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Annual Report 2021

More than 75 years of experience
in the development of sustainable
materials and technologies



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experience in the
development of
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Greeting

Dear customers, colleagues, and friends,

I am pleased to present you with this Annual Report. The Fraunhofer Institute for Wood Research, Wilhelm-Klauditz-Institut WKI, continues to be a worldwide leader in the development of sustainable materials and technologies through its focus on renewable resources covering the entire spectrum from materials to emissions and recycling. We focus on the substance necessary to meet sustainability goals.

2021 was not an easy year for any of us and was marked by the continuous presence of

a virus that complicated our lives. We have, however, met the challenges with high adaptability and flexibility in the ways we conducted our daily operations. We reduced our costs to a manageable level and were able to finish the year with positive numbers. Our scientific strength has significantly improved and we have maintained our position among the top Fraunhofer Institutes.

After years of delays in planning and construction, we were able to open and move into our new ZELUBA® building on the campus of the TU Braunschweig. This is a great accomplishment and will bring our cooperation with the university to a new, higher level. Our Junior Research Group's focus on sustainable building materials and our active engagement in the Graduate College are just two examples of joint university-Fraunhofer WKI teams that attract national and international attention.

Through ZELUBA®, we have continued upgrading our research competencies by adding a new dynamic testing capability that includes a state-of-the-art shaking table for seismic simulations, a dynamic test frame for cyclic experiments, and a high-frequency shaker complemented with modern data-acquisition and sensor technologies. This will position the Fraunhofer WKI as one of the worldwide top laboratories to address the issues of earthquake resistance of structures, with specific focus on timber.

We have further invested in our infrastructure, and our new laboratory bay area is being equipped to better serve the industry, focusing in particular on our new accredited

program for testing structural adhesives as well as strengthening our indoor-air quality program. This is a great success and will bring us closer to our industrial partners by offering required services.

We continue to plan our new pilot plant facility, which is long overdue. The pilot plant will replace our 60-year-old facility, which is the heart of our institute, and we still hope that the initial delays can be made up for.

Our institute is the leader in opening new avenues and ideas of research through collaboration with artists and designers via "Artist in the Lab" and "Designer in the Lab" programs within the Fraunhofer network of science, art, and design. This brings us closer to people, gives us new ideas, and adds to the visibility of our work.

None of these accomplishments would have been possible without the immense dedication and focus of all WKI employees and the support of our partners and friends. This gives me the confidence that the Fraunhofer WKI will continue to prosper. My sincere thanks and appreciation go to all of you!

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

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What will we use to make light-weight wood-based materials when spruce is no longer available?

Material-efficient
lightweight materials
made from hardwood.

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-dimensioned wood. He is regarded as a co-founder of the modern wood-based materials industry.

Today, at the Fraunhofer WKI, we examine 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 and indoor air analysis.

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. 15 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 for the processing of the research contracts.

The Fraunhofer WKI is a member of the Fraunhofer Group for Materials and Components - MATERIALS, the Fraunhofer Alliances Vision, Building Innovation, Lightweight Design, and Technical Textiles, and the Fraunhofer Networks for Sustainability and Science, Art and Design as well as the Research Alliance for Cultural Heritage. Within the Fraunhofer-Gesellschaft, the Fraunhofer WKI occupies a unique position as regards its holistic research approach to the material usage of wood and lignocellulosic materials.



Entrance area of the "Center for Light and Environmentally-Friendly Structures ZELUBA®" in Braunschweig, completed in 2021.

Self-Perfection

Vision

Our vision is a globally successful research institute which processes 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 application-oriented 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 the industrial partners involved. We thereby strive to establish a long-term cooperation based on partnership.

In addition to the most important renewable raw material, namely wood, the institute also 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 application, through industrial use, and on to recycling.

The effective utilization of complex materials on the basis of these raw materials requires highly specialized knowledge, the scope of which encompasses many disciplines of the 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

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Departments

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Application Center HOFZET®

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Infrastructure Services

General Administration

Dipl.-Wirt.-Ing. Ulrike Holzhauser

Information Technology

Andreas Schlechtweg

Technical Services

Dipl.-Ing. (FH) Stephan Thiele

Board of Trustees

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

Dr. Markus Boos

Remmers GmbH, Lönigen, Germany

Christine Dübler

ZwickRoell GmbH & Co. KG, Ulm, Germany

Dipl.-Ing. Hubertus Flötotto (Deputy Chair)

