TECHNISCHE UNIVERSITÄT DRESDEN

Research Report 2022

Institut für Leichtbau und Kunststofftechnik

List of Abbreviations

TUD	Technische Universität Dresden
ILK	Institute of Lightweight Engineering and Polymer Technology at the TU Dresden

Overview
research report 2022

https://tu-dresden.de/ing/maschinenwesen/ilk/das-institut/veroeffentlichungen-ilk?set_language=de#

Content

Prof. Dr.-Ing. habil. Maik Gude

Chair of Lightweight Systems Engineering
and Multi Material Design
Speaker of the board

Prof. Dr. rer. nat. Hubert Jäger

senior professorship

Prof. Dr.-Ing. Niels Modler

Chair of Function-integrative Lightweight
Engineering

Introduction

"We cannot change the wind, but we can set the sails differently" - Aristotle is said to have given us this wise saying more than 2,300 years ago. For us as scientists, however, it does not mean blindly following the ever faster changing spirit of the times, but recognising the important currents and thus setting useful and noticeable impulses in the implementation of urgent tasks.

Under the star of a now controllable pandemic, in 2022 we managed to achieve decisive milestones on our way, which we would like to present to you on the following pages. In addition to many small and large successes, however, it is the opening of the National Lightweight Validation Centre (LEIV) that marks the past year for us. We fought for more than ten years for the establishment of such a demonstration and transfer factory and finally brought it to life in a joint effort of the BMWK and the BMBF. Embedded in the Handelsblatt Innovation Summit, the ceremonial opening was attend ed not only by high-ranking representatives from politics, science and administration but also by more than 1,000 innovation ambassadors from industry. Our declared and, above all, achievable goal is to save more than 80 % of greenhouse gases by 2030 in the production of lightweight high-tech structures. In this context, the LEIV serves as a place for research and also for the transfer of know-how to industry.

In a globalised world, it goes without saying that the focus must not remain limited to our SME-oriented region or our closer European surroundings. A special example of this networking idea is the expansion of our long-standing relationships with researchers from India, which we were able to give new directions and significantly more depth with a large delegation last autumn. After the splendid 25th Anniversary Lightweight Engineering Symposium this year, which met with a particularly broad response with the motto "Neutral lightweight engineering – routes to a world in balance!", we will focus entirely on this valuable cooperation between India and Germany in 2023.

There are many keywords that did not make it into the foreword: new ideas and solutions for the use of hydrogen in aviation, ILK initiatives for dual training, presidents and representatives from 20 German Chambers of skilled crafts in discussion, the National Round Table LCA, which has returned to presence. Above all, we care about your support as well as your interest as a supporter of Dresden's lightweight engineering. We invite you to continue to accompany us and to set sail with us for our students and researchers towards a liveable and positive future.

We wish you a successful and healthy year 2023. May our Research Report 2022 inspire you and offer new impulses for your work.

Prof. Dr.-Ing. habil. Maik Gude

Prof. Dr. rer. nat. Hubert Jäger

Prof. Dr.-Ing. Niels Modler

The Year 2022

Life cycle analysis and its significance in neutral lightweight engineering

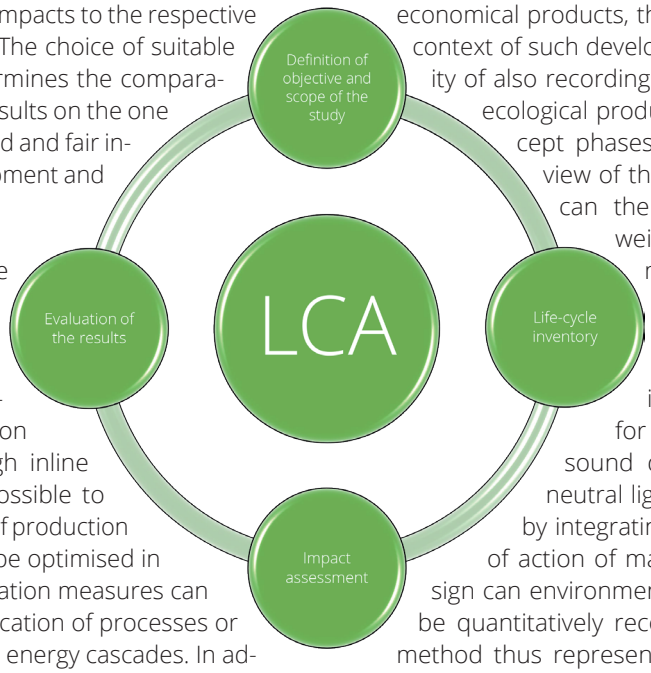
Lightweight Engineering is a decisive key technology for environmentally compatible mobility, sustainable energy supply and efficient production processes. However, the primary goal of lightweight engineering, the reduction of material use and resources, must be expanded in the future to include aspects of sustainability and circular economy in order to avoid emissions over the entire product life cycle and to ensure the long-term availability of high-tech materials. The concept of neutral lightweight engineering, which emerged against this background, is steadily establishing itself in industry and science, driven by ongoing social and political pressure. Innovative recycled or bio-based materials that fulfil the technical properties of virgin materials, AI-optimised production control and sustainability-oriented development processes are no longer topics of the future but are lived every day. When researching and implementing these topics, however, the question always arises: Is an idea more sustainable than the current state of the art? In order to answer such questions, life cycle assessment (LCA) is used.

Life cycle analysis is a method for the holistic assessment of the environmental impacts of a product or service. The method enables a systematic quantification and analysis of the environmental impacts along the different life cycle phases, starting with the extraction of raw materials, through production, transport processes and use to the end-of-life phase. By its standardisation, LCA is divided into four essential phases: the definition of the objective and the scope of the study, the life cycle inventory, the impact assessment and the evaluation of the results. While precise standardisation and increasingly sophisticated software solutions simplify the implementation of most phases of LCA, the life cycle inventory is usually the most time-consuming phase. For a system to be assessed, all material and energy flows entering and leaving the scope of the study must be quantified. The use of increasingly comprehensive databases facilitates this process. Against the background of increasing material diversity and highly individual production processes, however, the existing database quickly reaches its limits, so the efficient determination of primary data plays an increasing role.

In neutral lightweight engineering, life cycle analysis is applied in all three essential fields of action. At the material level, the environmental impacts of the materials are recorded within the framework of cradle-to-gate balances.

Materials that are recycled, but also biobased or chemically recycled, are often characterised by a significantly improved ecological property profile compared to primary materials. For cross-life cycle considerations, the allocation of environmental impacts to the respective life cycles also plays a role. The choice of suitable allocation procedures determines the comparability of the balance sheet results on the one hand and aims to set targeted and fair incentives for product development and recycling on the other.

At the technology level, the environmental impacts of production are usually assessed within the framework of gate-to-gate balances. The efficient collection of e.g. energy data through inline measurements makes it possible to identify ecological hotspots of production processes so that they can be optimised in a targeted manner. Optimisation measures can be, for example, the electrification of processes or the use of waste heat within energy cascades. In addition to production processes, this also applies to recycling processes in particular. Particularly in the context of upcycling technologies, process optimisation by means of LCA plays a decisive role in making lightweight materials recyclable due to the high energy input. Furthermore, LCA represents an important instrument within sustainable product development. While classic development processes aim to generate technically high-quality and economical products, the application of LCA in the context of such developments offers the possibility of also recording, evaluating and optimising ecological product properties in early concept phases. Only by taking a holistic view of the life cycle in development can the optimum between lightweight design, materials and manufacturing technologies be found.



Overall, life cycle analysis is an indispensable method for making environmentally sound decisions in the sense of neutral lightweight engineering. Only by integrating LCA into the three fields of action of material, technology and design can environmental impacts and potentials be quantitatively recorded and optimised. The method thus represents a necessary tool within neutral lightweight engineering in order to achieve the ideal of a resource-neutral circular economy for highly stressed lightweight structures.

Together for a Sustainable Future: The 25th International Dresden Lightweight Engineering Symposium 2022

At a time when the world is facing great challenges, the Symposium reminds us that neutral lightweight engineering is the way to restore the balance between people and the environment. It is the vision of a sustainable future. The Lightweight Engineering Symposium 2022 was a glimmer of hope that this vision can become a reality.

The event highlighted the importance of lightweight engineering as a key to sustainability. An environmentally friendly economy does not necessarily require strict asceticism, but nevertheless a conscious use of the resources still available as well as a reduction to the most necessary value and materials. Modern lightweight systems engineering has been researched in Dresden since the early 1990s and has become a central approach to a climate-friendly industry. Lightweight engineering technologies are a powerful lever for the social-ecological market economy of the future.

The ILK recognised the urgency of this task back in 2017 and began research into environmentally neutral and globally fair product and process design that goes far beyond the current state of the art and opens up broad research and development potential for the coming decades.

After two years marked by the pandemic, the Symposium 2022 finally returned to presence. Under the motto "Neutral lightweight engineering – routes to a world in balance", more than 300 guests from science, industry and politics came together to outline and discuss the ways to a future worth living. The anniversary symposium promised top-class lectures and in-depth insights from renowned experts who will help us shape the future of lightweight engineering.

Particularly fascinating were the presentations that provided vivid examples of how economic incentives can be used as powerful accelerators for environmental protection and resource conservation. These innovative concepts may hold the key to creating a more socially just and liveable world for future generations under limited

resource conditions.

The Lightweight Engineering Symposium featured an impressive series of presentations that advanced the vision of neutral lightweight engineering. Dr. Thomas Becker spoke about the BMW Group's sustainability strategy, highlighting the commitment of a global automotive company to reduce its environmental footprint. Dr. Oliver Schauerte discussed new lightweight solutions in the context of e-mobility, circular economy and carbon footprint and explained how these factors are shaping the future of the automotive industry. In addition, Nicolai Neumann and Prof. Dieter Peitsch from the Institute of Aeronautics and Astronautics, Department of Aerospace Propulsion Systems, TU Berlin shared insights into new lightweight solutions in the context of e-mobility, circular economy and carbon footprint. The presentations underlined how the industry can implement sustainable approaches in practice.

The 25th International Dresden Lightweight Engineering Symposium 2022 was characterised by forward-looking socio-eco-technological ideas and innovations that implemented the triad of people, technology and environment in an exemplary manner. It was a call to action, a promise to achieve the necessary changes together.

Member of the board: Prof. Dr.-Ing. habil. Maik Gude in the lecture.

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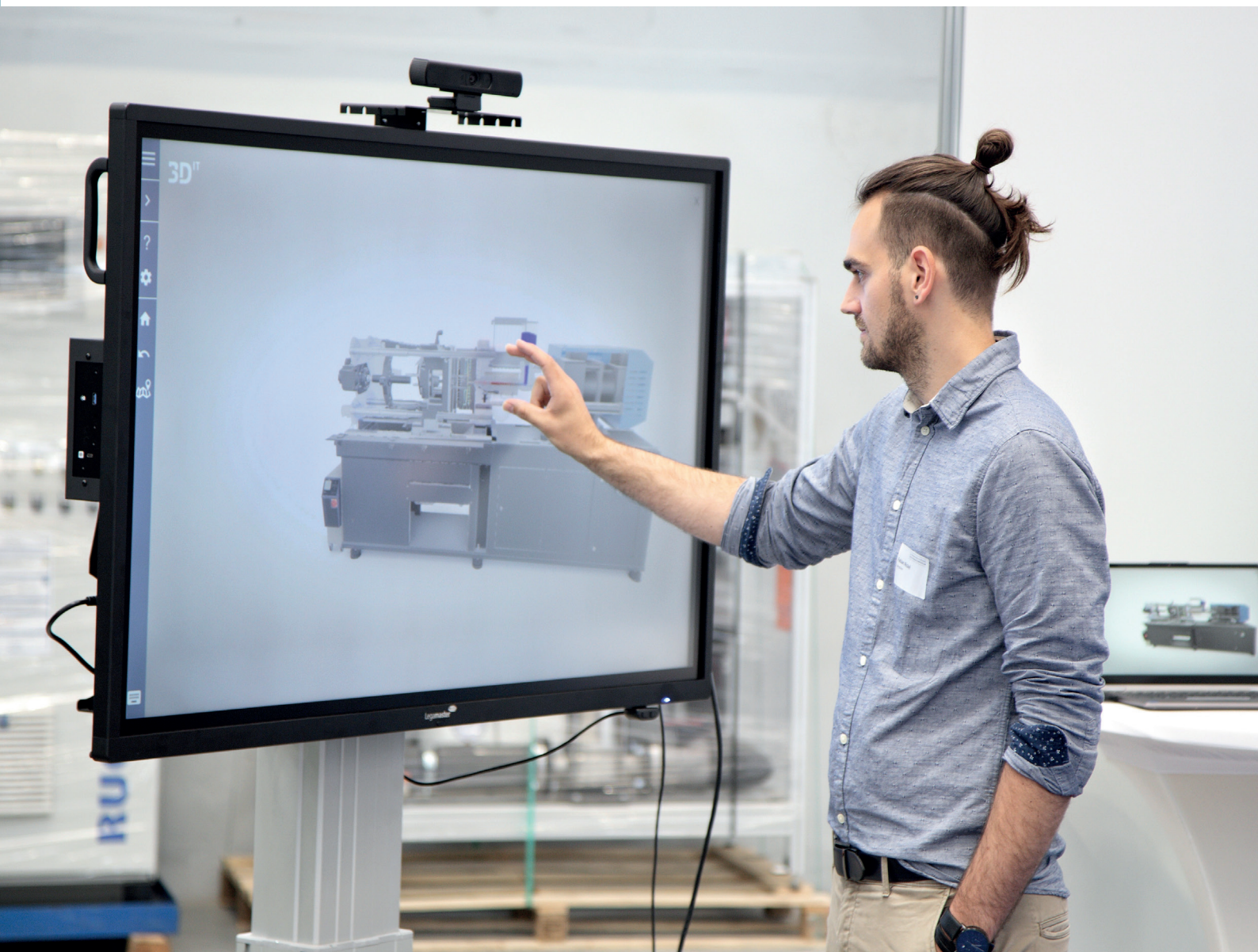

Prof. Dr.-Ing. habil. Maik Gude takes over professorship for Lightweight Systems Engineering and Multi Material Design at the ILK

The ILK is delighted to announce the appointment of Prof. Dr.-Ing. habil. Dipl.-Math. Maik Gude as the new Professor of Lightweight Systems Engineering and Multi Material Design. This appointment evidences both the professor and university's dedication to pioneering research and advanced education in the field of lightweight engineering and polymer technology.

The professorship taken over by Prof. Gude is dedicated to the comprehensive development, evaluation and technological implementation of innovative lightweight structures and -systems. The focus here is on the application of novel fibre composites, polymeric, metallic and ceramic construction materials as well as material composites for the production of series-ready, complex components, parts and systems. The research covers different fields of application, including vehicle construction, electromobility, aerospace, mechanical and plant engineering and energy technology.

With Prof. Gude's extensive research and development experience and solid fundamental knowledge from his previous professorship of Lightweight Design and Structural Assessment in lightweight system construction, mixed construction methods, and lightweight construction technologies, he possesses a broad range of expertise that is also beneficial for teaching purposes. This is particularly relevant in the Mechanical Engineering degree programme, where he will be responsible for courses such as "Fundamentals of Lightweight Construction", "Designing with Fibre Composites", "Modelling and Calculation of Composite Materials and Structures", "Fibre Composite Technologies" and "Joining Techniques for Mixed Construction Methods". Practical courses will be offered alongside the modules to provide students with hands-on experience.

Prof. Gude is distinguished by his international research profile. His work concentrates on generating novel, energy- and resource-efficient lightweight structures, developing customised manufacturing processes and joining techniques, as well as designing stress-appropriate reinforcement structures. He also carries out extensive research into digitisation and design methods, and the development of virtual twins for structures and processes. His commitment and excellent work have led to him taking over the professorship for Lightweight Systems Engineering and Multi Material Design at a nationally and internationally renowned institute with over 200 employees and strong third-party funding.

The ILK looks forward to following the developments and successes of the Professorship of Lightweight Systems and Mixed Structures under Prof. Gude's leadership in the coming years and is excited about the innovations that will emerge from this partnership. The ILK wishes Prof. Gude a successful and productive tenure in his new professorship.


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The National Lightweight Validation Center (LEIV) – Opening of the LEIV as a bridge between research and industrial practice

Recyclable lightweight technologies are a key to a sustainable economy and industrial future. The opening of the National Lightweight Engineering Validation Centre (LEIV) on 14 June 2002 marked a major step towards the rapid, direct transfer of research results in the field of Neutral Lightweight Engineering into industrial practice, from which small and medium-sized enterprises (SMEs) in particular will benefit. The LEIV is a point of contact at eye level, which quickly and purposefully prepares the latest research results for their specific challenges, away from large-scale research projects or long-term collaborations. The particular reach of the LEIV real laboratory is achieved through the direct transfer of know-how to industry. Through a cross-border collaborative demonstration on an industrial scale, the transfer of knowledge becomes literally tangible and thus significantly accelerated.

With the start-up financing from the budget of the Technology Transfer Programme for Lightweight Construction (TTP LB), the German Federal Ministry of Economics and Climate Action (BMWK) has created an exposed stepping stone in Dresden, which for the first time can be used to create a largely environmentally neutral production network for sustainable lightweight engineering. The approximately 1,500 square metre test area in the LEIV was built by IMMOPACT Immobilien GmbH on the grounds of the Universelle Werke in Dresden in a record time of only 14 months for around seven million euros. Most of the equipment already installed at the start, worth around 12 million euros, was purchased over ten years by the Research and Technology Center for Resource-Efficient Lightweight Structures (FOREL). Previously funded mainly by the German Federal Ministry of Education and Research (BMBF), the FOREL cluster is now one of the most successful European lightweight engineering networks with more than 120 active partners.

The symbolic button for the opening was pressed by Michael Kellner, Parliamentary State Secretary at the German Federal Ministry for Economics and Climate Action. (BMWK), Dr. Robert Franke, Head of the Office for Economic Development of the City of Dresden, Prof. Ursula M. Staudinger, Rector of the TU Dresden, Prof. Niels Modler, Member of the board of the ILK, and Prof. Maik Gude, Spokesman of the board of the ILK. Professor Gude spoke of a milestone for european lightweight engineering research, which the BMWK in Dresden had helped to make possible. "Our efforts to achieve a sustainable approach to the development and manufacture of largely resource-neutral high-tech products are being brought to life here at LEIV. Our vision of neutral lightweight engineering is now within reach".

Awards and Prizes 2022

In 2022, the Institute of Lightweight Engineering and Polymer Technology achieved significant successes, which were recognised by a number of awards and prizes.

