processing, machine vision and optical measurement and testing technology, in particular in manufacturing and quality assurance.

www.vision.fraunhofer.de

Cultural Heritage Research Alliance

The top priority of this interdisciplinary alliance is the preservation of cultural heritage through material-analysis research and innovation. Written documents, paintings, sculptures and historical buildings are not only invaluable to society in an idealistic sense - they also represent an enormous economic factor.

www.forschungsallianz-kulturerbe.de

Fraunhofer Sustainability Network

The Fraunhofer Sustainability Network actively supports the Fraunhofer-Gesellschaft's current strategy process: The focus is on stronger networking and interlinking both of research topics and of research stakeholders who demonstrate a close connection to sustainability. The aim is to increase research efficiency and, at the same time, to fulfil the requirements arising from the increasing complexity of research with regard to "sustainable developments".

www.fraunhofer.de

International Association for Technical Issues Related to Wood e. V.

The shortage of wood as a raw material and the obligation to use the available timber economically provided the impulse for the founding of the Association for Technical Issues related to Wood in Braunschweig in 1946. Through its activities, the Association, renamed as iVTH - International Association for Technical Issues Related to Wood e. V., continues to contribute towards the deepening and sharing of knowledge concerning wood as a material as well as its utilization.

The aim of the association is to transfer the knowledge from research projects practice-oriented into the timber industry, in order for procedures and products to be newly-developed or enhanced. The competitiveness of SMEs should thereby be strengthened. The focus of our activities is, after all, placed mainly upon small and medium-sized companies in the timber industry and their suppliers. Nationally and internationally, we maintain close contact with research bodies and businesses with practical involvement.

Our services at a glance:

- The iVTH promotes research and development work in the forestry and wood industries and associated fields, both nationally via cooperative industrial research (IGF) and internationally via CORNET (in each case BMWK via DLR Projektträger)
- allocates research projects with currently-relevant objectives,
- organizes scientific events,
- awards the Wilhelm Klauditz Prize for wood research and environmental protection,
- contributes to advisory committees,
- is member of the German Federation of Industrial Research Associations AiF, the Austrian Society for Wood Research ÖGH, the Joint Committee on Adhesive Technology GAK, the Hardwood Research Interest Group IGLHF and
- is a cooperation partner for initiatives concerning wood as a resource.

If you have project ideas, are seeking a contact partner or would like to support our work, please do not hesitate to contact us:

International Association for Technical Issues Related to Wood - iVTH e. V.
 Riedenkamp 3 | 38108 Braunschweig | Germany
 Phone: +49 531 2155-209 | Fax: +49 531 2155-334
 contact@ivth.org | www.ivth.org

The Fraunhofer-Gesellschaft

The Fraunhofer-Gesellschaft, based in Germany, is the world's leading applied research organization. Prioritizing key future-relevant technologies and commercializing its findings in business and industry, it plays a major role in the innovation process. A trailblazer and trendsetter in innovative developments and research excellence, the Fraunhofer-Gesellschaft supports science and industry with inspiring ideas and sustainable scientific and technological solutions and is helping shape our society and our future.

At the Fraunhofer-Gesellschaft, interdisciplinary research teams work with partners from industry and government to turn pioneering ideas into innovative technologies, coordinate and implement system-relevant research projects and strengthen the German and European economies with a commitment to value creation that is based on ethical values. International collaboration with outstanding research partners and companies from around the world brings the Fraunhofer-Gesellschaft into direct contact with the most prominent scientific communities and most influential economic regions.

Founded in 1949, the Fraunhofer-Gesellschaft currently operates 76 institutes and research units throughout Germany. Currently around 30,800 employees, predominantly scientists and engineers, work with an annual research budget of about 3.0 billion euros, 2.6 billion euros of which is designated as contract research. Around two thirds of Fraunhofer contract research revenue is generated from industry contracts and publicly funded research projects. The German federal and state governments contribute around another third as base funding, enabling the Fraunhofer institutes to develop solutions now to problems that will drastically impact industry and society in the near future.

The impact of applied research goes far beyond the direct benefits to the client. Fraunhofer institutes strengthen companies' performance and efficiency and promote the acceptance of new technologies within society while also training the future generation of scientists and engineers that the economy so urgently requires.

As a scientific organization, the key to our success is highly motivated employees engaged in cutting-edge research. Fraunhofer therefore offers its researchers the opportunity to undertake independent, creative and, at the same time, targeted work. We help our employees develop professional and personal skills that will enable them to take up positions of responsibility within Fraunhofer itself or at universities, within industry and in society at large. Students involved in projects at Fraunhofer institutes have excellent career prospects on account of the practical vocational training they enjoy and the opportunity to interact with contract partners at an early stage in their career.

The Fraunhofer-Gesellschaft is a recognized non-profit organization named after Joseph von Fraunhofer (1787–1826), an illustrious researcher, inventor and entrepreneur hailing from Munich.

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www.fraunhofer.de

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Aerial image of the Fraunhofer campus in Braunschweig.
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Beech-wood fiber insulation materials as filling for thermal-insulation bricks.
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Visitors on the Fraunhofer WKI stand at LIGNA.
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Laminated material made from hardwood veneers for a free-form pedestrian bridge.
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We have placed particular emphasis on the use of environmentally friendly materials in the production of this annual report.