Sauerländer Spanplatten GmbH & Co. KG, Arnberg, Germany

Prof. Dr. Eva Frühwald Hansson

Lund University, Faculty of Engineering, Sweden

Dipl.-Ing. Kai Greten (Chair)

Gronau, Germany

Prof. Dr. Joachim Hasch

SWISS KRONO Tec AG, Luzern, Switzerland

Dr. Jörg Hasener (Guest)

Fagus-GreCon Greten GmbH & Co. KG, Alfeld, Germany

Dr. Frank Herrmann (Guest)

Pfleiderer Deutschland GmbH, Neumarkt i.d.Opf., Germany

Dr.-Ing. Hans-Werner Hoffmeister

Technische Universität Braunschweig, Institute of Machine Tools and Production Technology, Germany

Dr. Sebastian Huster

Ministry for Science and Culture of Lower Saxony, Hanover, Germany

Dr. Helge Kramberger (Guest)

Dr.-Robert-Murjahn-Institut, Ober-Ramstadt, Germany

Prof. Dr. Andreas Krause

Thünen Institute of Wood Research, Hamburg, Germany

Status: March 2022

Karl-Robert Kuntz

elka-Holzwerke GmbH, Morbach, Germany

Dr. Klaus Merker

Niedersächsische Landesforsten, Braunschweig, Germany

Prof. Dr. Holger Militz

Georg-August-Universität Göttingen, Wood Biology and Wood Products, Forest Sciences and Forest Ecology, Germany

Prof. Dr. rer. nat. Klaus Richter

Chair of Wood Science - Holzforschung München
Technical University of Munich, Germany

Anemon Strohmeier

Verband der Deutschen Holzwerkstoffindustrie e. V., Berlin

Prof. Dr.-Ing. André Wagenführ

TU Dresden, Institute of Natural Materials Technology, Chair of Wood Technology and Fibre Materials Technology, Germany

Dr. Stephan Weinkötz

BASF SE, Ludwigshafen, Germany

Dr. Hans-Kurt von Werder

Cadolzburg, Germany

MR'in Dr. jur. Birgit Wolz

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Bonn, Germany

Dr. Tanja Zimmermann (Guest)

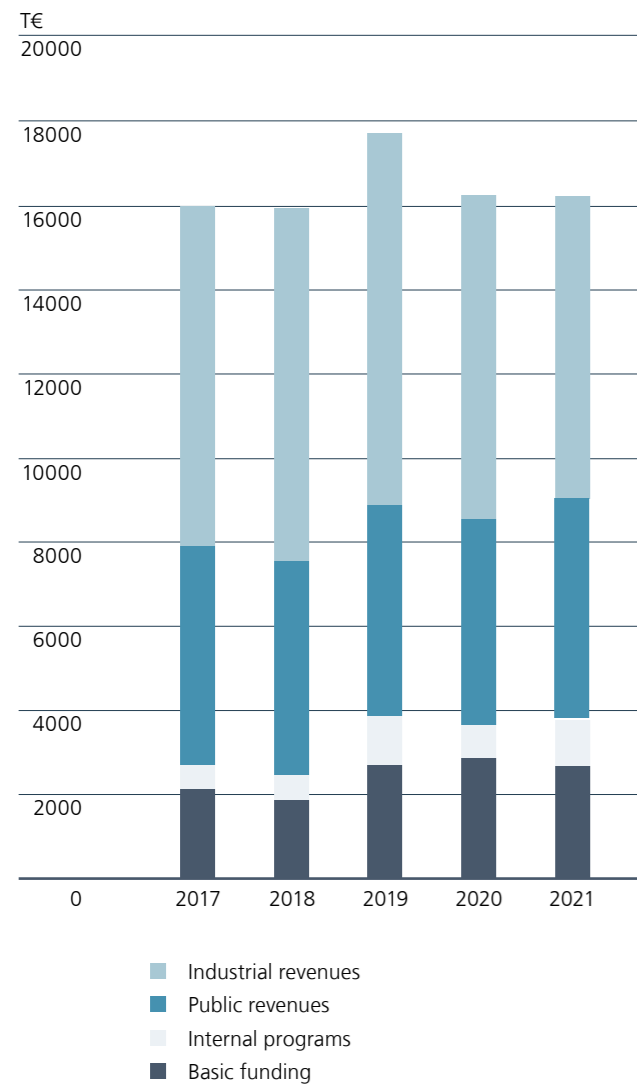
EMPA, Materials Science and Technology, Dübendorf, Switzerland