Chairman's Farewell PhD Bursary Award 2022

At the Rolls-Royce UTC Directors Seminar in Derby, England, in November 2002, scholarships were awarded in the name of former Chairman Sir Ian Davis for outstanding engineering achievements in support of the environment. One of the deserving recipients is Mr. Levin Schilling, whose work in the field of lightweight construction is outstanding. The acknowledged achievement doesn't come without reason. It builds on the success of his diploma thesis, which was awarded the WAK prize. Mr. Schilling has specialized in two key areas: life cycle engineering and the integration and application of life cycle analysis in the early stages of product development. These key research areas are crucial because they enable a holistic view of products over their entire life cycle, which is particularly important in aviation. The aviation industry faces the challenge of developing and operating more environmentally friendly aircraft. This is not only about reducing fuel consumption but also about reducing emissions and using sustainable materials. This is where Levin Schilling's work comes in. His research helps minimize the environmental impact of aviation development decisions by providing a long-term, holistic perspective.

The ILK congratulates Mr. Schilling on the award and wishes him continued success on his way to designing innovative solutions for an environmentally friendly future!

Ceremonial presentation of the "Chairman's Farewell PhD Bursary Award 2022" by Chris Young to Mr Levin Schilling.

SICK sponsorship award for pioneering work in sensor technology

For his work during a research internship at the ILK, Mr. Nils Wieja was honoured with the renowned SICK Promotion Award for Sensor and Measurement System Technology. Mr. Wieja received the award for his project work, in which he investigated the correlation between mechanical and electrical properties of carbon fibres. Carbon fibres are complex materials consisting of numerous individual carbon filaments and therefore exhibit a wide range of properties. Understanding the interactions between these properties is crucial for the development of carbon fibre-based sensors and measurement systems.

The special feature of Mr. Wiejas' work lies in the identification of probabilistically distributed dependencies on the microscale (see Fig. 01). These findings allow for the first time a combined description of the mechanical and electrical property distributions of carbon fibers. This forms the basis for a deeper understanding of load-bearing sensor systems based on carbon fibers and opens up new possibilities for their development.

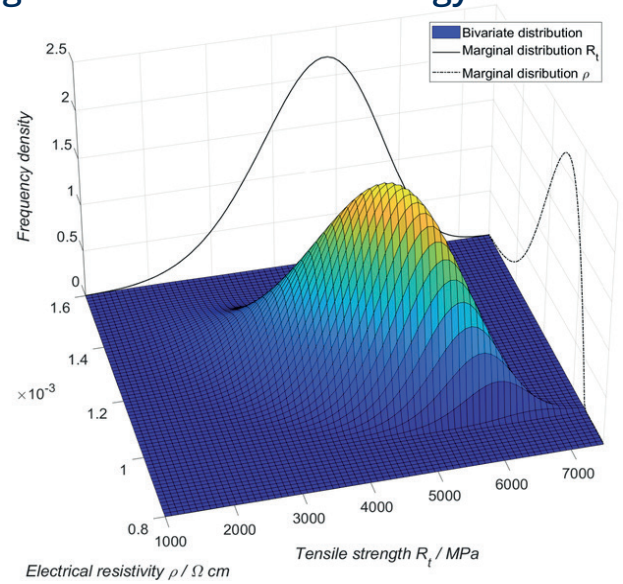
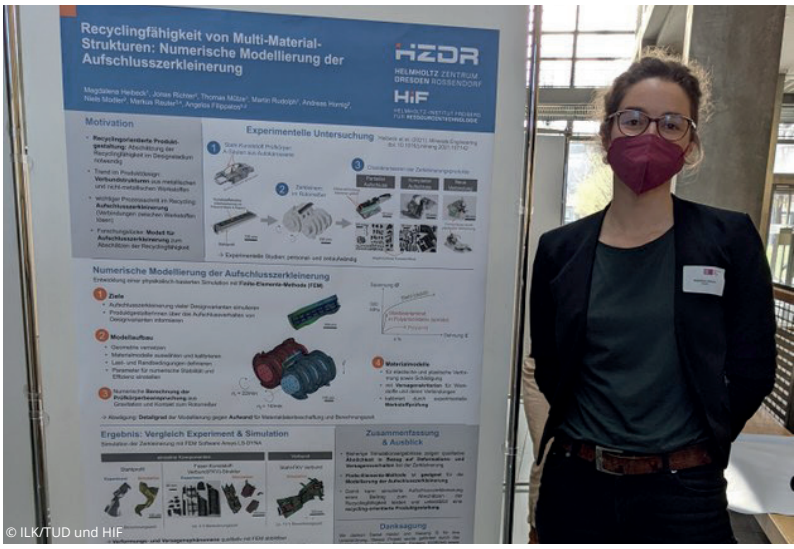


Abb. 01 Multivariate property distribution of one of the investigated carbon fibers.

DGWA Science Award for the intended ILK/HIF promotion on sustainable product design of multi-material structures

In March 2022, the 11th DGAW Scientific Congress "Waste and Resource Management" took place at the TU Dresden. During the event, Magdalena Heibeck's PhD project on predicting and improving the recyclability of multi-material structures received special recognition from the expert audience, with her poster being awarded third best topic.

The award-winning PhD project aims to predict and improve the recyclability of composite structures already at the design stage. A particular focus is on evaluating the disintegration behaviour during the comminution process. For the first time, the finite element method is being used to model disintegration during the recycling process. In the future, this simulation should help to investigate different design variants and analyse their behaviour in the comminution process, which represents an important contribution to the development of recycling-friendly products.



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The award winner, Ms Magdalena Heibeck, next to the winning poster for her dissertation at the DGAW Science Congress.

The dissertation is the result of a successful cooperation between the ILK and the Helmholtz Institute Freiberg for Resource Technology (HIF) of the Helmholtz Zentrum-Dresden - Rossendorf (HZDR). The project is supervised by Prof. Niels Modler (ILK, Chair for Function-integrative Lightweight Engineering) and Dr. Angelos Filippatos (Dresden Center for Intelligent Materials (DCIM) at the TU Dresden), supported by Jonas Richter, Thomas Mütze, Dr. Martin Rudolph, Dr. Andreas Hornig and Markus Reuter. The project is funded within the framework of the HIF project "Circular by Design", in whose thematic context it is located as a side project.

Oechsler Prize honours first joint dissertation between TU Dresden and the University of Bristol

The Scientific Working Group of Plastics Engineering (WAK) has established itself as an organisation that recognises and promotes excellent research in the field of plastics engineering. Each year, the WAK awards the coveted Oechsler Prize for the best scientific work in the field of innovative processes and approaches in the design and manufacture of plastic components. On 24th October 2022, the Oechsler Prize was marked by a collaboration between the TU Dresden and the University of Bristol and was awarded in Düsseldorf at the "K 2022" trade fair.

Dr.-Ing. Mario Adrian Valverde was awarded the prize for his dissertation entitled "An Improved Description of the Bonding and Consolidation for Overmoulded Thermoplastic Composite Ribbed Plates".Adhesion and consolidation of thermoplastic fibre composite sheets are critical factors in the manufacture of plastic components, especially in industries such as automotive and

Oechseler Award Ceremony at K 2022 in Düsseldorf.

aerospace, where light weight and strength are of great importance.Dr Valverde's thesis contributes to a better understanding of these aspects and provides innovative solutions.

Dr. Valverde's work was supervised by Prof. Dr.-Ing. habil. Gude.The collaboration between the PhD student and his supervisor demonstrates the importance of academic guidance and support in promoting high quality research. It is an excellent example of international cooperation between different educational institutions contributing to the quality and relevance of research.

Karl-Kolle-Prize for Master's thesis in the field of lightweight engineering

During the graduation ceremony of the Faculty Mechanical and Energy Engineering at the University of Applied Sciences Leipzig (HTWK), the coveted Karl Kolle Prize was awarded for the best Master's thesis. The award went to Dipl.-Ing. Willi Zschiebsch for his outstanding work in the field of mechanical engineering. In his thesis, entitled "Conception and Implementation of a Methodology for the Realization and Optimization of Automated Development Processes in Fiber Composite Lightweight Design", Zschiebsch addressed the question of how experts from different disciplines can work together effectively in the development of lightweight products.

As part of his thesis, Zschiebsch worked on the development of a software tool specifically tailored to the needs of lightweight composite design. This tool made it possible to reduce the high costs and development times that often occur in practice, even when the optimisation goals are sometimes contradictory. The integration of this tool into the development process opened up new possibilities for more efficient collaboration between the technical experts.

Willi Zschiebsch's work was carried out in close collaboration with the TU Dresden. At the HTWK Leipzig, the work was supervised by Prof. Robert Böhm (Chair of Lightweight Construction with Composite Materials), while Dr.-Ing. Angelos Filippatos from the Dresden Centre for Intelligent Materials (DCIM) at the TU Dresden was the co-supervisor. The collaboration of these two renowned institutions contributed to the success of the work.

The winner of the 2022 Karl Kolle Prize, Dipl.-Ing. Willi Zschiebsch (left) with his supervisor Prof. Robert Böhm (right).

The Karl Kolle Foundation has been promoting science and research since 1998. By awarding doctoral and half scholarships, grants for stays abroad or research projects and by honouring outstanding scientific achievements, it supports work dedicated to the topic of "Human – Technology – Environment".

Internationalisation

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Australia	Deakin University, Melbourne/Geelong
Belgium	Ghent University
China	Tongji University, Shanghai University of Shanghai for Science and Technology (USST) Tianjin University
Greece	University of Patras (UoP)
Great Britain	University of Oxford University of Bristol University of Nottingham Queen's University Belfast Imperial College London
India	Indian Institute of Technology, Neu Delhi (IIT Delhi) Indian Institute of Technology, Madras (IIT Madras)
Latvia	Technical University, Riga
Netherlands	Technical University Delft
Poland	Politechnika Warszawska, Warschau Politechnika Wrocławska, Breslaun Akademia Górniczo-Hutnicza, Krakau Politechnika Śląska, Gleiwitz
Singapore	Nanyang Technological University (NTU)
South Korea	Inha University (IU), Incheon Korea Institute of Science and Technology (KIST), Jeonbuk Branch Korean Institute of Material Science (KIMS), Changwon Jeonbuk National University (JBNU), Jeonju

Think globally, act jointly: The ILK's international research network

Finding joint answers to the questions of our time requires interdisciplinary cooperation worldwide. Throughout its 29-year history, the ILK has always been committed to building relationships and supplementing its own competences with the expertise of international partners. From student exchanges and visits by visiting researchers to the realisation of joint international projects and events - a broad international network with leading research institutions and renowned scientists has been established at all levels and continues to grow from year to year.Our strategic focus is on strengthening cooperation with established partner institutions in **India, South Korea, Singapore, China** and **Greece** as well as further promoting and intensifying cooperation with **Poland** and the **UK** in the areas of education, digitalisation, joint research as well as knowledge transfer and knowledge dissemination. Existing collaborations will be bundled and strategically advanced, particularly with regard to the **UTC Dresden** and the international **DAAD education projects**: the EDI:TUD project with a special focus on the integration of international students, the bilateral IGP project COMPOLL with IIT Delhi and mobility projects as part of the Partnership for Early Career Researchers (PPP) programme, especially with Poland. Finally, the regularly organised international summer schools are of crucial importance for the Institute's internationalisation strategy.

The efforts of ILK contribute to building an international community of researchers and their institutions, promoting cutting-edge innovations and lightweight solutions globally, particularly those that are resource-efficient. The goal is to find collective answers to the pressing questions of our time.

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Successful – Digital – Integrated. The second project year

The STIBET II project "Successful - Digital - Integrated: Studies at the TU Dresden" (EDI:TUD), which was launched in 2021, aims to research and improve the welcoming culture and integration of international students at the TU Dresden. The results of the pilot project, which is funded by the DAAD and the German Federal Foreign Office until 2023 and carried out at the ILK, are to be extended to other faculties and institutions at the TU Dresden in the long term.

The focus of the project is to support international students on their educational path at the TU Dresden through suitable measures and thus promote their integration. The aim is to reduce drop-outs, shorten the overall duration of studies, improve study results and derive recommendations for action. The project places particular emphasis on recognising language barriers as a possible source of uncertainty for students, which in the worst case can lead to students dropping out. Another aim of the accompanying research as part of the EDI:TUD project is to evaluate the study conditions for international students at the TU Dresden. In a next step, this research work will form the basis for a follow-up project to analyse the study and living situation of students. The results of EDI:TUD so far show that the targeted promotion of integrative and interactive meeting spaces between international and German students can make a significant contribution to improving the welcoming culture and integration. At the ILK, which is home to a considerable number of international students, mainly from China, these findings are particularly relevant. In order to encourage exchange between students, student mentors are appointed to organise various meetings, joint activities and smaller student events. Against this background, the EDI:TUD team plans and realises a variety of sports and cultural events for all ILK students, with a special focus on international participants, in addition to academic activities. These events promote both social integration and mutual understanding and also help to celebrate the diversity of the student body.

Further information on the project and its results can be found in the article "Willkommenskultur im Fokus" by Dr Franziska Schulze Stocker (ZQA - Centre for Quality Analysis at the TU Dresden) in the Dresdner Universitätsjournal:

https://tu-dresden.de/ing/maschinenwesen/ilk/das-institut/news/edi-tud-im-letzten-dresdner-universitaetsjournal

Close neighbourhood partnership with the Czech cluster WASTen

The Czech-German workshop "Recovery of Valuable Materials" of the TU Dresden, the Saxon Agency for Structural Development GmbH (SAS) and the Czech cluster WASTen took place on 26/27th September 2022 as part of the cross-border cooperation between the Engineering Sciences Department (ING) of the TU Dresden and the Czech Republic. At the two-day workshop, high-calibre representatives from the TU Dresden, the Jan Evangelista Purkyně University Ústí nad Labem and the Czech cluster WASTen met with various other experts from science, politics and business to discuss the recovery of valuable materials from waste and residual materials. The ING department was represented in the front row by its spokesperson Prof. Michael Beckmann and Ms. Maike Heitkamp-Mai, the department's International Affairs Advisor. The interests and perspectives of the WASTen cluster were represented by high-ranking members of the cluster, such as Dr. Radek Hořenovský, Vojtěch Brož and Tadeas Rusnok. Prof. Maik Gude and Ms. Radka Tomečková, ILK International Affairs Advisor, were present on behalf of the ILK. The highlight of the event was the round table

The participants of the workshop "Recovery of Valuable Materials", Sep. 2022.

discussions, which stimulated a lively exchange. While Prof. Gude presented the innovations of future-oriented, resource-efficient lightweight construction and plastics technology at the "Plastic Materials & Composite" table, Ms. Tomečková was able to support the trilingual, German-Czech-English debates of the experts with her personal background. With around 60 participants, the first Czech-German workshop on important future-oriented topics in the context of materials science was able to strengthen cross-border cooperation between the TU Dresden and the Czech Republic and systematically expand the individual partnerships into a network. The meeting thus marks an important step towards institutional cooperation and paves the way for future joint projects and initiatives.

Progress and innovations in the Polish Partnership 2022

The Joint PhD Programme between Politechnika Warszawska and the ILK, which was launched in 2017, made significant progress in 2022. Representatives from both institutions met at Politechnika in Warsaw on 11th July 2022 to plan the next steps and strengthen the cooperation. The meeting was attended by high-ranking personalities, including Prof. Anna Boczkowska from Politechnika Warszawska and Prof. Maik Gude from the ILK. Changes to the legal framework on the Polish side made it necessary to adapt the existing agreements between the two universities. The revisions were initiated at this meeting. Two new candidates for the joint PhD programme are also already in the starting blocks.

The fourth Saxon-Polish Innovation Day, which took place on 15/16th September 2022 at the Politechnika Wrocławska (PWR), is another milestone in the sustainable, cross-border cooperation between science and industry between the Free State of Saxony and the Republic of Poland. This innovation summit, which was held under the motto "The future of European industry: flexible – digital – sustainable" and focused on the megatrends of sustainability and digitalisation, was organised by the TU Dresden in cooperation with the Saxony Economic Development Corporation (WFS), the Saxony's Liaison Office in Wrocław and the City of Wrocław.

Saxony's Minister President Michael Kretschmer opened the event, while Justice Minister Katja Meier accompanied the second day of the event. The cooperation agreement between the TU Dresden and PWR was also ceremoniously renewed during the Innovation Day.

Now in its fourth year, the Saxon-Polish Innovation Day remains an important platform for cross-border dialogue on jointly tackling global challenges, particularly in the areas of climate protection and sustainability.


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Cooperation with Riga Technical University and Development of new co-operation projects with T.I.M.E. Association

From 18th to 29th July 2022, the summer school on "Fracture Structures" took place at Riga Technical University (RTU), which was organised under the leadership of RTU and with the participation of the TU Dresden, LUT Finland and Politechnika Wroclawska. Scientists from all participating universities jointly designed the programme.

The ILK scientist, Dipl.-Ing. Karsten Tittmann, travelled to Riga as a guest lecturer and presented his research. In the lecture "Damage and Fatigue in Fiber Reinforced Plastics - Phenomenology and Modelling Approaches" he gave a broad overview of the research activities at the ILK and discussed the special features of the damage behaviour of fibre-reinforced plastics under monotonic and cyclic load. In addition to the presentation of the damage phenomenology from numerous experiments, a special focus was placed on the possibilities for modelling the damage. Basic modelling approaches were presented and transferred to advanced fatigue and damage models that have been developed in various past and current ILK dissertation projects.

The summer school was funded by the T.I.M.E. Association, an association of more than 50 technically orientated universities, of which the TU Dresden has been a member since 2002. Ms. Maike Heitkamp-Mai (International Affairs Advisor at the Department of Engineering Sciences) took the opportunity to take up the cooperation with RTU, especially after the long corona-related break, and to develop new approaches for future cooperation projects at departmental level together with the T.I.M.E. Associationpartners present.

Participants of the summer school "Fracture Structures".

Design, synthesis and integration of intelligent Materials: Review of the DCIM Summer School 2022

From 22th to 25th August 2022, an international summer school on the topic of "Dimensions of Intelligence in Materials" was held with the support of the TU Dresden and DRESDEN-concept. The Dresden Centre for Intelligent Materials (DCIM) organised the event. More than 30 students, doctoral candidates and young scientists came together with internationally renowned experts from the Dresden Technical Collections to discuss the design, synthesis and integration of intelligent materials.

The summer school presented various approaches to defining "intelligent" materials. These materials can perform calculations independently, assemble themselves, have sensory and actuator properties and can be integrated into complex systems and increase their functionality. The central subject of the summer school was developed from the laboratory scale and approaches for the synthesis of intelligent materials. It was also shown how simulation, modelling and design help to prepare materials for practical use. The lectures were given by renowned representatives from ETH Zurich, the University of Oxford and the University of Auckland. The laboratory visits to the Leibniz Institute of Polymer Research Dresden (IPF), the Helmholtz-Zentrum Dresden Rossendorf (HZDR) and the ILK included in the summer school programme gave the participants an insight into the research spectrum and scientific achievements of the Dresden area. A visit to the Gläsernen Manufaktur of Volkswagen successfully

International DAAD scholarship holders support the ILK doctoral students and contribute to lightweight construction research

Every year, the DAAD programme RISE Germany awards research internships to students from North America, Great Britain and Ireland, which they can complete at the TU Dresden and other Dresden research institutions. The RISE scholarship holders have the opportunity to complete a research stay of up to three months in Dresden, which is funded by the Federal Foreign Office and through institutional cooperation with various research institutions in the city.