Werner Zimmermann

Rhenocoll-Werk e. K., Konken, Germany

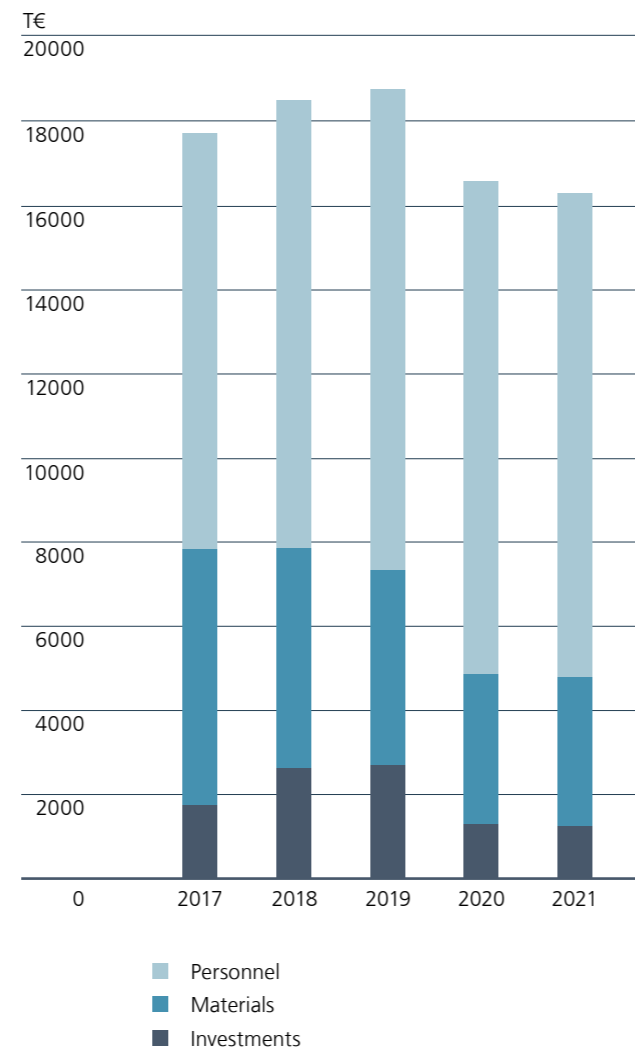
Figures | Data | Facts

Revenue Structure

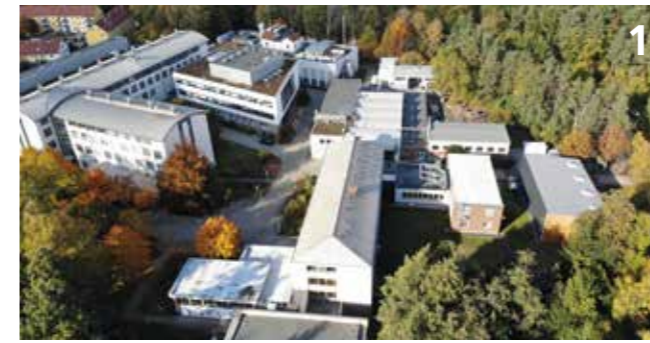


In 2021, a total of 12.5 million euros in external revenues was realized. This enables the Fraunhofer WKI to once again build on the above-average results of previous years. More than 55 % of the revenues were financed by industrial partners. Public sponsors supported our research projects with almost 5,4 million euros.

Budget & Investments



The operating budget amounted to around 15 million euros in the year under review. Personnel expenses amounted to 11.4 million euros and material costs totaled 3.6 million euros. The investment budget had a volume of 1.2 million euros. The share of normal investments amounted to 800,000 euros. 65,000 euros were financed through external projects.



Locations

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Fraunhofer WKI | Application Center HOFZET®
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Fraunhofer-Projektzentrum Wolfsburg
 c/o Open Hybrid LabFactory e.V.

Staff



In the reporting period, the Fraunhofer WKI employed around 160 staff, 40 % of whom were scientific personnel, engineers and doctoral students. Technical staff, administrative personnel and IT specialists as well as master's/bachelor's students and student assistants supported the research work.

The institute enabled nine trainees to embark upon their careers in the fields of information technology, office communication, industrial and wood mechanics, and media and information services.

Innovative Fields of Research



**Being special in all areas
has only one single
disadvantage: one is
exceptionally alone
thereby.«**

Thomas S.
Lutter

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.

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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 fields of work. We investigate questions of indoor hygiene and indoor climate with regard to the environment, health and consumer protection. For this purpose, we analyze real interiors, such as residential buildings and means of transportation, as well as the air quality in showcases, exhibition rooms and storage rooms of museums. In collaboration with other Fraunhofer institutes, we work on solutions for improving air quality by means of (photo)catalytically equipped materials and devices for air purification. Furthermore, we develop model systems with the help of which the complexity of the indoor environment and the resulting air hygiene can be calculated in dependence on the most diverse parameters (climate, installed materials, chemical-physical reactions, etc.).

A current priority topic concerns the influences of short- and long-term climatic changes on indoor air quality for the region of Central Europe and the relationship between building-product emissions and the resulting indoor air quality. We are thereby contributing our expertise on the relevant committees. Furthermore, we cooperate with numerous research institutions 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 that protect wood from environmental influences, abrasion and fire, we also develop binders for adhesives for the production and bonding of wood, wood-based materials and other 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.

Standardprüfungen, Schadensanalysen sowie die Entwicklung von Methoden zur Beurteilung und Optimierung der Bewitterungsstabilität von Materialien runden unser Profil ab.

Head of Department

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Quality Assessment

The focus of the research projects in the department “Quality Assessment” is directed at the assessment of bondings, evaluation of bonding processes, forestry-relevant issues for products made from wood, and the further development of test methods for measuring the formaldehyde emission of products with and from renewable raw materials.

In an interdisciplinary team, we elaborate and develop solutions for and with customers from, among others, the forestry and timber industry, the construction industry, the furniture industry and the chemical industry. The expertise we have gained through contact with manufacturers and from our research work is made available in certified advanced training courses at our **WKI | AKADEMIE**®.

We are furthermore internationally recognized as a testing, monitoring and certification body and are consequently a competent partner for all issues relating to testing, monitoring and certification.

Head of Department

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Center for Light and Environmentally-Friendly Structures

At the “Center for Light and Environmentally-Friendly Structures ZELUBA®”, we develop sustainable solutions for the construction industry. We support industrial partners from the wood-based materials and prefabricated-house industries, as well as companies from the manual-skills trades, in the development of new systems.

One of our major competences is the transmission of fundamental research via applied research through to the finished product within the construction industry.

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

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

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

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Application Center HOFZET®

The aim of the “Application Center HOFZET®” is, in collaboration with industrial partners, the identification of new applications for sustainable composites and the development of future-oriented products and technologies.

The research fields range from simple material developments through to complex complete solutions for products, components and semi-finished products. We develop sustainable solutions from raw-material selection, material production and processing, through material-appropriate design and simulation, and on to the ecological evaluation and production maturity.

The material focus is directed at 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 thermoplastic composites. The focus in the material development is on the utilization of cellulose-based fibers, yarns and fabrics as well as the use of biopolymers and recycled materials.

Our developments always take place under consideration of the corresponding impact categories of a life-cycle assessment; as a result, the topic of sustainability is addressed from the selection of raw materials, through component production and the life cycle, and on to recycling.

The topic of recycling does not come last in the list of importance for us, but instead accompanies every development from the very beginning. Recycling strategies are therefore an intrinsic element in the preparation of the specification sheet.

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Research Highlights



Today, research means searching for ever-smaller needles in ever-larger haystacks.«

Prof. Dr. Hans-Jürgen Quadbeck-Seeger

FutureWood – Optimization of the utilization of softwood

The softwood-based timber industry is being confronted with a shortage of resources as a result of climate change and forest restructuring. It is therefore imperative for existing material flows of coniferous wood to be used as effectively as possible and for the silviculture of future coniferous stands to be optimally adapted.

On six investigation sites in spruce stands in the Harz Mountains and the State of Hesse, the tree anatomy was determined by the project partners of the HAWK Göttingen by means of terrestrial laser scanning. Properties such as crown radius, crown length and tree diameter can provide information concerning the management history of the investigated trees. A comparison of the properties of the harvested wood should provide information on the application possibilities. The visual grading criteria for sawn timber – as defined by DIN 4074-1 – and the elasto-mechanical properties derived from destructive 4-point bending tests of sawn and glued laminated timber are hereby taken into consideration. In this way, a technology-based evaluation of the underlying silvicultural treatment should become possible. The visual assessment of the quality proved to be less conclusive than the mechanical testing of the materials. Solely in the case of the sample plot which was significantly inferior in both cases was it possible to identify a correlation that could be attributed to growth rate and wide annual rings. The criteria of origin and wood density have proven far more significant in predicting mechanical properties than the visual property profile. Regression analysis of mechanical properties and tree anatomy as a snapshot of the growth history without additional data achieves only inaccurate models.