As part of this programme, the ILK offered five places for RISE interns in 2022. The RISE programme is characterised by a number of benefits, including the support of dedicated supervisors, the internationalisation of the host institutions, the targeted further training of the scholarship holders and the opportunity to gain cultural experience.

A look at specific research projects reveals the range of topics addressed within these collaborations. These range from the vibration analysis of fiber composite structures and testing methods for hydrogen storage systems to the squeeze-flow behavior of fiber-reinforced plastics. In addition, innovative approaches such as machine learning for generating microstructures and data-driven prediction of the deformation of compliant mechanisms were explored

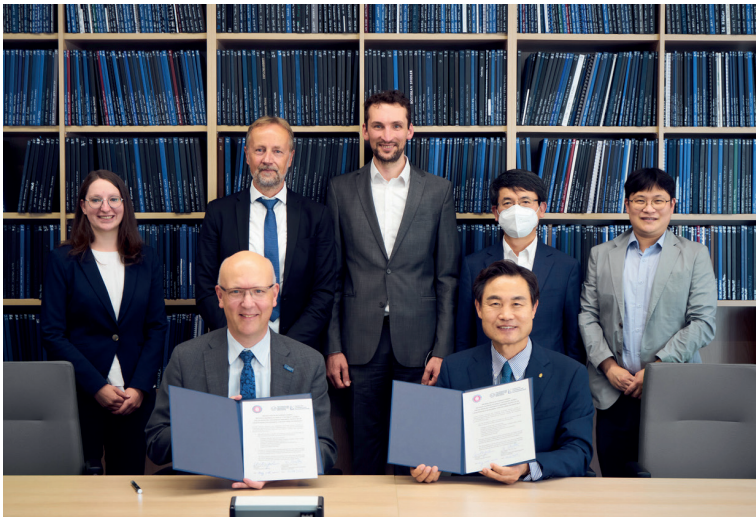
To promote networking and exchange not only among ILK fellows but among all Dresden RISE scholarship recipients, the ILK organized a meeting at the 'Fährgarten Johannstadt' on the Elbe River. The event provided an opportunity to exchange experiences and establish new contacts in a relaxed atmosphere.

South Korea.
A new 'friendship' within the Lighthouse Countries Network

The ILK has signed a Memorandum of Understanding (MoU) with Jeonbuk National University (JBNU) to strengthen future collaboration between both institutions. JBNU is a key player in the Jeonju region of Korea and is actively seeking international contacts in Europe, particularly exploring opportunities for educational exchanges and mobility activities. This initiative was brought to ILK's attention in 2022, aligning with the university's interest in fostering international partnerships.

On 10th August 2022, Professor Dong-Won Kim, President of JBNU, accompanied by the core team from JBNU's Internationalization Office, visited the ILK and its technical facilities. The delegation's visit concluded with the signing of the MoU by Professor Kim on behalf of JBNU and Professor Niels Modler on behalf of the ILK.

Jeonju, the region around Jeonbuk, is an H2 model region – from the production and storage to the utilisation of hydrogen. The ILK is also highly active in these fields. Topics such as H2 compression, transmission and storage in stationary and mobile systems and, in particular, hybrid-electric flying and H2-powered vehicles are among the ILK's areas of interest. The research areas and issues of the JBNU and the ILK overlap considerably here, so that in the first meetings in 2022, the possibilities for future joint projects between the JBNU and the ILK's "Lightweight Design" specialist group, headed by Dr Sebastian Spitzer, were already discussed in addition to the intended educational cooperation.



Signing of the Memorandum of Understanding by Prof. Modler (front left) for the ILK and Prof. Kim (front right) for the JBNU.

COMPOLL. Mobile again at last! Delegation visit at the end of the year

On 16th December 2022, a TU Dresden delegation led by Prof. Ronald Tetzlaff (CTIO of TU Dresden) travelled to India to deepen the existing university partnerships with IIT Delhi and IIT Madras and to promote the networking of TUD alumni, representatives of German science organisations and industry contacts in India. The focus of the visit was on the cooperation projects ABCD Centre and COMPOLL. During their stay in India, the delegation held talks with the heads of the institutes and faculties of the two IITs to identify opportunities for strategic cooperation. Other important topics of dialogue were the mobility of students and researchers as well as the interdisciplinary nature of potential joint projects.

In addition to the IITs, the commission established contacts with the German Research Foundation (DFG) in India, in particular via the Indo-German Chamber of Commerce (AHK India) and the German Centre for Research and Innovation DWIH New Delhi. The TU Dresden organised a meeting with representatives of German university liaison offices, funding organisations and the German Embassy to discuss the options and challenges for university partnerships and student mobility between Germany and India. The COMPOLL project and the ABCD centre also carried out independent activities to intensify their respective cooperation with the corresponding IIT partner. The two-day conference "Pollution Awareness in Research and Teaching" jointly organised by the IIT Delhi and the ILK provided an excellent platform to present the latest research activities of both COMPOLL partners. This was the event in presence since the project began in 2020.

The poster session, in which excellent students and doctoral candidates from the IIT Delhi could apply for a COMPOLL scholarship with a poster presentation of their research results, was highly successful in terms of exchange and the acquisition of qualified candidates for individual COMPOLL mobilities and research stays at the ILK. In the end, Mr. Jonty Mago and Ms. Sushmita Ghosh shared the first prize for the best poster and thus also the scholarship for 2023.

The COMPOLL travel team also used the week-long stay to hold a partner meeting and various closed meetings with high-ranking department representatives, the Dean's Office and the International Office of the IIT Delhi. The insights gained into the institutional structures of the IIT, campus life and the scientific and technical network enabled structured planning of future measures until the end of the project. The COMPOLL visit to New Delhi was rounded off with intercultural leisure activities organised by the partner – a gala dinner, a city tour through the metropolis of New Delhi and the highlight: a visit to the Taj Mahal.

The COMPOLL project, its implemented activities as well as its prominent position within the TUD delegation in India, emphasise the importance of international cooperation in tackling global environmental problems. The guiding vision is to develop a better understanding of the challenges, shortcomings and solutions related to pollution awareness in the two countries, India and Germany. A comprehensive, bilateral dialogue should enable the identification of the most important aspects.

COMPOLL-Meeting at the Indian Institute of Technology Delhi.

Expert Groups

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Lightweight Design

The realisation of new ideas, such as neutral lightweight construction, requires a strategy of holistic product development. Thus, modern lightweight construction solutions represent more than a material substitution on the individual part. The scientists in the Lightweight Construction Methods Group are therefore pursuing a methodical development approach that focuses on overall systems and functional spaces in order to demonstrate the entire lightweight construction potential.

On the basis of material-appropriate design and construction approaches and with the help of methodical concept analyses, lightweight components and systems are developed up to the prototype component for cross-sectoral applications in close international industrial cooperation, which go far beyond the state of the art. The development strategy is characterised above all by the material-oriented approach, which allows all construction materials and material combinations to be considered and thus forms the basis for highly efficient hybrid lightweight construction. To achieve demanding development tasks, a systematic development process is applied that actively considers the models, methods and data to be used and makes use of possibilities for digitalisation in order to increase the effectiveness and efficiency of individual process steps and the entire development process. In particular, numerical methods that accompany the engineering design process are used.

Calculation Methods and Simulation

The development of modern lightweight structures requires scientists to exploit the whole potential a material has to offer while also enhancing the level of cost efficiency achieved. Computer-aided methods can make a decisive contribution to and are of increasing importance in future engineering development processes. Therefore, linking the calculation methods along the entire value chain plays a key role.

The scientific focus of our work lies on developing and realizing of practice-oriented methods combining multi-process, multi-material, multi-scale simulation techniques which facilitate the design of efficient lightweight materials, structures and systems in multi-material design. We benefit from the broad expertise of the ILK in the fields of experimental analysis, process engineering and design and incorporate this know-how directly into both the model development and the results evaluation processes. So, the design process, which is largely shaped by the complex interactions between material, production, joining and system behavior, can be made more robust, precise, and efficient.

Our goal is to synergistically exploit the currently insufficiently used high material-specific potential of new materials and design methods, through digital twins and data driven methods. We combine in-house developed simulation and analysis methods with commercially available software solutions.

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Thermoplastic Processing

The manufacturing of promising lightweight structures demands the availability of efficient and networked process chains. With this in mind, the research carried out by the Expert Group on Thermoplastic Processes targets maximum efficiency throughout the entire value chain and the ambitious goal of a closed material cycle with simultaneous reduction of energy requirements.

To this end, the expert group manages a complex process network starting with the development, manufacturing and characterization of novel semi-finished thermoplastic goods with tailored characteristics, for example compounds, films, tapes and organosheets. Subsequently, new preforming technologies suitable for semi-finished products are developed, ranging from near-net-shape depositing of thermoplastic tapes to braiding of complex hollow structures. The process chain ends with the development of efficient manufacturing processes based on injection molding, compression molding, pultrusion, extrusion and generative techniques. The unique machine park available at ILK's Process Development Centre enables the group's scientists to set up and test fully automated networked, robust process chains under realistic serial manufacturing conditions. The activities draw on longstanding experience and extensive know-how gained in connection with the development of innovative tooling, automation and processing techniques for the efficient manufacturing of hybrid thermoplastic structures. The group's process development activities are supported by the use of continuous process simulation.

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Thermoset Processing and Preforming

The development of efficient manufacturing processes which factor in interaction between materials, processes and component properties has an increasingly significant role to play in the field of heavy-duty fibre-reinforced composite components based on thermosetting matrix systems. In addition to robust processing techniques compatible with serial manufacturing technologies and rapid-hardening matrix systems demand for realization of individualized lightweiht structures is particularly high.

Research at ILK's Expert Group on Thermosetting Processes and Preforming focuses on the characterisation, modelling and simulation of reactive processes, the engineering of systems and processes for innovative preforming concepts and the development and refinement of novel materials, semi-finished products and corresponding processing technologies. The manufacturing of active composite structures represents another area of research emphasis, which focuses on the targeted exploitation of the moderate process conditions that characterise the processing of thermosetting matrix systems. A comprehensive technological equipment enables the group's scientists to make use of both prototypical and serial processing technologies. Areas of focus include filament winding and braiding, injection and pressing techniques, additive manufacturing and pultrusion. Interdisciplinary cooperation with ILK's other expert groups is the basis for consistent research in the different subject areas.

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Joining Technologies

In the conception, design and dimensioning of lightweight structures, the provision of suitable joining systems has a decisive importance. The aim of our Expert Group is to identify the relevant problems in the field of joining technology at an early development stage especially with regard to multi material design. Based on this, application-oriented joining solutions are identified and investigated scientifically. For this purpose, both established technologies are considered and applied to specific joining tasks as well as novel material-adapted joining methods are developed. The Expert Group pursues a holistic, material-independent development approach. It includes the technological basics, the material-structural phenomena in joining zones and the modelling of both the joining process and the load-bearing behaviour.

One main research focus are intrinsic joining zones, which are formed in hybrid structures during component manufacturing: e.g. when overmoulding laser-structured or plasma-treated surfaces. Extrinsic joining zones, which enable the integration of hybrid structures into the system environment, are another focal point: e.g. the novel joining process Hotclinching. In addition, we develop novel methods for the analysis and description of the local composite material structure in joining zones for the design and dimensioning of joining systems: e.g. for inserts embedded by warm forming.

Testing Methods and Material Models

For the design of lightweight structures and systems, the knowledge and mathematical description of the process-specific material properties as well as the damage and failure processes is essential. Due to the testing equipment at the ILK, it is possible to comprehensively record the material and component characteristics. The characterization can be carried out starting with the determination of the thermomechanical properties of the materials, through the analysis of the stiffness and strength properties of the semi-finished products, to complex load tests on structures and systems. For the correct use and further development of the experimental methods and the implementation of the findings in material models and validation strategies, the experience and competences are bundled in the specialist group Testing Methods and Material Models. We thus see ourselves as an open forum for all issues relating to scientific experimentation and description – from the choice of methodology and statistical data evaluation to interpretation and mathematical description. In the area of material models, we therefore concentrate on the elucidation and description of the process-structure-property relationships.

In the area of materials and component testing, we devote ourselves to standardized and newly developed methods of destructive and non-destructive testing and meet the challenges of new materials and hybrid functional structures.

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Function Integration

Scientists at the ILK see function integration as a physical expression of their interdisciplinarity. Our well-coordinated, multidisciplinary team unites experts from a variety of disciplines including lightweight engineering, electrical engineering, mechatronics and computer science. By ensuring the targeted combination of mechanical, electronic and software-based R&D activities, ILK is able to develop products and solutions that go far beyond the state of the art.

The institute's approach not only combines functions and reduces the number of parts at component level, but also factors system-level interactions that arise from phenomena in the different scientific "worlds". This includes the identification and targeted application of cross-sector synergies between fields such as aviation, e-mobility, energy, mechanical and plant engineering, medical technology, consumer products, custom machine building and safety equipment. Through the successful cooperation of lightweight design, electronics and software experts and the associated "speaking a common language", the scientists meet the requirements placed on them. A special focus is the integration of mechanical, electronic, acoustic, haptic, actuatory and sensory functions into overall systems.

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Novel Materials and Special Processes

In order to pave the way to a climate-neutral circular economy in lightweight engineering, “Neutral lightweight engineering” is the upgrade of the previous ILK philosophy of “Function-integrative system lightweight engineering in multi-material design”. Under this aspect, the research group Novel Materials and Special Processes addresses the targeted development and research of climate-friendly hybrid technologies for the production of new types of recyclable mixed composites with application-oriented properties.

The high degree of customisability of additive manufacturing processes, the performance of fibre materials, the adaptability of bionic structures, the tolerant failure behaviour of metallic materials as well as the thermal resistance of ceramics can open up unexpected potential and new fields of application. This intended fusion of different technologies for the highest possible functionality and improvement of utility value is the key competence of the research group Novel Materials and Special Processes.

Our research focuses both metallic and ceramic fibre composites, the development of novel “hybrid casting” technologies for Aluminium/Magnesium thermoplastic composites as well as generative manufacturing processes (e.g. continuous fibre-reinforced 3D printing), the application of electron beam technology for energy-efficient cross-linking of plastics and the development and advanced processing of customised multifunctional carbon fibres based on renewable materials.

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Neutral Lightweight Engineering

The Neutral Lightweight Engineering group conducts research on interdisciplinary sustainability-oriented issues in the context of lightweightdesign. Guided by the ILK concept of neutral lightweight engineering, we explicitly include in our research and development not only the technical and economic criteria but also the ecological and social aspects along the entire product or material life cycle. The positive vision of neutral lightweight engineering is a resource-neutral circular economy.

In particular, we address sustainability-oriented development processes for lightweight systems, the recycling of lightweight materials, resource-saving production technologies, lightweight design with materials from renewable resources, and life cycle analyses of lightweight products and technologies.

A current focus is the recycling of large-scale FRP structures from the wind power and aerospace industries and the reuse of the recycled fibers obtained in the process in lightweight components. Above that we are investigating the waste-free production of hybrid thermoplastic lightweight structures and researching how material properties change as a result of recycling and can still be reliably predicted.

It is crucial for us that, in addition to recycling, other R-strategies like repair, reuse, refurbish or remanufacture and the resulting value chains are also considered in the future product development.

Selected Projects

FATIIGUE

Experimental and numerical modeling of micro crack induced delaminations under reversed cyclic loading

The research activities within the FATIIGUE project aim at the numerical description of the delamination growth in fiber composite laminates under fatigue loading originating from inter-fiber failures. At the ILK, the influence of the different fiber orientations of the adjacent laminate layers on the delamination growth and the suitability of standardized fracture mechanics tests are investigated. For this purpose, delamination growth in fracture modes I and II was analyzed by means of cyclic Double Cantilever Beam (DCB) and End Notch Flexure (ENF) tests for parallel (0°/0°) and transverse (0°/90°) fiber orientations in the layer interface.

As a result, significantly different correlations for the delamination growth of the tested layer interface orientations were obtained in the form of Paris laws. The different parameters of the power law type relations can be explained, among other things, by the experimentally observed form of the delamination growth. It can be seen that the fracture surfaces in the 0°/90° interface are significantly rougher and characterized by several growing crack tips, which causes the crack growth to deviate from pure mode I or II growth and therefore, the real fracture surface in the DCB/ENF tests is underestimated. Thus, the experimentally determined Paris laws are questionable for the moment.

The improved analysis of delamination growth in 0°/90° interfaces is part of further research work.

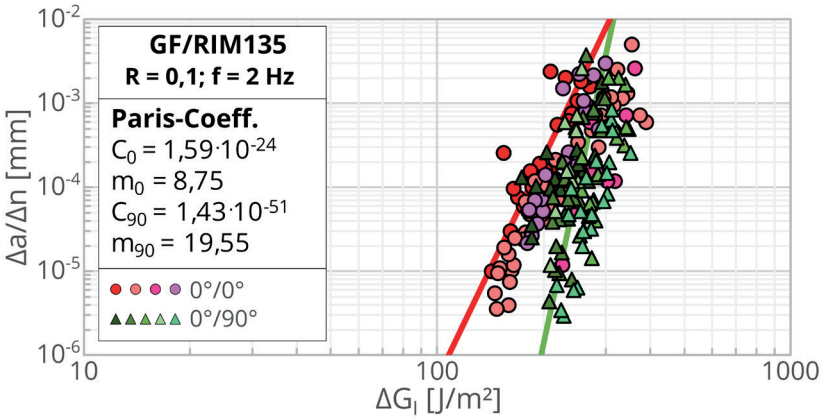

Fig. 01 Paris-Laws for mode I crack growth.

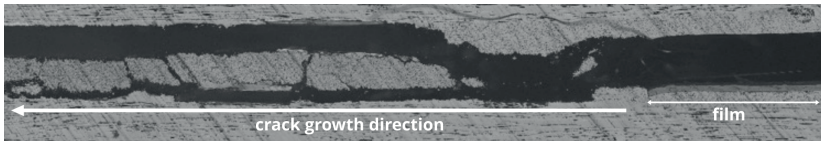

Fig. 02 Typical delamination for 0°/90-layer interface.

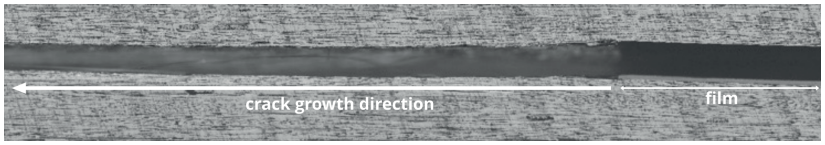

Fig. 03 Typical delamination for 0°/0°-layer interface.