Funding: Fachagentur Nachwachsende Rohstoffe e. V.

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Influence of climate change on indoor air quality

The 2021 report from the Intergovernmental Panel on Climate Change (IPCC) predicts rising global temperatures and increasingly frequent extreme weather events in the future, which will have varying impacts on the regional climate and the concentrations of air pollutants. The question therefore arises as to what extent these changes will influence indoor air quality and the well-being of the occupants.

The currently running EKIEPI project aims to quantitatively relate indoor air quality to the effects of climate change. A new modeling system – Indoor Air Quality Climate Change (IAQCC) – is currently being developed by the Fraunhofer WKI and the Fraunhofer IBP. The IAQCC is a holistic model that combines different climate-change scenarios and a number of sub-models: building physics, emissions, chemical-physical processes, mold formation, and exposure. The IAQCC model enables the simulation of heat and moisture transport in indoor areas, of concentrations of gaseous substances and particles in indoor areas, and of the risk of mold formation, thereby taking into account external influences (e.g. air exchange), indoor materials and activity emissions, particle dynamics, chemical reactions, and the distribution of SVOCs. The exposure model provides predictions regarding both thermal comfort in indoor areas and pollutant levels. The expected changes in exposure in indoor areas as a result of climate change can be used as a basis for future political decisions. Based on the IAQCC model system, an interactive web-information platform will be created that can be accessed in an easily understandable form by the general public.

Funding: German Environment Agency

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Formaldehyde-free adhesives made from lignin for the production of wood-based materials

In the “AdLigno” project, we have succeeded in developing a 100 percent bio-based and formaldehyde-free alternative to phenol-formaldehyde (PF) resins, on the basis of lignin and hydroxymethylfurfural (HMF). The novel lignin-HMF resins are suitable, for example, for the production of wood-based panels and can be manufactured and applied using conventional processes.

Phenol-formaldehyde resins belong to the group of condensation resins which are utilized, amongst other things, in the manufacture of wood-based materials. Since the classification of formaldehyde as a carcinogen, an intensive search has been conducted for suitable substitution possibilities. Of equal concern is phenol, which is classified as being physiologically questionable on account of the fact that it can damage organs and is suspected of influencing genetic material. We have succeeded in developing a functioning resin system in which we were able to completely replace both the phenol and the formaldehyde with harmless, bio-based starting materials. We replaced the phenol with lignin, a by-product of pulp production. Hydroxymethylfurfural (HMF), which is produced from sugars, proved to be suitable as a formaldehyde substitute. As with commercial PF resins, the synthesis of the novel lignin-HMF resins can be carried out in water. The resulting resins exhibit low viscosities and a storage stability of several months. Measurements have demonstrated that complete curing of the resins at 130 °C occurs within a matter of seconds. Initial orientational tensile tests reveal good tensile shear strengths.

Funding: German Federal Ministry of Education and Research via Project Management Jülich (PtJ).

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Wood-fiber panels with casein binder for architecture and furniture construction

Items of furniture are often made from wood-fiber panels. Currently, they are predominantly produced using petrochemical binders that emit formaldehyde. In collaboration with the Fraunhofer WKI, designer Sofia Souidi is developing a material made from wood fibers and casein. Color pigments, granulates and 3D-moldability enable a diverse range of design possibilities.

Medium-density fiberboard (MDF) has advantageous properties for furniture and interior design. Even in the case of fluctuations in temperature and humidity in the room, the boards hardly warp at all. Thanks to their homogeneous structure, they can be very easily bonded and painted to form furniture items. Glue made from casein was already being used in ancient Egypt as an adhesive for furniture and boat construction. In collaboration with the product designer Sofia Souidi, we want to develop a high-performance, formaldehyde-free binder on the basis of casein. In conjunction with wood fibers, this should result in a material that can be processed in the same way as MDF. It should be possible to press it into panels as well as molded parts. Our objective is to enable the use of recycled wood fibers from waste wood. Furthermore, we are testing the admixture of differently colored forest and production waste. This allows a variety of decorative patterns to be created. The research work focused on the composition and optimization of the material on a small industrial scale. It was possible to achieve very promising results with regard to stability and strength. The material already fulfills the required transverse tensile strengths for MDF panels in accordance with DIN EN 622-5 type MDF.

Funding: In-house research within the framework of the Fraunhofer Network “Science, Art and Design”, and the IKEA Foundation.