Period

01.09.2021 – 31.08.2023

Project management

Prof. Dr.-Ing. habil. Maik Gude

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Gordon Just

Project partners

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Funding

Funded by

DFG Deutsche Forschungsgemeinschaft
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German Research Foundation (DFG)

Project number: 457043708

DIWA

Consistent analysis and evaluation of manufacturing-related fibre misorientations in thick-walled fibre-plastic composites

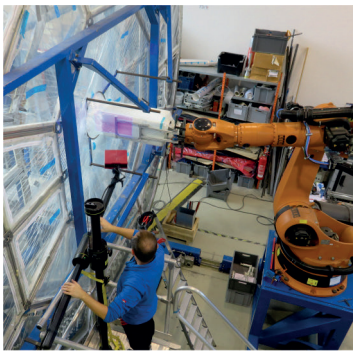

Fig. 01

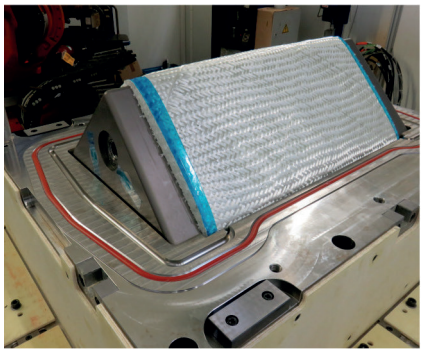

Fig. 02

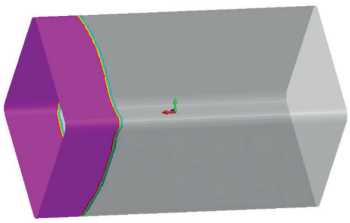

Fig. 03

Braiding process with optical process documentation (Fig. 01), Preform in HD-RTM tool (Fig. 02) und Mold filling simulation (Fig. 03).

Braiding technology and the high-pressure resin transfer moulding (HP-RTM) process are suitable for the efficient production of thick-walled components made of fibre-reinforced plastic (FRP) composites. The stacking of a large number of textile reinforcement layers, the high infiltration speeds in the HP-RTM process and curing effects of the matrix material often lead to production-related composite imperfections such as fibre misorientations. These mainly manifest themselves in the laminate plane, but also become more pronounced in the laminate thickness direction as the laminate thickness increases. The formation and evolution of such imperfections in the manufacturing process are detected, analysed and evaluated in the research project PAK988 using the example of test plates and a generic test structure made of glass fibres and polyurethane resin. For this purpose, the ILK is investigating the sequential production steps from the insertion of the dry preform into the infiltration tool (Pre-Infiltration), through high-pressure infiltration to curing (Post-Infiltration) (see Fig. 04). The generated data is stored reproducibly in a uniform research data management system.

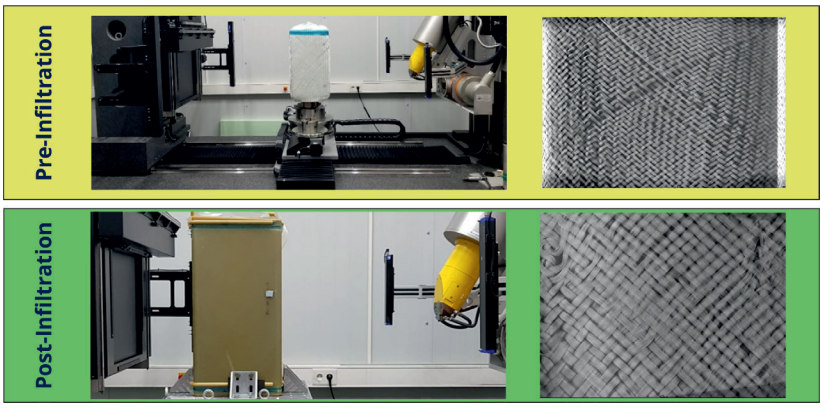

Fig. 02 Computer tomography for analysis of manufacturing-related effects before and after infiltration.

Period

01.04.2020 – 31.08.2023

Project management

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Dr.-Ing. Richard Protz
Eckard Kunze

Project partners

- Institute of Aircraft Design and Lightweight Structures (IFL) at the Technical University Braunschweig
- Institute of Plastics Engineering (IKT) at the University Stuttgart
- Institute of Polymers and Composites (IPC) at the Technical University Hamburg (TUHH)

Funding

Funded by

DFG Deutsche Forschungsgemeinschaft
German Research Foundation

German Research Foundation (DFG)
Project number: 428328210

SWING

Modelling and simulation of the manufacture-dependent shrinkage behaviour of glass-fibre reinforced epoxy resins for the improved prediction of surface-waviness and warpage

The SWING project is making a significant contribution to improving the understanding of process-dependent shrinkage-induced residual stresses in the processing of thermoset fiber-reinforced plastics (FRPs). The focus is on the experimental characterization and modeling of previously neglected material properties. For example, the project partners developed two novel test rigs, one for investigating the pressure-dependent shrinkage of fast-curing resins and the other for analyzing fiber-matrix interaction during processing (see Fig. 01). This makes it possible for the first time to quantify the phenomena mentioned and to investigate them systematically in a laboratory environment. The collected findings are transferred into practical material models, which were subsequently used to predict manufacturing-related residual stress states and surface waviness. For this purpose, a multi-scale simulation approach is adopted, which allows the phenomena inside a layered composite and on its surface to be described using a consistent modelling strategy (see Fig. 02). This can significantly increase the prediction accuracy of simulations as well as the process and material understanding of thermoset FRPs.

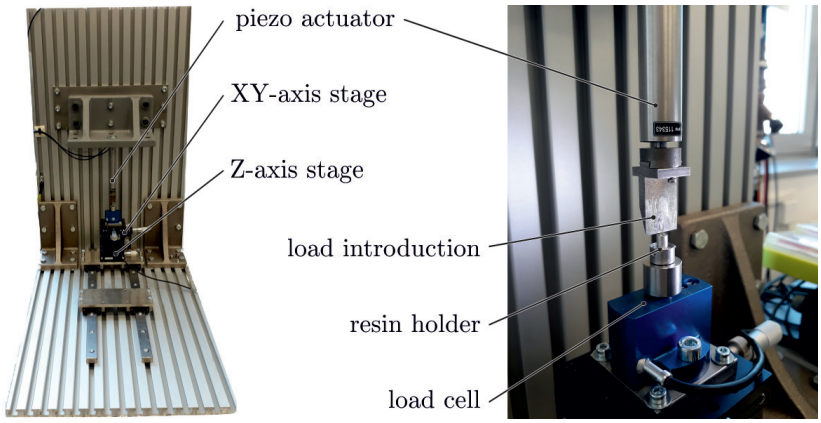

Fig. 01 Setup of the fiber matrix test rig to study cure-dependent load transfer at the micro level.

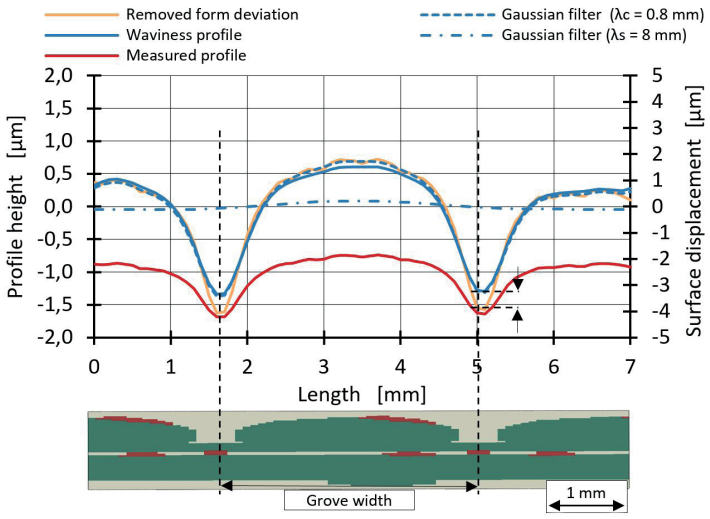

Fig. 02 Results of the process simulation for the determination of shrinkage-induced surface waviness.

Period

01.02.2019 – 31.07.2022

Project management

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Funding

Funded by

DFG Deutsche Forschungsgemeinschaft
German Research Foundation

German Research Foundation (DFG)
Project number: 415849481

SFB/GRK2430–P11

Methodical development of active multi matrix composite (MMC) components

The Research Training Group GRK2430 is an inter-university structured program that aims to develop novel, innovative interactive fiber-elastomer composites (I-FEC). The focus is on the systematic description, comprehensive characterization and cross-scale modeling of such composites. In subproject 11, the ILK is working on the development of a systematic method for the fabrication of compliant active compliant mechanisms, which can follow given trajectories.

The research focus is on the numerical and experimental characterization of I-FEVs with integrated shape memory alloys (SMA), the development of design tools using optimization algorithms, the development of interfaces between the design and development tools, and the validation of the results by using additive manufacturing techniques.

In the first phase of GRK2430, a computational tool for the generation of complanar compliant structures through the use of genetic algorithms was created. In the second phase, this is to be extended to non-complanar mechanisms. Here, material- and structure-based anisotropy effects are specifically exploited to derive spatial motions from an in-plane excitation.

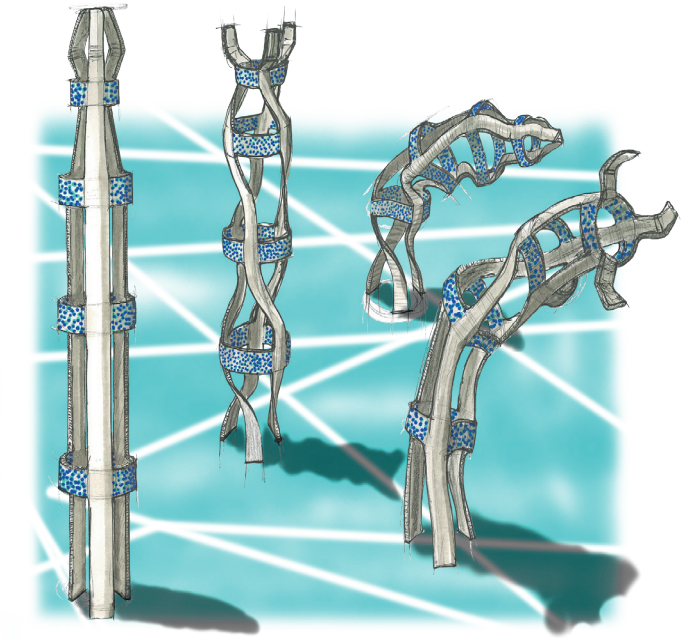

Fig. 01 I-FEC-based design. ©ITM/TUD

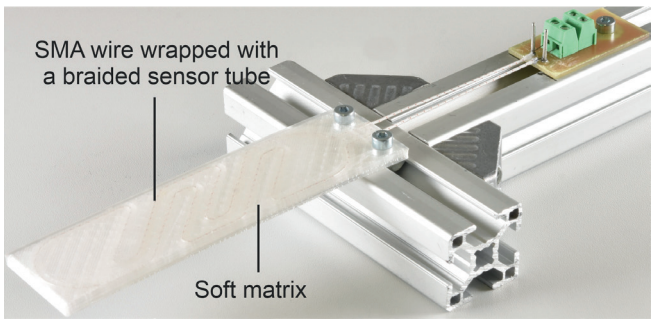

Fig. 02 3D-printed MMC-sample. ©ITM/TUD

Period

01.11.2018–31.10.2027

Project management

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- Fraunhofer Institute for Material and Beam Technoloy (IWS)
- Institute of Textile Machinery and High Performance Material Technology (ITM) at the TU Dresden
- Chair for Rubber Materials Institute of Materials Science (IfWW) at the TU Dresden
- Institute of Fluid Mechanics at the TU Dresden
- Chair of Technical Thermodynamics at the Institute of Power Engineering (IET) at the TU Dresden
- Institute of Structural Analysis (ISD) at the TU Dresden
- Institute of Solid State Electronics (IFE) at the TU Dresden
- Institute of Control Theory (RST) at the TU Dresden
- Chair of Materials Mechanics and Damage Analysis at the Institute of Materials Science (IfWW) at the TU Dresden
- Chair of Function-Integrative Lightweight Engineering at the Institute of Lightweight Engineering and Polymer Technology (ILK) at the TU Dresden

Funding

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German Research Foundation

German Research Foundation (DFG)

Project number: 380321452

SPP1897

Complex-Shaped Lightweight Structures with Adaptive Dynamic Behaviour through Evanescent Morphing

Compressible Constrained Layer Damping (CCLD) is a novel, semi-active solution for vibration mitigation of complex-shaped lightweight structures based on the well-known Constrained Layer Damping principle. For CCLD, the constrained damping layer consists of a compressible damping material with the thickness that can be adjusted in operando by fluid actuation (see Fig. 01). The actuation deformations, referred to as "evanescent morphing", change both the damping material properties and the amount of vibration-induced shear deformation, enabling a tuning of the overall structural dynamic behavior according to the excitation parameters. The CCLD can be applied to the entire surface of the vibrating structure or as patch only partially, without causing a significant increase of mass. The project demonstrated the potential of the damping measure using different damping materials. The materials were investigated and characterized at varying compression levels and the hereby obtained results were implemented in a numerical model (see Fig. 02). Experiments carried out on a single-curved shell structure with a partial CCLD patch coverage served for validation and confirmed the effectiveness of the novel damping measure.

The project is part of the research within the context of the Priority Program (SPP1897) "Calm, Smooth and Smart – Novel Approaches for Influencing Vibrations by means of Deliberately Introduced Dissipation".

Period

01.10.2019–31.12.2023

Project management

Dr.-Ing. Pawel Kostka

Contact

Tom Ehrig

Funding

Funded by

Deutsche Forschungsgemeinschaft
German Research Foundation

German Research Foundation (DFG)
Funding code: 315011510

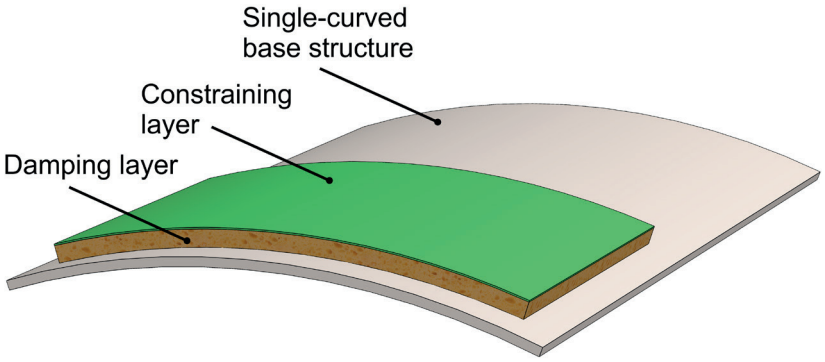


Fig. 01 Schematic structure of the CCLD.

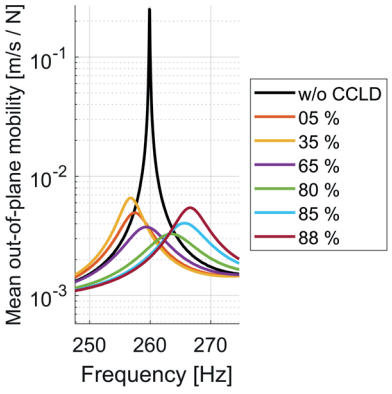


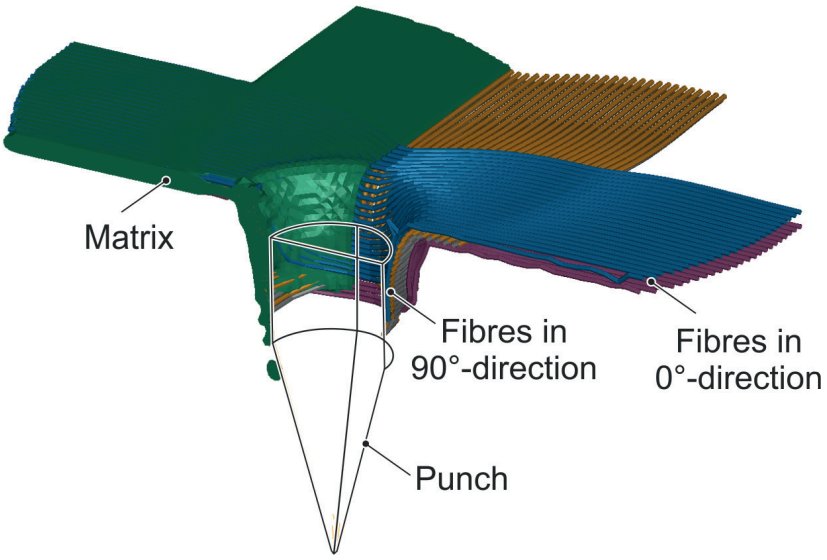
Fig. 02 Example of the change of the vibration amplitude at different compression levels of the damping layer.

SFB/TRR 285–A03

Calculation and evaluation of process-induced material structure phenomena in FKV-metal connections

Fibre-reinforced plastic (FRP) composites with thermoplastic matrix enable the production of lightweight structures within very short cycle times. By using the specific material properties of the FRP, it is possible to realise connections of dissimilar joining partners with new types of assembly interfaces. The joining processes are accompanied by local changes in the material structure. Within the scope of the project, a simulation chain from the joining process to the evaluation of FRP/metal joints is being developed.

In cooperation with other research projects in joining technology, the joining processes of thermally assisted clinching, embedding inserts and contour joining were characterised with regard to the joining-specific deformation and displacement phenomena. For this purpose, a scale-specific overview of the phenomena based on the state of the art was developed. The further development of a modelling method was based on a novel fibre-matrix interaction test device in which a single fibre is deformed in a shear flow. Parallel to the modelling, an evaluation method for the experimental test was tested. The further developed modelling method could be used to perform numerical pin penetration tests and to validate them with experimental investigations.



Numerical results of a piercing process based on the Arbitrary-Lagrangian-Eulerian method.

Period

01.07.2019 – 30.06.2027

Project management

Prof. Dr.-Ing. habil. Maik Gude

Contact

Dr.-Ing. Andreas Hornig
Benjamin Gröger

Project partners

- Automotive Lightweight Design (LiA) at the Faculty of Mechanical Engineering at the Paderborn University (UPB)
- Laboratory for Material and Joining Technology (LWF) at the Faculty of Mechanical Engineering at the Paderborn University (UPB)
- Chair of Forming and Machining Technology (LUF) at the Paderborn University (UPB)
- Institute of Polymer Technology (LKT) at the Friedrich-Alexander-University Erlangen-Nuremberg (FAU)
- Institute of Manufacturing Technology (LFT) at the Friedrich-Alexander-University Erlangen-Nuremberg (FAU)
- Institute of Solid Mechanics (IFKM) at the TU Dresden
- Institute of Manufacturing Science and Engineering (IFF) at the TU Dresden

Funding

Funded by

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German Research Foundation (DFG)

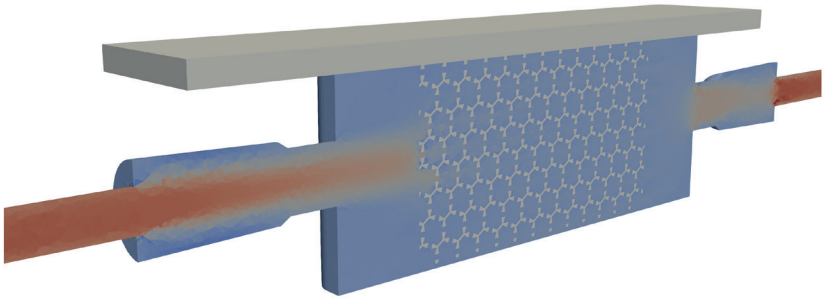
Project number: 418701707 - TRR285

KoLiBri

Complex Lightweight structures used in electronic applications in the field of mobility

The project KoLiBri aims at a holistic solution for the cooling concepts of mobility. The focus is on the complete creation of a new cooling structure, including material developments and simulations. By using open-pored metal foam structures, the project partners expect an increased cooling performance of 20-50 % or a mass reduction of 50 % with the same performance. Through the use of metallised plastics, a cost reduction of up to 75 % is targeted. The use of new materials and production technologies creates a product that reduces mass, saves resources and thus lowers CO_2-emissions. At the same time, a recyclable product is to be created.