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Sustainable crash barriers made from wood-composite elements

Crash barriers provide a crucial contribution towards safety in road traffic. In collaboration with project partners, we are developing a sustainable alternative: a crash-barrier system made from indigenous wood species. It needs to be compatible with existing systems, just as durable and financially competitive.

In the current project, a prototype is to be developed that fulfills all the requirements necessary for application. The target criteria sought are the assurance of durability of at least 25 years, the demonstration of the functionality of the system by means of crash tests for passenger cars, the suitability of the system for trucks by means of simulation, the applicability in curves and straight sections of road, and the fast and secure assembly even in the case of relatively large tolerances of the posts to which the system is attached.

The deployment of wooden crash-barrier systems is an efficient means of improving the eco-balance of the construction sector. They can be manufactured using comparatively little energy and store CO₂ for a long period of time. From a global perspective, there are already a handful of systems which are made entirely or partially from wood. These have, however, various system-specific disadvantages, including a still-high steel proportion, the use of tropical hardwood, very elaborate construction, and incompatibility with established systems.

By developing a compatible crash-barrier system made from indigenous woods, we aim to create a consistently sustainable solution with high market potential.

Funding: German Federal Ministry of Food and Agriculture and German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety via Fachagentur Nachwachsende Rohstoffe e. V.

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www.wki.fraunhofer.de/zeluba

PET fiber-reinforced polypropylene for small load carriers

For utilization in the manufacture of returnable transport containers, the influence of polyethylene terephthalate (PET) fibers with a melting point of approx. 250 - 260 °C is being investigated as a possible fiber reinforcement in polypropylene (PP) with a melting point of approx. 165 °C.

The objective of the material development is an increase in stiffness with simultaneous good impact-strength values and suitable processing characteristics for the injection-molding process of thin-walled components. This potential is being tested by means of returnable transport containers for automotive-industry logistics, the so-called small load carriers (SLC, German: KLT). Higher material strengths and stiffnesses offer weight savings in the application as a result of reduced material usage, which brings both economic and ecological advantages.

During the service life of the containers, they are exposed not only to oil and fuel in the production environment but also to environmental influences and washing-process cycles at 60 °C with cleaning agents. These external influences lead to accelerated embrittlement of the series material, which makes them significantly more sensitive to impact and shock and consequently results in damage. These damaged SLCs are discarded, as they are no longer suitable for the secure transport of goods.

Within the project, investigations are being carried out to determine the extent to which the incorporated PET fibers positively counteract the embrittlement of the PP as a consequence of weathering and washing processes.

Funding: German Federal Ministry of Education and Research via Project Management Jülich.

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Public funding sources

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
BMU	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
BMVI	Federal Ministry of Transport and Digital Infrastructure
BMWi	Federal Ministry for Economic Affairs and Energy
BÖLN	German Federal program for organic farming and other forms of sustainable agriculture
DBU	German Federal Environmental Foundation
DFG	German Research Foundation
DLR	German Aerospace Center
EBA	Federal Railway Authority
EU	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
UBA	German Environment Agency
VDI/VDE	VDI/VDE Innovation + Technik GmbH
WKF	Waldklimafonds

61
public
funding
projects 2021

Scientific excellence

55	Publications
1652	Citations (Source: Scopus)
30	Presentations
7	In-house seminars
6	Webinars
6	Lecturers
22	Lectures
1	Training events by the WKI AKADEMIE®
2	Guest scientist
0	Doctoral theses
11	Master theses
12	Collaborations with expert committees and working groups
46	Involvements in standardization committees
1	Patent applications
2	Evaluated excellence research



The future has several names. For the weak, it is impossible; for the faint-hearted, it is unknown; but for the valiant, it is ideal.»

Victor Hugo



Events

Webinars

Mérono, M.: Innovative bonding technique simplifies the utilization of wood-concrete composite elements in the construction industry
Robert, T.: UV-curing materials on the basis of itaconic acid for 3D printing – Potentials and challenges
Schirp, A.: New materials made from beet pulp
Haxter, C.: Continuous and comprehensive monitoring of the road condition through sensors in the asphalt (project "SenAD")
Friebel, S.: Environmentally-friendly vehicles thanks to bio-lightweight bodywork (Part 1)
Yan, L.; Pöhler, C.; Fu, Q. (TU Braunschweig): Long-term performance of adhesively-bonded timber-concrete composite and FRP-timber structures