The main work in this project is fluid-temperature and fluid-structure interaction. The developed simulation methods are applied to the demonstrator. In order to generate a performance and flow optimised porous foam cooling structure, a combination of different optimisation methods is applied. It should be emphasised that the developed methods use freely available software (e.g. OpenFOAM). The mechanical characteristic of the foam is part of the work. In addition, work is being carried out in the area of mechanical characterisation of the foams, here above all by means of non-destructive structure analysis using CT.



Flow through cooling application made of foam.

Period

01.12.2021 – 30.11.2024

Project management

Prof. Dr.-Ing. habil. Maik Gude

Contact

Dr.-Ing. Bernd Grüber
Tobias Ryll

Project partners

- Siemens AG Technology
- Siemens Mobility GmbH
- Valeo Siemens GmbH
- NRU GmbH
- iPoint-systems
- Fraunhofer Institute for Electronic Nano Systems ENAS
- Fraunhofer Institute for Machine Tools and Forming (IWU)
- Institute of Mineral Processing Machines (IAM) at the Technical Univeristy Bergakademie Freiberg
- Electric Flytrain GmbH
- METROM Mechatronische Maschinen GmbH

Funding

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Managed by:

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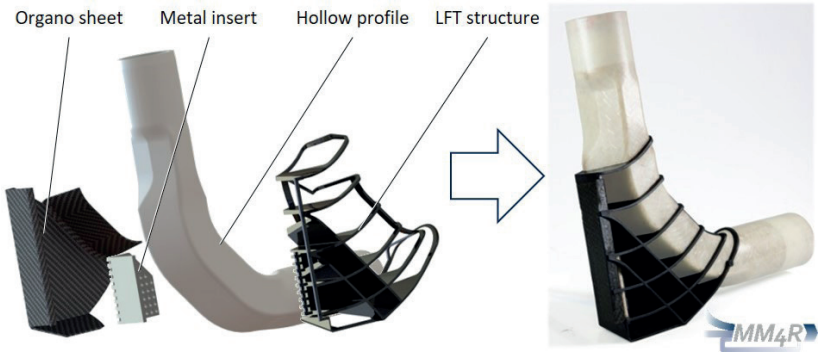
Projektträger Jülich (PTJ)

MM4R

Recycling-ready multi-material design for lightweight structures

Lightweight design is a key factor on the way to resource-efficient mobility. In addition to technical and economic criteria, environmental and social aspects become more and more important in this context. Hybrid designs in which fiber-reinforced plastic composites (FRP) are combined with e.g. steel can significantly reduce environmental impacts compared with Al/Mg structures, for example. This potential is enhanced by the recyclability of the materials. The combination of thermoplastic FRP hollow profiles, organo sheets and injection molding material (FuPro) is predestined for this. With just one material system, which is also easy to recycle, maximum design freedom can be achieved. In addition, the FuPro design has considerable economic potential compared with conventional designs. The focus of the project is the transfer of this lightweight design to the industrial scale with the lowest possible environmental impact, taking into account all phases of the product's life cycle. On the one hand, the ILK is concentrating on the further development of consolidation technology with the aim of achieving high energy efficiency. In addition, the ILK supports the partners in the development and analysis of the process chain for demonstrator production.

Other key points are the development of design guidelines for recycling-friendly multi-material design, the design of joints in line with requirements, and the upcycling of recycled materials by means of fiber direct compounding.



Generic FuPro structure: design and manufactured part.

Period

01.12.2021 – 30.11.2024

Project management

Prof. Dr.-Ing. habil. Maik Gude

Contact

Alexander Liebsch
Dr.-Ing. Robert Kupfer

Project partners

- Dr. Ing. h.c. F. Porsche AG
- Arburg GmbH + Co KG
- AUMO GmbH
- EKF Automation GmbH
- FRIMO GmbH
- SMP Germany GmbH
- Institute of Sustainability in Civil Engineering (INaB) at the RWTH Aachen University
- Fraunhofer Institute for Material and Beam Technology (IWS)

Funding

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Federal Ministry for Economic Affairs and Climate Action (BMWK)

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Projektträger Jülich Forschungszentrum Jülich

Projektträger Jülich (PTJ)

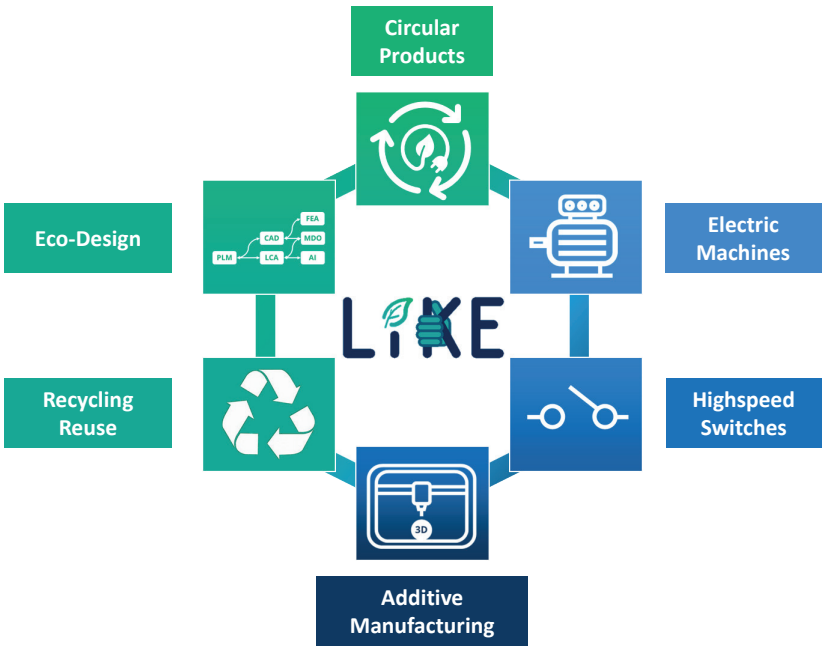
LiKE

Lightweight construction technologies in cross-life cycle products of the energy transition

The aim of the project LiKE is to develop product development models, methods and data for integrating sustainability aspects and sustainable technologies into energy-efficient products over the entire product life cycle. The methodological focus lies on the integration of LCA and the 9R framework into product design as well as on circularity models for the realisation of product systems with minimal environmental impact. New technologies in the field of recycling and product and material identification technologies serve as enablers for closed-loop models.

In the Electric Motor Product System, sustainable concepts are thus being developed for recyclable lightweight rotors with a reduced proportion of resource-intensive materials and reduced mass inertia.

In the Electrical High-Speed Switches product system, complex, highly dynamic multi-layer fibre composite structures are designed to realise high switching speeds.



Overview of the focal points in the project LiKE.

Period

01.01.2021 – 31.12.2023

Project management

Prof. Dr.-Ing. habil. Maik Gude

Contact

Paul Hoffeins

Project partners

- Siemens AG Deutschland
- iPoint-systems gmbh
- Polysecure GmbH
- MetisMotion GmbH
- THM Recycling solutions GmbH
- Institute of Mineral Processing Machines (IAM) at the Technical University Bergakademie Freiberg
- Institute for Microstructure Technology (IMT) at the Karlsruhe Institute of Technology

Funding

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Funding code: 03LB2008G

Managed by:

Projektträger Jülich Forschungszentrum Jülich

Projektträger Jülich (PTJ)

HyDrun

Analysis of the interface during inline hybridization of metal die-casting and injection moulding

The manufacturing of multi-material structures is currently performed by individual processes, where metal parts have to be die-casted, deburred, cleaned, pretreated and hybridised by an injection moulding separately. The individual processes require complex technologies and different manufacturing equipment. Additionally, storage capabilities and coordinated logistic systems have to be obtained, which leads to long cycle times, high costs and processes prone to errors.

New machine technologies allow existing processes to be rethought. The innovative DuoCast vertical die-casting technology, manufacture two die-cast components simultaneously with the fixed casting chamber out of the center of the machine (figure left). The aim of the BMBF-Project HyDrun is to develop an innovative manufacturing process for complex multi-material components, combining die-casting and injection moulding within a single manufacturing step (figure centre), thereby saving energy, costs and transfer times in particular.

To achieve high performance hybrid parts, durable and media-tight bonding between the metal and thermoplastic has to be developed. A promising approach is the metal surface pretreatment using laser beams to clean and modify the surface to achieve sufficient bonding (figure right).

Finally, the new manufacturing process chain is energetically assessed and recycling as well as second life concepts for multi-material structures are developed.

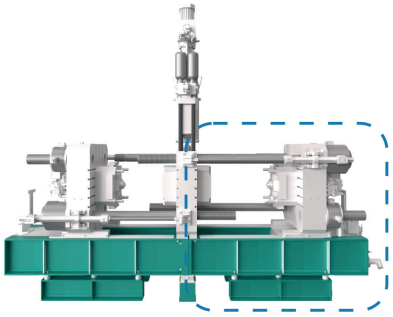

Fig. 01

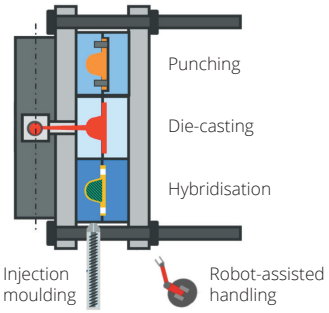

Fig. 02

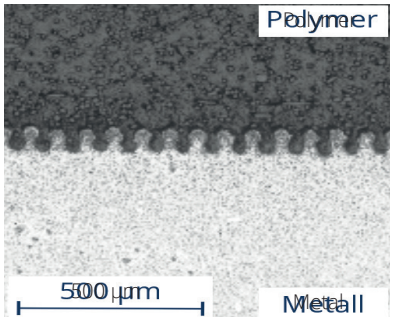

Fig. 03

Figure of synchronous manufacturing steps: DuoCast vertical die-casting machine (Fig. 01) with the modular tool concept (Fig. 02) and surface pretreatment (Fig. 03).

Period

01.06.2021 – 30.11.2023

Project management

Prof. Dr.-Ing. habil. Maik Gude

Contact

Tino Mrotzek
Rebecca Bräuer

Project partners

- AXIAL Ingenieurgesellschaft für Maschinenbau mbH
- Druckguss Service Deutschland GmbH
- FRIMO Group GmbH
- HILTI Entwicklungsgesellschaft mbH
- FRIMO Group GmbH
- Härte- u. Oberflächentechnik GmbH & Co. KG
- HYDRIVE Engineering GmbH
- INNOVENT e.V. Technologieentwicklung
- KraussMaffei Technologies GmbH

Funding

Supported by:

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HyMat Hybride Materialien

on the basis of a decision by the German Bundestag

Federal Ministry for Economic Affairs and Climate Action (BMWK): Programme "Materialforschung",
Materials platform: "Hybrid materials – New Possibilities, New Market Potentials" (HyMat)

Funding code: 03XP0383I

Managed by:

ptj Projektträger Jülich Forschungszentrum Jülich

Projektträger Jülich (PTJ)

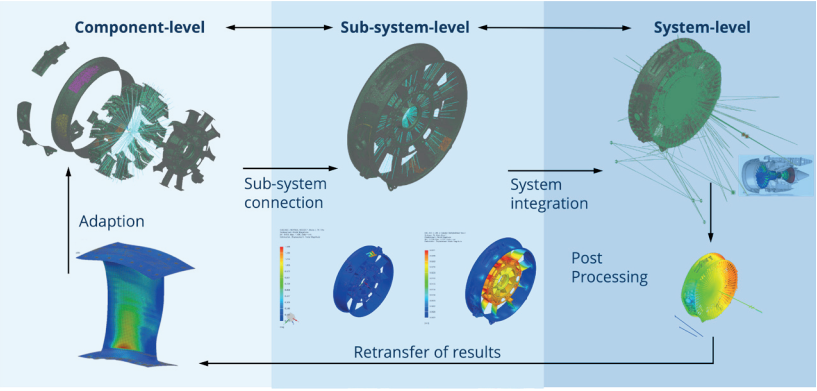
PEP4.0

Development of a highly efficient linked product development process (PEP) for hybrid lightweight structures in the context of Industry 4.0

In the "PEP4.0" project, the ILK, together with Rolls-Royce Germany, is researching efficient methods for the development of hybrid lightweight designs using the example of an intermediate engine casing in metal/fibre/polymer composite design. The basis for this is a digitally linked engineering design process, which combines the methods, models and data of the individual disciplines of design, dimensioning and manufacturing to form a linked development process from the specification of requirements to manufacturing and verification. Special system modelling software for Model Based Systems Engineering (MbSE) is used for this process modelling and linking of the individual steps. A methodology was developed with which processes from construction and design can be transferred and linked into the MbSE systematics and this was demonstrated with the MbSE software Cameo Systems Modeler.

Within the framework of virtual product development, a multi-scale simulation methodology has been developed from the structural component to the engine model. This allows the hybrid design to be developed taking into account representative engine load cases.

Such a model-based approach allows an effective and efficient validation and verification strategy to be derived, from material properties at the coupon level to testing of the entire assembly at the system level. The data generated is used to create digital twins.



Dimensioning of lightweight structures in interaction with the whole engine system.

Period

01.07.2018 – 30.06.2023

Project management

Prof. Dr.-Ing. habil. Maik Gude

Contact

Dr.-Ing. Sebastian Spitzer

Project partners

- Rolls-Royce Deutschland Ltd. & Co. KG
- CTC GmbH

Funding

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Federal Ministry for Economic Affairs and Climate Action (BMWK): Federal Aviation Research Programme LuFo V-2

Funding code : 20X1717B

Managed by:

DLR Projektträger

German Aerospace Center (DLR)

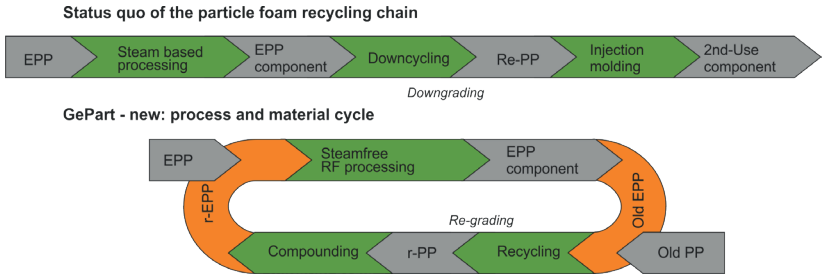
GePart

Development of efficient process technologies within the closed particle foam material cycle

The aim of the project is to improve resource efficiency for expanded polypropylene (EPP) throughout its life cycle. Important topics are, on the one hand, to enable and sustainably close the EPP material cycle by establishing recycling methods on an industrial scale and, on the other hand, to significantly increase the energy efficiency of EPP processing by using the new radio frequency (RF) process technology.

In order to evaluate the possibilities of a closed EPP material cycle, the use of regranulated EPP for the production of new EPP beads (rEPP) with a recycled content of up to 70 % was investigated. For this purpose, EPP structures were produced from known raw materials in a steam mold process and then recycled. The regranulate was then used for rEPP beads with a recyclate content of 70 %. The investigations carried out at the ILK to characterize the materials without and with 70 % recyclate did not show any significant material degradation. There are similar indications for the ongoing tests of EPP and rEPP foam structures.

In the remaining project period, efforts are now being made to include additional regranulates from EPP structures with no longer traceable sources in the investigations. Furthermore, the determination of the processability of rEPP using a 3D RF foaming tool and the LCA consideration of the entire process chain are in the focus of the work.



From EPP downcycling chain to EPP recycling loop.

Period

01.12.2012 – 30.11.2023

Project management

Prof. Dr.-Ing. habil. Maik Gude

Contact

Dr.-Ing. Bernd Grüber

Project partners

- Consortium leadership: Ruch Novaplast GmbH
- Kaneka Belgium NV (associated partner)
- Kurtz GmbH
- Neue Materialien Bayreuth GmbH
- R.Plast Kunststoffaufbereitungs- und Handels-GmbH
- T. Michel Formenbau GmbH & Co. KG
- Volkswagen AG

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on the basis of a decision by the German Bundestag

Federal Ministry for Economic Affairs and Climate Action (BMWK): Technology Transfer Programme Lightweight Construction (TTP LB)

funding code: 03LB2000G

Managed by

Projektträger Jülich Forschungszentrum Jülich

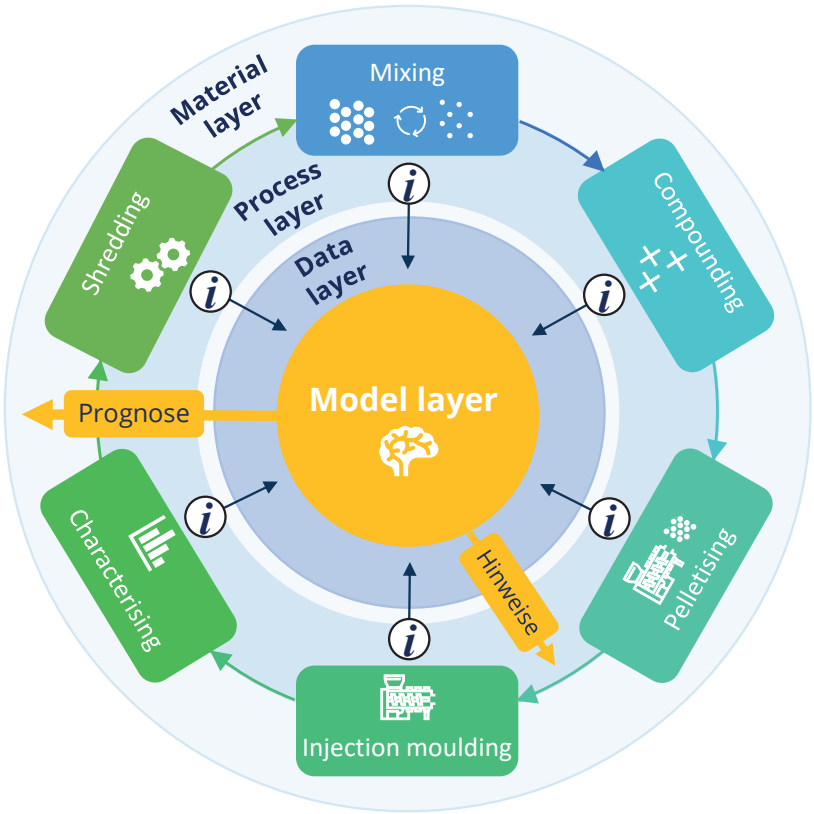
Projektträger Jülich (PTJ)

DiDe4Rec

Digital design 4 recycling process for fiber-reinforced lightweight structures

The aim of DiDe4Rec is to elaborate and validate a holistic development approach for recyclable lightweight products based on fiber-reinforced polymers. This enables the product designer to take into account not only technical specifications and the economic environment, but also the ecological dimension of recyclability already in the design process. In this context, the cross-life-cycle knowledge of the relationships between processing, use, reprocessing and reuse of the materials is a core aspect, which will be achieved in the project through the digital provision and analysis of material, process and environmental information. Therefore, in addition to the actual "design for recycling", the focus will be on the description of product and quality parameters as well as their modification through the corresponding process design and the associated data collection.

Within the framework of DiDe4Rec, the ILK wants to better understand the complex interaction between product development, use, reprocessing and reuse and investigate it in an application-oriented manner on the example of injection molding. Using exemplary components, quality-relevant process and material data will be recorded over several life cycles in order to develop a parametric material card that describes the material behavior as a function of the life-cycle-spanning material history and the recycled content.



Circular economy scenario investigated in DiDe4Rec for injection molding of fiber-reinforced molding compounds.

Period

01.11.2022 – 31.10.2025

Project management

Prof. Dr.-Ing. habil. Maik Gude

Contact

Dr.-Ing. Robert Kupfer
Lisa Dahrmann

Project partners

- Consortium leadership: Forward Engineering GmbH
- Baumüller Gruppe
- Brose Fahrzeugteile SE & Co. KG
- Mitsubishi Chemical Advanced Materials GmbH
- Centrotherm Systemtechnik GmbH
- Symate GmbH
- Institut für Textiltechnik Augsburg gGmbH (ITA)
- VDMA e.V. AG Hybride Leichtbau Technologien
- Geba Kunststoffcompounds GmbH
- Simutence GmbH
- Fraunhofer Institute for Chemical Technology (ICT)

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on the basis of a decision by the German Bundestag

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Funding code: 03LB3047

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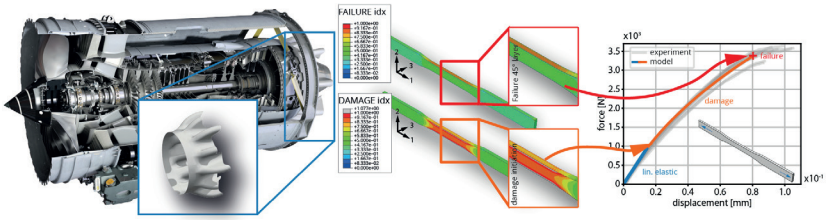
Projektträger Jülich Forschungszentrum Jülich

Projektträger Jülich (PTJ)

CMC–TurbAn

CMC optimization for turbine applications

The demand for lighter and more heat-resistant materials in modern engine components is increasing continuously. Textile-reinforced oxide ceramic composites (O-CMC) are used more frequently, driven particularly by the growing demands for elevated operating temperatures for energy efficiency. In contrast to conventional metallic components, there is still a considerable need for research on the damage behavior of O-CMC for industrial application. In the HoMAS project CMC-TurbAn, the ILK successfully implemented a progressive continuum damage model based on the fracture mode-related failure criterion of CUNTZE for O-CMC in cooperation with the partners DLR Stuttgart, Schunk, Fraunhofer HTL, and Rolls-Royce Germany. For this purpose, the ILK supported selecting and evaluating suitable test methods to determine necessary model parameters. By developing a data-driven optimization method in Python, model parameters will be calibrated rapidly and efficiently on new data in the future. The ILK implements the progressive damage model in the FE environment Abaqus in an implicit subroutine. The model was sufficiently verified on bi-axial test data and in a further step, the model could be validated by comparing the mode shapes, resonance amplitudes, and damage patterns with an air pulse excited three-dimensional curved substructure.



Examples of O-CMC structure applications in energy-efficient jet engines (left), comparison of model prediction on experimental data of a quasi-isotropic tensile specimen ([(0°/90°)/(+45°/-45°)]s) (right).

Period

01.11.2018 – 31.11.2022

Project management

Prof. Dr.-Ing. habil. Maik Gude

Contact

Christian Düreth

Project partners

- Rolls-Royce Deutschland Ltd. & Co. KG
- Schunk GmbH & Co KG
- Fraunhofer Institute for High Temperature Materials and Design (HTL)
- Institute of Structures and Design (DLR)

Funding

Supported by:

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Joint Project "High Performance Materials for Efficient and Environmentally Friendly Propulsion Systems (HoMAS)"

Funding code: 03XP0189B

Managed by:

Projektträger Jülich
Forschungszentrum Jülich

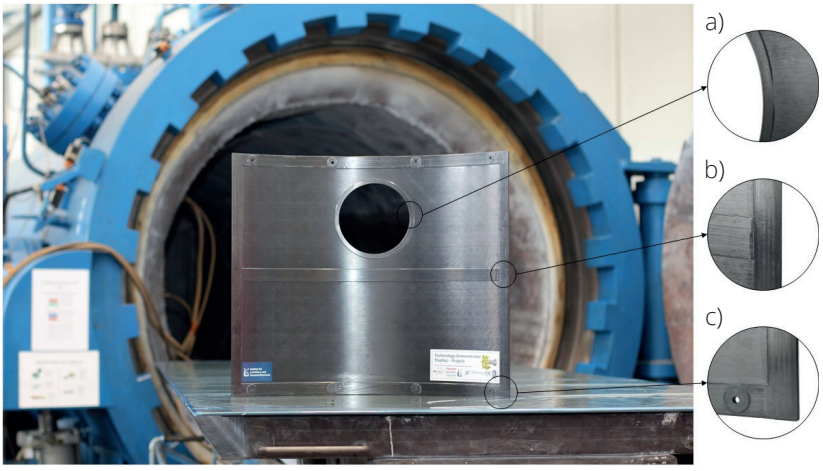
Projektträger Jülich (PTJ)

ThoPoL

Thermally highly resistant polymer systems for lightweight propulsion systems

The overall objective of the ThoPoL collaborative project was to increase the long-term operating temperature range of polymer matrix materials for fibre-reinforced polymers as cost-neutrally as possible, while maintaining the reliability, safety and service life of the overall system. This included a comprehensive characterisation of the polymer systems under the relevant operating conditions, as well as the development of design, dimensioning and manufacturing concepts for thermally highly loaded fibre composite components of the highest quality.

Within the framework of the project, both thermoplastic matrix materials were investigated and thermoset high-temperature matrix systems were developed. In the case of the high-performance thermoplastics, a process combination led to an innovative overall manufacturing process that meets the demands with regard to the application requirements. In the development of the thermoset high-temperature matrix systems, the focus was on increasing the long-term and temperature resistance. The expansion of the long-term operating temperature range opens up the use of fibre-reinforced plastics in a variety of components that are currently reserved for purely metallic materials. At the end of the project, a technology demonstrator was produced from carbon fibre-reinforced polyetheretherketone tapes with various reinforcing elements.



Technology demonstrator produced by autoclave process with
a) assembly hole reinforcement, b) frame reinforcement and c) drill hole reinforcement.

Period

01.02.2019 – 31.12.2022

Project management

Prof. Dr.-Ing. habil. Maik Gude

Contact

Tino Wollmann
Wikentij Koshukow

Project partners

- Rolls-Royce Deutschland Ltd. & Co. KG
- Enrichment Technology Company Deutschland
- Wacker Chemie AG
- Hexion GmbH
- Teijin Carbon Europe GmbH
- EAST-4D Carbon Technology GmbH
- Fraunhofer Institute for Applied Polymer Research

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on the basis of a decision by the German Bundestag

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Joint Project "High Performance Materials for Efficient and Environmentally Friendly Propulsion Systems (HoMAS)"

Funding code: 03XP0170I

Managed by:

Projektträger Jülich Forschungszentrum Jülich

Projektträger Jülich (PTJ)

STYQZAHL

Structural metal-plastic hybrid design demonstrated on a bumper crossmember in electrified automotive large-scale production

The growing demand for electrified vehicles is leading to an increasing variety of components in the automotive industry. Due to the higher vehicle weight and stricter safety standards, demanding requirements are arising for crash-loaded components. In addition, there is an increasing demand for flexible crash components that have both identical connection dimensions to the vehicle body and exhibit component behavior adapted to the overall vehicle. The aim of this project was the local hybridization of a crash management system (CMS) in an automated series environment with increased volumes and cycle time requirements. The starting point was existing multi-part steel structures based on hot-formed steels. The project investigated hybridization by means of thermoset molding compounds (SMC) and short fiber reinforced injection molding. Various joining options such as subsequent bonding and intrinsic joining in the process were also considered. An essential focus was the improvement of accuracy in process and structural simulation for the prediction of SMC component properties. The results obtained were applied in the development of the project demonstrator of the bumper crossmember, which was manufactured and tested in the load case "fast rear-end crash" in order to evaluate the performance of the hybridization technology developed and to demonstrate its suitability for use.

Crash management system (CMS) with hybridized bumper crossmember made of hot-formed steel sections and a local rib structure formed using thermoset molding compound (SMC).

Period

01.05.2020 – 31.12.2022

Project management

Prof. Dr.-Ing. habil. Maik Gude

Contact

Daniel Haider
Tony Weber

Project partners

- Bilsing Automation GmbH
- Bilsing Werkzeugbau GmbH
- ESI Germany GmbH
- Gns mbH
- Kirchhoff Automotive Deutschland GmbH
- Volkswagen AG

Funding

Supported by:

Federal Ministry of Education and Research

HyMat Hybride Materialien

on the basis of a decision by the German Bundestag

Federal Ministry of Education and Research (BMBF): Programme "From Material to Innovation",
Materials Platform "Hybrid Materials – New Possibilities, New Market Potentials (HyMat)"

Funding code: 03XP0278A

Managed by:

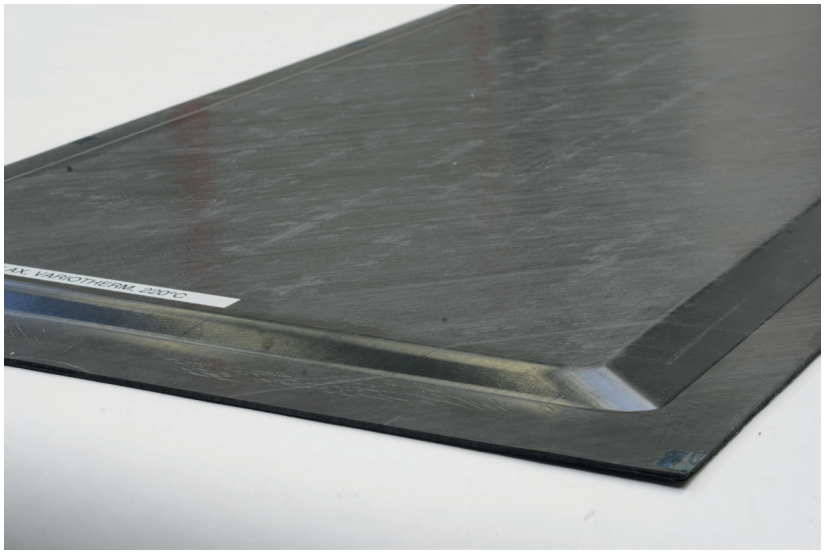
Projektträger Jülich Forschungszentrum Jülich

Projektträger Jülich (PTJ)

TerESa

Thermoplastic end contour sandwich for innovative aerospace applications

The provision of reliable, lightweight and cost-effective components with a large number of variants is increasingly challenging the aerospace industry. Customer-specific configurations with only a few repeat parts stand in the way of high levels of automation. The aim of the joint project is to design and validate an automatable manufacturing technology for the production of near-net-shape thermoplastic sandwich preforms based on recycled or recyclable materials, which are thermally formed according to individual customer requirements and functionalized by inserted elements. The core of the innovation is the development of a generic thermoplastic sandwich structure that can replace existing structures at lower cost in a performance- and mass-neutral manner. In addition to the material bonding of the outer layers to the core layer in the molding process, the development work is focusing on forming and edge sealing. The challenges here lie primarily in the use of high-performance PEI and PEKK plastics for honeycomb core materials and cover layers, which requires high processing temperatures with a narrow tolerance corridor and thus makes process automation absolutely essential.



Sandwich component made of thermoplastic cover layers honeycomb core (PEKK+PEKK) with edge sealing produced in an one-shot pressing process.

Period

01.06.2019 – 31.12.2022

Project management

Prof. Dr.-Ing. habil. Maik Gude

Contact

Tony Weber
Kurt Böhme

Project partners

- Cotesa GmbH
- Boeing Deutschland GmbH
- ThermHex Waben GmbH

Funding

Supported by:

Federal Ministry for Economic Affairs and Climate Action

on the basis of a decision by the German Bundestag

Federal Ministry for Economic Affairs and Climate Action (BMWK): Federal Aviation Research Programme LuFo V-3, Funding line "Technology"

Funding code: 20W1720C

H2GA

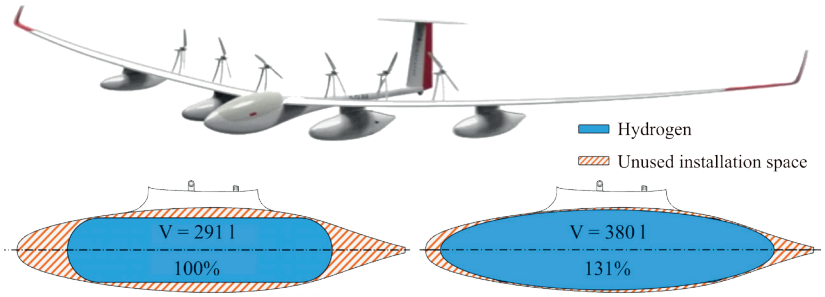
Hydrogen fuel cell technology as a hybrid-electric drive in the demonstrator Antares E2

For the aviation industry, hydrogen represents a potential climate-friendly fuel of the future. Compared to jet fuel, however, a much higher storage volume is required for the same amount of stored energy and due to high storage pressures the tank mass increases too. Therefore, lightweight concepts for the space-optimised integration of hydrogen tanks must be researched.

In the H2GA project, type IV hydrogen high-pressure tanks with 700 bar nominal working pressure are being researched which, on the one hand, have a very high gravimetric efficiency and, on the other hand, make the best possible use of the available installation space of the external nacelles of the Antares E2 experimental aircraft intended for tank storage.

In the first phase of the project, the ILK is designing a cylindrical pressure tank with a high storage density for this purpose. This hydrogen storage tank will be used by the project partner Lange Research Aircraft to test the fuel cell system developed by the Fraunhofer ICT and the overall aircraft system.

Since the cylindrical tank geometry utilises the available installation space of the aerodynamically designed outer nacelles only insufficiently, an ellipsoidal tank design will be implemented in the second project phase. For this, the knowledge gained from the first tank generation, such as the optimisation of the isotensoid laminate structure in line with the load or the implementation of production technology, will be further deepened.



Aircraft type Antares E2 (top) with sketched utilisation of the available installation space of the outer nacelles for cylindrical (bottom left) and ellipsoidal (bottom right) tank design.

Period

01.12.2021 – 30.11.2024

Project management

Prof. Dr.-Ing. habil. Maik Gude

Contact

Florian Schmidt
Dr.-Ing. Sebastian Spitzer

Project partners

- Lange Research Aircraft GmbH
- Fraunhofer Institute for Chemical Technology (ICT)

Funding

Supported by:

Federal Ministry for Digital and Transport

on the basis of a decision by the German Bundestag

Federal Ministry for Digital and Transport (BMDV): Funding guideline "National Innovation Programme Hydrogen and Fuel Cell Technology" (NIP) Phase II

Funding code: 03B10707C

Managed by:

Projektträger Jülich Forschungszentrum Jülich

Projektträger Jülich (PTJ)

ELAN

Electric power units for hybrid electric propulsion systems

In the ELAN project, the ILK, together with Rolls-Royce Electrical, Schaeffler Aerospace Germany and the institute of electrical power systems and high voltage engineering, is working on the development of electrical power units for hybrid-electric drive systems of eVTOLs and CS23 aircraft. In this context, the TU Dresden is supporting Rolls-Royce in achieving the "Flightpath 2050" goals.

Currently, the ILK is working on the bearing shields of the transverse flux motor (see Fig.01). The aim is to develop a topology-optimised fibre composite structure that saves mass and at the same time guarantees the heat dissipation in the form of air passages. The ILK's tasks include an analysis of the current reference structure, in which the components with the highest lightweight design potential are selected and a technology and construction matrix is developed for optimising the components. This is followed by an evaluation and the selection of a preference variant. Subsequently, a load- and function-oriented lightweight structure is iteratively developed and its functionality is virtually verified. Subcontractors then manufactures fibre composite structures that can be validated and the real functional verification of the assembly is carried out under laboratory conditions. In parallel, the ILK is developing a Rolls-Royce-compatible catalogue of methods for the design and layout of structural and functional elements, which can be applied to later developments.

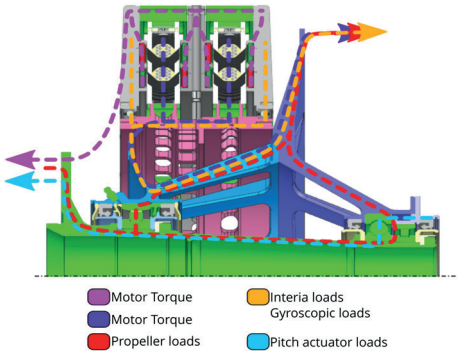


Fig. 01

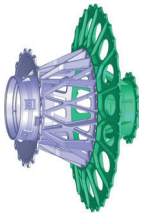


Fig. 02

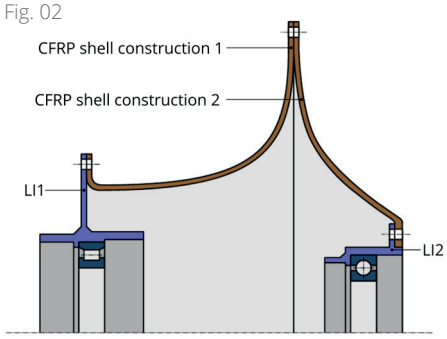


Fig. 03

Development stages of the ELAN project.