In-house-Seminars

Habermann, C.: Facilities for sustainable materials of the future - Equipment at the Application Center HOFZET
Robert, T.: Development of formulation expertise in the field of UV-curing materials for additive manufacturing
Salthammer, T.: The olfactory perception of non-deuterated and deuterated molecules
Majstorovic, F.: Filip Majstorovic – A short introduction and new challenges as a new PhD student at WKI
Micke-Camuz, M.: ECo2Floor - Development of CO₂-optimized vehicle underbodies
Hussein, T. (Universities of Helsinki and Jordan): A Combination of Experimental and Modelling Tools towards Personal Exposure Assessment
Banholzer, M.; Berger, J. (Universität Hamburg): Investigation of extractive types and proportions in dependence on the growth location and their influences on the bonding

BAU 2021

13th – 15th January 2021 | online

Heat-flow thermography for industrial quality assurance

23rd March 2021 | Fraunhofer Vision, online

Woche der Umwelt (Environment Week)

10th – 11th June 2021 | Berlin

Tag der Architektur (Architecture Day)

27th June 2021 | ZELUBA® Braunschweig

IAA Mobility 2021

7th – 12th September 2021 | Munich

Subcontractor Materials 2021

9th – 12th November 2021 | Jönköping, Sweden

Fraunhofer Group Meeting MATERIALS

16th – 17th November 2021 | Fraunhofer WKI, Braunschweig

ZELUBA® new building

Following completion of the new ZELUBA® building at the end of 2020, the employees of the ZELUBA department were able to move into their offices in the summer of 2021 and to commence research activities in the laboratories and in the large hall of the technical center.

75th anniversary of the Wilhelm-Klauditz-Institut

On 7th June 2021, the Fraunhofer WKI, Wilhelm-Klauditz-Institut, celebrated its 75th anniversary. A wonderful opportunity to reflect on the roots of the institute, its long history of development, and the future. The highlights were summarized in a chronicle, which was punctually distributed to the employees on the anniversary in gratitude for their successful activities.

Recognition as an inspection body for bonding work in timber construction

In 2021, the Fraunhofer WKI was recognized by the Lower Saxony ministry for the environment, energy, building, and climate protection as an inspection body for the verification of "Suitability for the execution of bonding work for the manufacture of load-bearing timber components and glued laminated timber" and is authorized to issue certificates in accordance with this qualification.

In accordance with DIN 1052-10:2012-05 "Design of timber structures - Part 10: Additional provisions", the execution of bonding work for the manufacture or repair of load-bearing timber components requires special expertise on the part of the persons entrusted with the task, and special equipment for the companies with suitable facilities. Companies wishing to carry out adhesive bonding work for the manufacture or repair of load-bearing timber components must therefore be able to prove to a recognized inspection body that they have the necessary skilled personnel, suitable operational equipment and adequate in-house production control. In addition to the inspection of the technical equipment, the professional suitability of the executing and managing persons must be verified. For this purpose, the Fraunhofer WKI offers the focus course "Bonding in wooden construction" via the **WKI | AKADEMIE®**.



Groups, alliances and networks

Institutions with differing competences collaborate within the Fraunhofer Groups, Alliances and Networks in order to mutually manage and promote a business segment.

The WKI is a member of the Group MATERIALS, of the Alliances Building Innovation, Vision, Lightweight Design and Technical Textiles as well as in the Fraunhofer Networks Sustainability and Science, Art and Design. Additionally, the Fraunhofer WKI is a member of the Cultural Heritage Research Alliance.

Fraunhofer Group MATERIALS

Fraunhofer materials research covers the entire value chain, from new material development and improvement of existing materials through manufacturing technology on a quasi-industrial scale, to the characterization of properties and assessment of service behavior. The same research scope applies to the components made from these materials and the way they function in systems. In all these fields, experimental studies in laboratories and technical institutes are supplemented by equally important numerical simulation and modelling techniques – across all scales, from individual molecules up to components and process simulation. As far as materials are concerned, the Fraunhofer MATERIALS group covers the full spectrum of metals, inorganic non-metals, polymers and materials made from renewable resources, as well as semiconductor materials.

www.materials.fraunhofer.de

Fraunhofer Network Science, Art and Design

How can science be inspired by art - and vice versa? What parallels exist in the work of researchers and creative minds? How can they benefit from mutual dialogue? The Network for Science, Art and Design, founded within the Fraunhofer-Gesellschaft in 2018, is addressing these questions.

www.art-design.fraunhofer.de

Fraunhofer Building Innovation Alliance

The objective of the Fraunhofer Building Innovation Alliance is to represent and process all scientific and research-relevant questions on the topic of construction from a single source within Fraunhofer. This will provide the construction industry with a central contact point for integral system solutions.