From the assembly

via
reference structure

to fibre composite design

Period

01.01.2022 – 31.012.2024

Project management

Prof. Dr.-Ing. habil. Maik Gude

Contact

Dr.-Ing. Sebastian Spitzer
Richard König

Project partners

- Rolls-Royce Deutschland Ltd. & Co. KG
- Schaeffler Aerospace Germany GmbH & Co. KG
- Institute of Electrical Power Systems and High Voltage Engineering (IEEH) at the TU Dresden

Funding

Supported by:

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for Economic Affairs
and Climate Action

on the basis of a decision
by the German Bundestag

Federal Ministry for Economic Affairs and Climate Action (BMWK): Federal Aviation Research Programme LuFo VI-2

Funding code: 20L2106A

Managed by:

DLR Projektträger

German Aerospace Center (DLR)

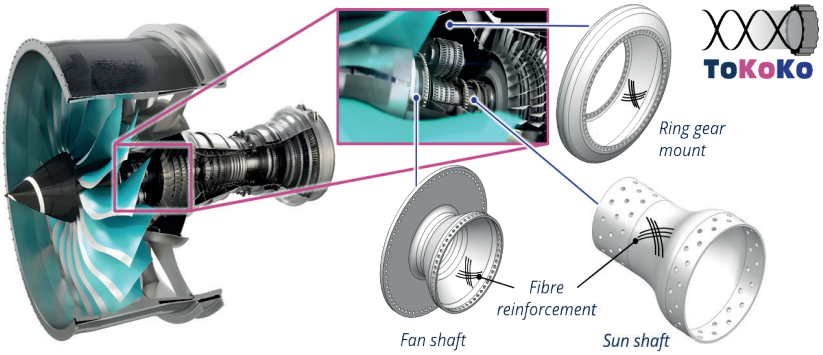
ToKoKo

Torsion-transmitting composite-components

In the project "Torsion-transmitting Composite-Components" (ToKoKo), the Institute for Lightweight Design and Polymer Technology (ILK) of the TU Dresden is investigating the use of fibre-plastic composites (FRP) in safety-relevant structures in the power transmission of future engines on behalf of Rolls-Royce Deutschland Ltd & Co KG together with CTC GmbH.

Gyroscopic loads in the engine create constraining forces in the engine gearbox, which can lead to increased stresses in the gears and thus reduce their service life.

In the development of the Sunshaft, FKV with its directional and adjustable properties is used to create a flexible structure with high torsional strength, which leads to a significant reduction in gearbox loads. Since the Sunshaft is a safety-critical component, the project is also working on the fundamentals for the methodical design of safety-critical FRP components and holistic manufacturing process monitoring. In the course of the failure analysis (DFMEA), possible failure mechanisms and their interactions are identified. For a better understanding of the failure mechanisms of drive shafts, experimental tests with tube test specimens of different diameters are conducted. By replicating the tests on a virtual level and comparing the results, the simulation models are validated.



Engine components investigated in the ToKoKo project.

Period

01.11.2020 – 31.08.2023

Project management

Dr.-Ing. Sebastian Spitzer

Contact

Alrik Dargel

Project partners

Rolls-Royce Deutschland Ldt. & Co. KG

Funding

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Funding code: 20T1921

Managed by:

DLR Projektträger

German Aerospace Center (DLR)

ABSOLUT

Automatic bus shuttle – self-organizing between Leipzig and the BMW terminal

© ABSOLUT

Vehicles equipped for autonomous driving.

The ABSOLUT project took a holistic approach to the development and approval of two autonomous driving, electrically powered vehicles for a Leipzig test route with driving speeds of up to 70 km/h: a 2nd generation EasyMile EZ10 people mover and a VW eCrafter minibus. In addition to the sensor system and mechanical vehicle upgrades, the infrastructure, including the communication between the control centre, the traffic lights and the vehicles, was also functionally enhanced. For the targeted higher speeds, the ILK equipped the EasyMile EZ10 in particular with a new suspension and more powerful drivetrain and energy supply technology. The design was based on simulation calculations of both the operating loads and the tipping load case, which is relevant for approval. The obstruction of the field of vision due to the very wide A-pillars led to the concept of a standing driver in the design of the safety driver workplace. The vehicle was equipped with a camera/monitor system that reduces the obscured field of vision in compliance with the approval. Sensor networks (cameras, lidars and radars) and associated computer technology were integrated into the supporting structure of both vehicles to record traffic and environmental conditions. Further vehicle-specific work by the ILK dealt with continuous technical inspection. For this purpose, systems for condition recognition and evaluation have been developed.

Period

01.01.2019 – 30.09.2022

Project management

Prof. Dr.-Ing. Niels Modler

Contact

Dr.-Ing. Frank Adam

Project partners

- Dresden Institute of Automobile Engineering (IAD) at the TU Dresden
- Institute of Traffic Telematics at the TU Dresden
- City of Leipzig
- Leipziger Verkehrsbetriebe GmbH (LVB)
- BitCtrl Systems GmbH
- Ingenieurgesellschaft Auto und Verkehr GmbH (IAV)
- Fahrzeugsystemdaten GmbH (FSD)
- Sedenius Engineering GmbH
- Virtence GmbH
- glts cotech GmbH
- INAVET GmbH
- ApiOmat GmbH

Funding

Supported by:

Federal Ministry for Economic Affairs and Climate Action

IKT FÜR ELEKTROMOBILITÄT

on the basis of a decision by the German Bundestag

Federal Ministry for Economic Affairs and Climate Action (BMWK): Technology programme "ICT for Electric Mobility III"

Funding code: 01ME18001H

Managed by:

DLR Projektträger

German Aerospace Center (DLR)

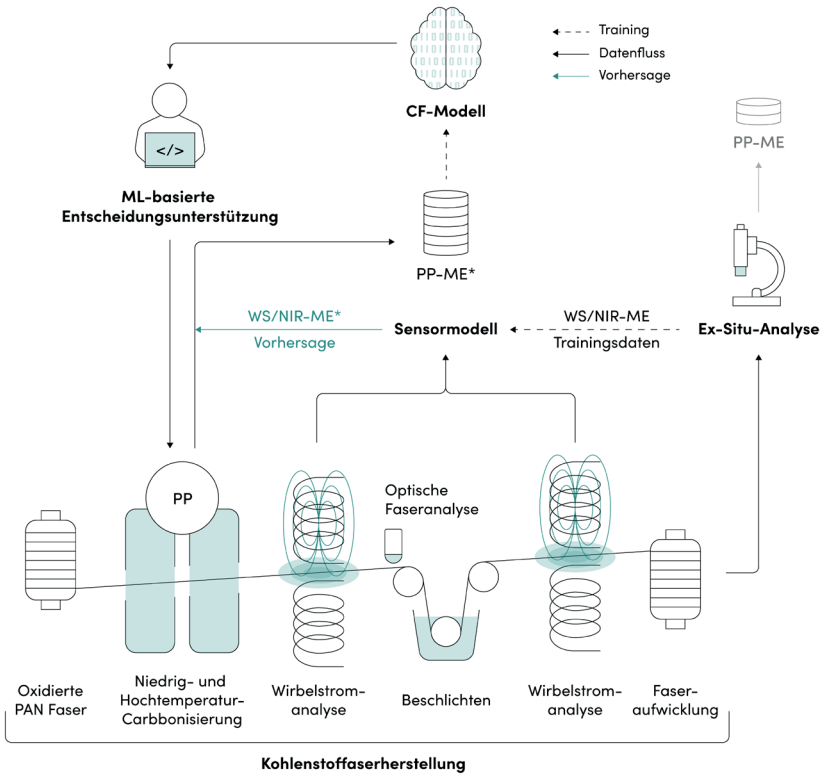
maQinto

Machine-trained quality sensor, intelligent process control and ML framework for resource-efficient, customized carbon fiber production

The production of carbon fibers (CF) is extremely complex due to its many different influencing parameters. In particular, the interaction of the individual process- and materialparameters and their effect on the produced CF properties is not sufficiently clarified, as offline analyses are time and material intensive. To meet this challenge, the MaQinto project aims to realize the prediction of CF properties during the manufacturing process, which allows easy adaptability of the process parameters to the desired CF properties.

Due to the complexity, the automated property analysis of CF can only be performed using AI-methods. This should capture the state of CF in the process in real time, correlate it with the process data and thus serve as intelligent decision support for process adaption. Since CF are electrically conductive, the magnetic field influences their properties by continuously passing them through a special eddy current (WS) sensor. From the magnetic field changes, conclusions can be drawn about the property and structural state of the CF (structure, morphology).

The goal of maQinto is to develop a sensor and process machine learning (ML) model with an integrated application programming interface (API) by using an online EC sensor for decision making for the setting of the process parameters.



Schematic of automated decision making in CF manufacturing.

Period

01.05.2022 – 30.04.2025

Project management

Prof. Dr.-Ing. Niels Modler

Contact

Jan Wolf
Daniel S. Wolz

Projekt partners

- SURAGUS GmbH
- tapdo technologies GmbH
- STRUCNAMICS Engineering GmbH
- Computer Vision and Machine Learning Systems Group at the Institute for Geoinformatics (ifgi) at the Westfälische-Wilhelms-Universität Münster (WWU)

Funding

Supported by:

Federal Ministry of Education and Research

on the basis of a decision by the German Bundestag

Federal Ministry of Education and Research (BMBF): "Erforschung, Entwicklung und Nutzung von Methoden der Künstlichen Intelligenz in KMU"

Funding code: 01IS22020E

Managed by:

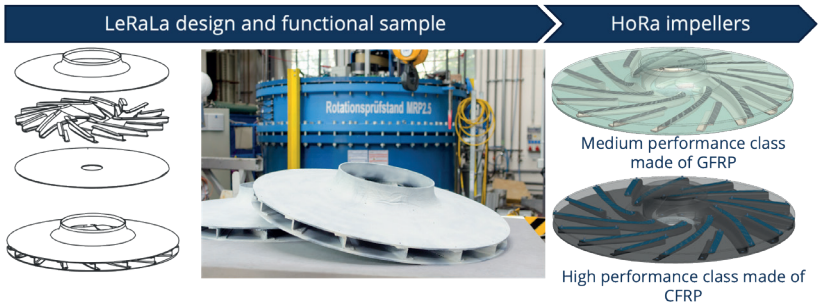
DLR Projektträger

HoRa

High-performance radial impellers in modular metal-fibre composite design

The AiF project "High-performance radial impellers in modular metal-fibre composite design" is another project at the ILK investigating the applicability of fibre reinforced polymers for high-speed radial impellers in ventilation and drying technology. In order to reduce emissions from gas turbines and to comply with the German Federal Immission Control Act, additional filter systems are required for existing plants. Their use leads to increased pressure losses, which could be compensated by more efficient, high-speed gas turbines. However, conventional metallic impellers are reaching the limits of their material strength. The use of fibre reinforced polymers, with their excellent, adjustable mechanical properties, enables fast rotating impellers.

In this project, the ILK is investigating the adaptation of a construction method developed in LeRaLa and the use of recorded spin test data from the first generation of prototype radial impellers made of metal/composites. Three radial impeller derivatives will be identified and adapted in terms of structural mechanics, aerodynamics and manufacturing technology for three specific requirement profiles (medium, high and maximum power). A research scale manufacturing process chain will be set up using metal tools to produce functional samples. These samples are then tested for failure on a centrifugal test rig.



Use of the results of the LeRaLa project and further development of the construction method for the medium and high performance class.

Period

01.04.2021 – 31.01.2024

Projectmanagement

Prof. Dr.-Ing. habil. Maik Gude

Contact

Dr.-Ing. Sebastian Spitzer

Funding

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Federal Ministry for Economics Affairs and Climate Action (BMWK): Programme "Industrial Collective Research" (IGF)

Funding code: 21813BR

Managed by:

German Federation of Industrial Research Associations "Otto von Guericke" e.V. (AiF)

FLT

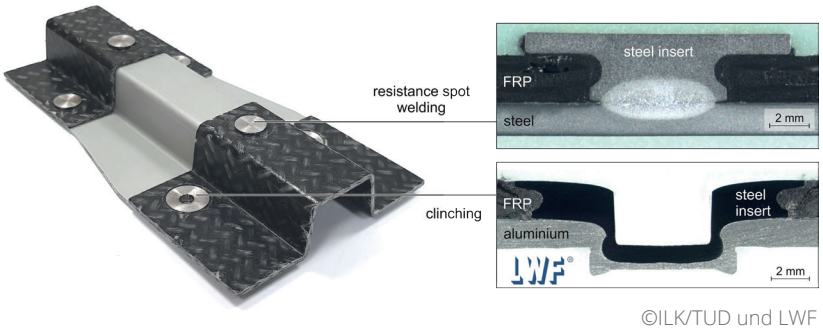
Forschungsvereinigung für Luft- und Trocknungstechnik e.V. (FLT)

MufuS

Development of multifunctional interfaces for joining FRP with metals using established joining technologies

Multi-material design with fibre reinforced plastic (FRP) and metals offers a high potential for resource- and cost-efficient s. However, there is an increasing demand in industry to reduce the number of different joining processes despite the growing diversity of materials.

ILK scientists, togeth er with the Laboratory of Materials and Joining Technology (LWF), developed a new technology for FRP/metal joints based on established spot joining processes such as resistance spot welding or clinching. For this purpose, steel inserts are embedded in a thermoplastic FRP structure during compression moulding as a multifunctional interface. The technology is based on the concept of moulding holes by a pin and simultaneously placing the metal insert in the moulded hole without fibre damage. The joining zone is then pressed by a counter punch arranged on the die side, creating a form fit between the insert and the FRP. In the project, a demonstrator was produced to show that several inserts can be moulded simultaneously into curved components. The FRP component can then be reliably joined to metal structures using established spot joining technologies. The project focused on simulation-supported design of the inserts, process-reliable joining, determination of the joint properties under quasi-static and cyclic loading, and derivation of application-relevant design instructions.



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Demonstrator made of FRP and metal joined by established spot joining processes using multifunctional interfaces.

Period

01.10.2019 – 31.03.2022

Project management

Prof. Dr.-Ing. habil. Maik Gude

Contact

Dr.-Ing. Juliane Troschitz

Project partners

Laboratory for Materials and Joining Technology (LWF) at the University of Paderborn

Funding

Supported by:

Federal Ministry for Economic Affairs and Climate Action

on the basis of a decision by the German Bundestag

Federal Ministry for Economic Affairs and Climate Action (BMWK): Programme: "Industrial Collective Research" (IGF)

IGF No. 20870 BG/EFB No. 08/119

Managed by:

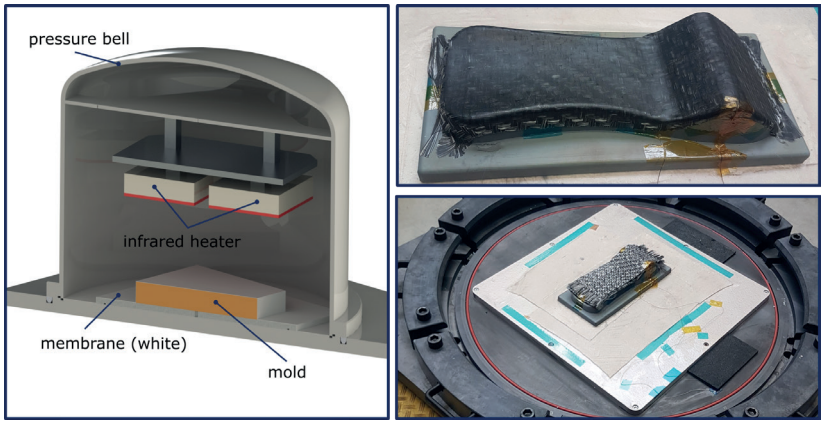
AiF Projekt GmbH, Subsidiary of the German Federation of Industrial Research Associations "Otto von Guericke" e. V. (AiF)

Europäische Forschungsgesellschaft für Blechverarbeitung e.V. (EFB)

iMEM

Development of an innovative membrane press for more efficient production of fiber composite components from thermoplastic semi-finished products for small and medium series sizes

Thermoplastic fiber composites are becoming increasingly important. Until now, hardly any tooling, process and plant technology existed with which thermoplastic semi-finished products could be effectively processed in small to medium batch sizes of 200-2,000 pieces. The aim of the project was therefore to develop an innovative membrane press that achieves cycle times in the range of 8-15 min at 5-10 bar. The necessary temperatures of 200°C-280°C were generated precisely and energy-efficiently by a controllable infrared radiator system. The heat radiation was emitted directly into the semi-finished product through a thermostable, highly formable silicone membrane. In addition to the development of the complex system structure with pressure-tight cable guides, electrical and pneumatic safety system, as well as a control system, cost-effective and pressure-stable molds were also developed, which are characterized by low thermal conductivity. Thus, the one-sided heating concept could be implemented. In addition, the thermodynamics of the innovative plant technology were researched by means of FEM simulations and practical tests, and based on this, an optimum process control for thermoplastic fabrics was defined. The process parameters and their influence were evaluated so that design guidelines and possible material combinations could be defined.



Schematic representation of the innovative membrane press (left), with the demonstrator before (bottom right) and after consolidation (top right).

Period

01.01.2020–31.12.2022

Project management

Prof. Dr.-Ing. Niels Modler

Contact

Felix Bonn
Kurt Böhme

Project partners

- Leibniz-Institut für Polymerforschung Dresden e.V.
- Wickert Maschinenbau GmbH
- Franz Fischler GmbH & Co. KG

Funding

Supported by:

Federal Ministry for Economic Affairs and Climate Action

ZIM Zentrales Innovationsprogramm Mittelstand

on the basis of a decision by the German Bundestag

Federal Ministry for Economic Affairs and Climate Action (BMWK): Central Innovation Programme for SMEs (ZIM)

Funding code: ZF4024720KO9

Managed by:

AiF Projekt GmbH, Subsidiary of the German Federation of Industrial Research Associations "Otto von Guericke" e. V. (AiF)

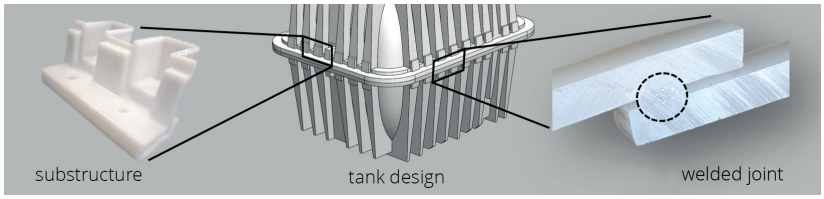
TraKuBe

Development of a transport-optimized plastic tank for small wastewater treatment plants

Small wastewater treatment plants are often used where there is no central sewage system. They often consist of monolithic tanks made of low-density polyethylene (LDPE) using rotary sintering and the internals required for wastewater treatment. Transporting finished systems to the global site is expensive because the transport volume is equal to the container volume and thus only a low packing density is achieved. The transport volume becomes significantly smaller if multi-part and stackable containers and built-in modules are used.

The aim of the joint project of batchpur GmbH & Co. KG and the (ILK) is therefore to develop a small wastewater treatment plant with a multi-part tank system and a suitable built-in module for wastewater treatment. Since the tank is to consist of two halves in the future, a connecting and sealing system is also being developed. This has to be designed in such a way that it can be used on site under construction site conditions and remains reliably tight during the entire period of use of the small wastewater treatment plant.

The result of the project so far is a stackable tank half that has been developed to meet requirements and production. Resistance welding with an integrated heating element was chosen to join the two halves in order to compensate for unevenness in the joint area. In joining tests at element level, process parameters and characteristic values were determined for the computational strength verification of the structure. The joining technique is now being validated under long-term stress on manufactured substructures of the container half.