www.bau.fraunhofer.de

Fraunhofer Lightweight Design Alliance

Lightweight construction means the realization of a weight reduction with sufficient rigidity, dynamic stability and strength. Hereby must be ensured that the developed components and structures can safely fulfill their task throughout their service life. The material properties, the constructive design, the construction method and the manufacturing process significantly determine the quality of a lightweight structure. The entire development chain, from material and product development through series production to approval and product application, must therefore be considered.

www.leichtbau.fraunhofer.de

Fraunhofer Technical Textiles Alliance

In order to fully exploit the potential of high-performance fibers for textile-reinforced lightweight structures, innovations must be created through application-oriented and product-specific developments of textile-based technologies and systems with direct linkage to preform and component manufacturing. The entire textile manufacturing chain is covered by the Fraunhofer Textiles Alliance, starting from fiber production and functionalization.

www.textil.fraunhofer.de

Fraunhofer Vision Alliance

The Fraunhofer Vision Alliance combines the expertise of institutes in the field of image processing. The allied institutes offer services relating to applications of innovative sensors, from infrared to x-ray, plus the associated handling apparatus. Their work focuses particularly on optical sensing and automated inspection processes for quality assurance.

www.vision.fraunhofer.de

Cultural Heritage Research Alliance

The highest priority of this interdisciplinary alliance is the preservation of our cultural heritage through research and innovation in materials science. Documents, paintings, sculptures and historic buildings are not only invaluable precious idealistically for society; they also represent an enormous economic factor.

www.forschungsallianz-kulturerbe.de

Fraunhofer Sustainability Network

The Fraunhofer Sustainability Network seeks to orient research and technical developments at the Fraunhofer-Gesellschaft more strongly towards the principle of sustainability and to develop a distinct image profile for this which is clearly recognizable both internally and externally. The Network is thus supporting the Fraunhofer-Gesellschaft's current strategy process involving twelve future-related topics under the title of "People need a future - the future needs research".

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 Association is one of 100 sector-orientated research associations which are members of the AiF (German Federation of Industrial Research Associations). We would like 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 BMWi via AiF),
- 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.
 Bienroder Weg 54 E | 38108 Braunschweig | Germany
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 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. It is a trailblazer and trendsetter in innovative developments and research excellence. The Fraunhofer-Gesellschaft supports research and industry with inspiring ideas and sustainable scientific and technological solutions and is helping shape our society and our future.

The Fraunhofer-Gesellschaft's interdisciplinary research teams turn original ideas into innovations together with contracting industry and public sector partners, coordinate and complete essential key research policy projects and strengthen the German and European economy with ethical value creation. International collaborative partnerships with outstanding research partners and businesses all over the world provide for direct dialogue with the most prominent scientific communities and most dominant economic regions.

Founded in 1949, the Fraunhofer-Gesellschaft currently operates 76 institutes and research units throughout Germany. Over 30,000 employees, predominantly scientists and engineers, work with an annual research budget of €2.9 billion. Fraunhofer generates €2.5 billion of this from contract research. Industry contracts and publicly funded research projects account for around two thirds of that. The federal and state governments contribute around another third as base funding, enabling institutes to develop solutions now to problems that will become crucial to industry and society in the near future.

The impact of applied research goes far beyond its direct benefits to clients: Fraunhofer institutes enhance businesses' performance, improve social acceptance of advanced technology and educate and train the urgently needed next generation of research scientists and engineers.

Highly motivated employees up on cutting-edge research constitute the most important success factor for us as a research organization. Fraunhofer consequently provides opportunities for independent, creative and goal-driven work and thus for professional and personal development, qualifying individuals for challenging positions at our institutes, at higher education institutions, in industry and in society. Practical training and early contacts with clients open outstanding opportunities for students to find jobs and experience growth in business and industry.

The prestigious nonprofit Fraunhofer-Gesellschaft's namesake is Munich scholar Joseph von Fraunhofer (1787–1826). He enjoyed equal success as a researcher, inventor and entrepreneur.

Figures as of: January 2022
www.fraunhofer.de

Impressum

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Entrance area of the newly built "Center for Light and Environmentally-Friendly Structures ZELUBA®".
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Aerial view of the Fraunhofer campus in Braunschweig.
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Portrait image of Professor Bohumil Kasal.
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Birch logs.
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Wooden cross-sections joined in the Fraunhofer WKI vacuum press.
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