Design of a stackable tank half.

Period

01.05.2021 – 30.04.2023

Project management

Prof. Dr.-Ing. habil. Maik Gude

Contact

Martin Pohl

Project partners

batchpur GmbH & Co KG

Funding

Supported by:

Federal Ministry for Economic Affairs and Climate Action

ZIM Zentrales Innovationsprogramm Mittelstand

on the basis of a decision by the German Bundestag

Federal Ministry for Economic Affairs and Climate Action (BMWK): Central Innovation Programme for SMEs (ZIM)

Funding code: KK5047603CM0

Managed by:

AiF Projekt GmbH, Subsidiary of the German Federation of Industrial Research Associations "Otto von Guericke" e. V. (AiF)

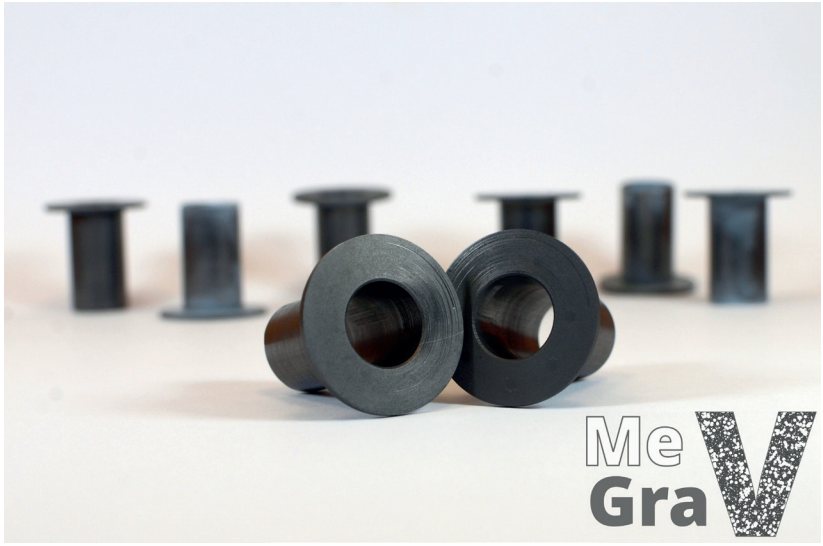
MeGraV II

Design of metal-graphite composites under consideration of application-related operating conditions

Tribological causes account for 23 % of the total global energy expenditure. Up to 20 % of the expenditures result from the pure overcoming of friction and approx. 3 % from the energetic expenditure for the restoration of worn machines and systems.

In the future, higher operating and emergency running properties have to be guaranteed, especially for plain bearings and mechanical seals. This results in a cross-industry demand for new bearing materials with a low tendency to wear for high operating temperatures.

In the current MeGraV II project, researchers from the ILK are investigating a new type of metal-graphite composite in collaboration with the Fraunhofer Institute for Manufacturing Technology and Applied Materials Research (IFAM). The focus of the investigations is on the carbide-free production of the material composites based on a squeeze casting process. The project makes an innovative contribution to the general methodical development of metal-graphite products by developing an adapted process control and design strategy for the first time. For this purpose, previously missing mechanical and tribological material data and a secured process window for the production of high-quality materials with suitable quality assurance methodology become available for potential users in the mechanical engineering sector.



Prototype flanged bushings made of aluminum - graphite composite and native graphite.

Period

01.06.2021 – 29.02.2024

Project management

Prof. Dr.-Ing. Niels Modler

Contact

René Füßel
Dr.-Ing. Thomas Behnisch

Project partners

Fraunhofer Institute for Manufacturing Technology and Advanced Materials (IFAM)

Funding

Supported by:

AiF Projekt GmbH, Subsidiary of the German Federation of Industrial Research Associations "Otto von Guericke" e. V. (AiF)

Managed by:

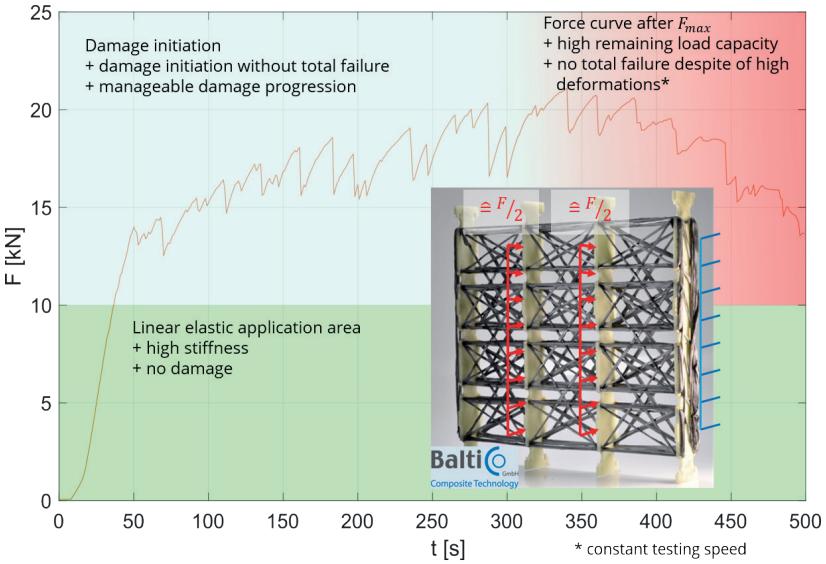
Science for a moving society

The Research Association for Combustion Engines e.V.

PLRV

Development of a large capacity lightweight transportation box

Against the background of dwindling resources and the need to reduce greenhouse gases, lightweight construction is gaining importance in the mobility of people and goods. A significant reduction in fuel consumption and CO2 emissions per tonne of payload can be expected through weight reduction in structural components of cars and trucks. For the development of a lightweight transportation box for small trucks the unique fibre-winding-technology, invented by the project partner BaltiCo (Patent: EP 2 598 309 B1) was applied. The great advantage of this technology is its flexibility in positioning the fibre strands along load paths and therefore its lightweight potential for highly loaded structures. Within the scope of this project, the successive damage and failure behaviour of the lattice structures was focussed and experimentally and analytically characterised. By means of specifically developed test methods, the node systems could be analysed at maximum load for the first time on sub structural and structural level. It could be shown, that the strands interacting in the area of the node develop diverse damage and failure modes, leading to a comparable good-natured behaving structure with high residual load carrying capabilities. The knowledge gain is incorporated together with the project partner BaltiCo into newly developed dimensioning tools.



©ILK/TUD and BaltiCo

Highly resolved lattice structure, force-displacement curve at 4-point bending.

Period

01.08.2020 – 30.06.2023

Project management

Prof. Dr.-Ing. habil. Maik Gude

Contact

Dr.-Ing. Ilja Koch
Felix Wiebicke

Project partners

BaltiCo GmbH

Funding

Supported by:

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on the basis of a decision by the German Bundestag

Federal Ministry for Economic Affairs and Climate Action (BMWK)
Funding code: 16KN085834

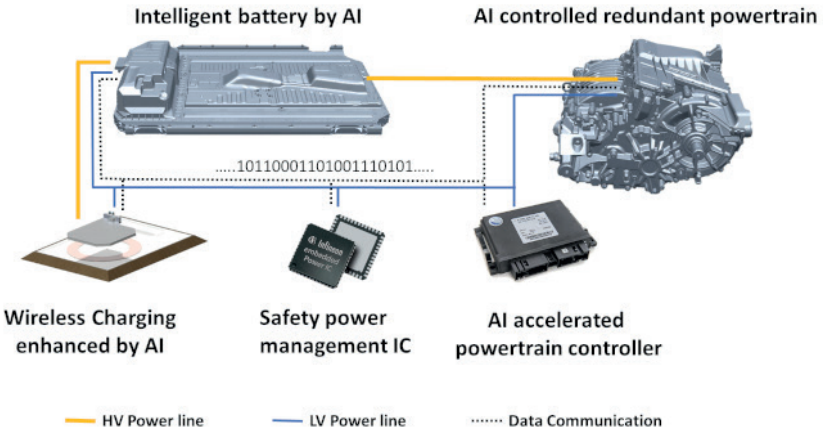
Managed by:

VDI/VDE Innovation + Technology GmbH

AI4CSM

Automotive Intelligence for/at Connected Shared Mobility

The AI4CSM project is developing high-reliability electronic components and systems for automated vehicles to accelerate the transition to the digital economy. New vehicle architectures and energy-efficient, high-performance hardware and software platforms enable the safe and reliable execution of AI algorithms. In this way, new AI-enabled electronic components and systems enable improved environmental perception, more efficient propulsion, and extended connectivity. The project, which involves 41 European and Indian partners, has a total budget of 41.53 million euros. The goal of the work at the ILK is to increase the availability and safety of wireless chargers for automated vehicles in public spaces. To this end, novel sensor principles and AI-based signal evaluation algorithms are being researched. The focus of the research work is on the development of a sensor based on electrical time-domain reflectometry for foreign object detection in wireless charging stations.



Overview of the main research areas in Supply-Chain 4.

Period

01.05.2021 – 01.05.2024

Project management

Prof. Dr.-Ing. Niels Modler

Contact

Martin Helwig

Project partners

- SINTEF
- Paxster AS
- NXTech AS
- AVL List GmbH
- Infineon Technologies Austria AG
- TTTech Auto AG
- Virtual Vehicle Research GmbH
- Austrian Institute of Technology GmbH (AIT)
- Technische Universität Graz
  Technische Universität Wien
- Ideas & Motion s.r.l.
- Infineon Technologies Italia s.r.l.
- VEM Solutions S.P.A.
- Politecnico di Torino
- Universität Modena und Reggio Emilia
- Bylogix s.r.l.
- Sleep Advice Technologies s.r.l.
- WaterView s.r.l.
- Interuniversitair Micro-Electronica Centrum
- Innatera Nanosystems B.V.
- Technische Universiteit Delft
- NXP Semiconductors Netherlands B.V.
- Technische Gediminas-Universität Vilnius
- Institute of Electronics and Computer Science (EDI)
- TeraGlobus UAB
- Infineon Technologies India Private Limited
- Technische Universität in Brünn
- Institute of Microelectronic Applications s.r.o. (IMA)

Funding

Supported by:

Federal Ministry of Education and Research

on the basis of a decision by the German Bundestag

Federal Ministry of Education and Research (BMBF)

Managed by:

VDI|VDE|IT

VDI/VDE Innovation + Technology GmbH

European Union

ECSEL Joint Undertaking

Electronic Components and Systems for European Leadership

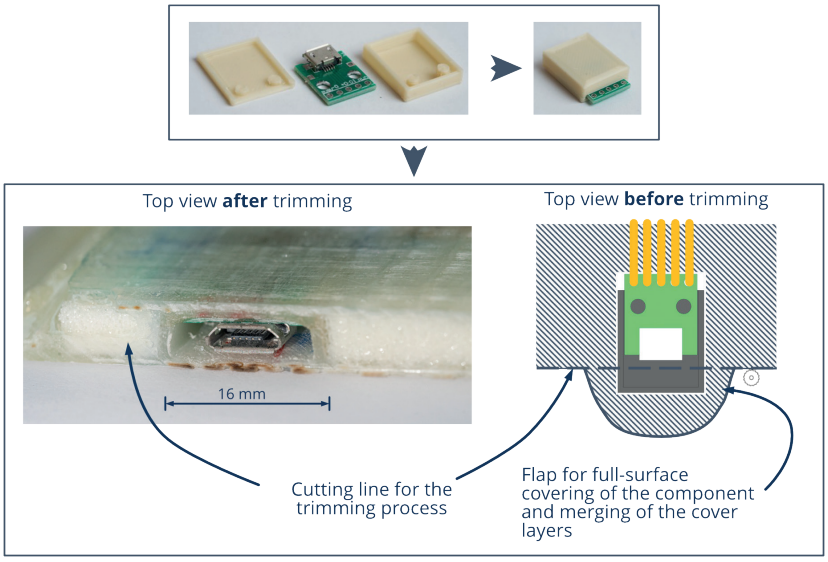
This project has received funding from the Electronic Component Systems for European Leadership Joint Undertaking (ECSEL) under grant agreement No. 101007326. This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme and Germany, Austria, Italy, Belgium, Czech Republic, Netherlands, Lithuania, Latvia, India, Norway.

ProPlug

Development of a structural-integrated connector system for the electrification of functionalized fiber composite components

For innovative lightweight structures, besides the realisation of structural properties, the integration of further functionalities, such as lights, sensors or heating elements, is increasingly being sought. However, practical experience has shown that the electrical contacting of functional elements integrated in lightweight structures made of fibre-reinforced plastic composites (FRP) in particular cannot be reliably realised at present. In particular, secure electrical and mechanical connection as well as the cable routing within the component up to the plug connection are currently still immature systems.

Within the framework of the ProPlug research project, a robust and long-term stable system for functionally integrative lightweight structures is therefore to be developed. The ILK is working closely with the project partners to develop integration and contacting methods suitable for fibre-reinforced composites as well as the associated technologies. The focus is on the conception, evaluation and technological implementation of functional specimen with integrated connectors for a thin-walled, fibre-reinforced container structure with adaptable heating function.



Composite integrated multifunctional interfaces.

Period

01.12.2020 – 30.11.2023

Project management

Prof. Dr.-Ing. Niels Modler

Contact

Florian Lehmann

Project partners

- Consortium Leadership: Lätzsch GmbH
- AUMO GmbH
- Embro GmbH
- HoTec Electronic Hollenberg GmbH
- Fraunhofer Institute for Ceramic Technologies and Systems (Fraunhofer IKTS)

Funding

Supported by:

Federal Ministry of Education and Research

on the basis of a decision by the German Bundestag

Federal Ministry of Education and Research (BMBF): Funding guideline "KMU-innovativ Elektronik und autonomes Fahren; High Performance Computing"

Funding code: ME1KMU19/004

Managed by:

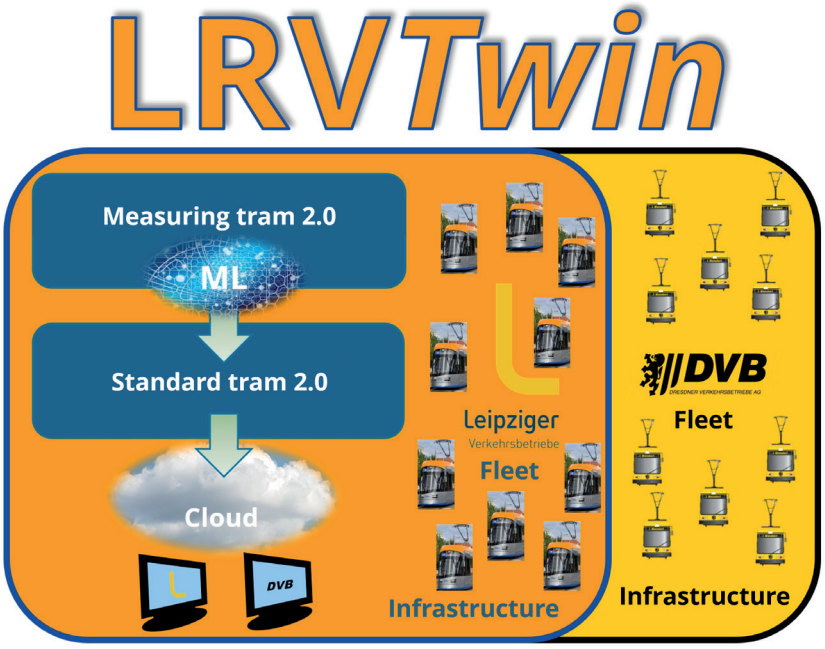
VDI/VDE Innovation + Technology GmbH

LRVTwin

Light Rail Vehicle Twin, A digital light rail twin

The aim of the LRVTwin project is to digitise a tram fleet in order to ensure better availability and reliability of the trams in service. Currently, the vehicle condition of a tram can only be determined at fixed maintenance intervals during inspection. In LRVTwin, an approach is used that makes it possible to implement a condition description of the entire fleet with minimal changes to the individual vehicles. In concrete terms, this means that no or only a few additional sensors are integrated into the individual vehicles, as complete sensor equipment would represent an insurmountable investment effort. Nevertheless, the states of all vehicles should be recorded as precisely as possible and changes in state should also be reliably predicted.

For this purpose, machine learning (ML) is used to evaluate estimated measured variables and detected damage events for all lanes. It is important here to develop ML models that are as precise as possible and that enable an accurate forecast for each individual vehicle. For the training of these models, a reference vehicle principle is implemented in which a measurement vehicle is realised that, in addition to sensors whose data are available as standard via the vehicle bus, also has extensive additional measurement technology and thus allows the creation of correlations between standard sensors and additional sensors.



Project concept of LRVTwin.

Period

01.01.2022 – 31.12.2024

Project management

Prof. Dr.-Ing. habil. Maik Gude

Contact

Dr.-Ing. Christoph Ebert
Dr.-Ing. Ilja Koch

Project partners

- Leipziger Verkehrsbetriebe GmbH
- Dresdner Verkehrsbetriebe AG
- Robotron Datenbank-Software GmbH
- IFTEC GmbH & Co. KG
- SDS Schwingungs Diagnose Service GmbH
- Estino GmbH
- Leichtbau-Zentrum Sachsen GmbH (LSZ)
- Fraunhofer Institute for Ceramic Technologies and Systems (IKTS)
- Chair of Computational and Experimental Solid Mechanics at the Institute of Solid Mechanics (IFKM) at the TU Dresden
- Chair of Dynamics and Mechanism Design at the Institute of Solid Mechanics (IFKM) at the TU Dresden

Funding

Supported by:

Federal Ministry for Digital and Transport

on the basis of a decision by the German Bundestag

Federal Ministry for Digital and Transport (BMDV): Funding programme: "Modernitätsfonds (mFund)"

Funding code: 19FS20212A

Managed by:

VDI|VDE|IT

VDI/VDE Innovation + Technology GmbH

AI4DI

Artificial Intelligence for Digitizing Industry

A novel sensor system based on electrical time domain reflectometry (TDR) is being developed to provide robots of all sizes and performance classes with a "tactile sense" as a prerequisite for efficient human-machine interaction (HMI). The TDR principle enables the implementation of scalable and comparatively low-cost touch sensors that can measure with both force and spatial resolution. However, the technical maturity of such sensors is still low.

The TU Dresden work program as part of the A4 "Smart Robot" supply chain therefore includes the scientific investigation of multiphysical issues in sensor design, signal pre-processing and conditioning, and the targeted evaluation of sensor data. In the development of the hardware component of the sensor system, the limits of applicability in terms of sensor size, spatial resolution, dynamics and sensitivity are being explored. In parallel, the integration of the novel sensors into flat and simple curved structural components of industrial robots is being investigated. In addition, a robust methodology for data interpretation in terms of HMI is being developed based on machine learning. This includes the design of analysis tools, off-site and on-site training, and the validation of measurement results in extensive test series. The results of the project should open up the potential of this measurement technology to a wide range of applications.

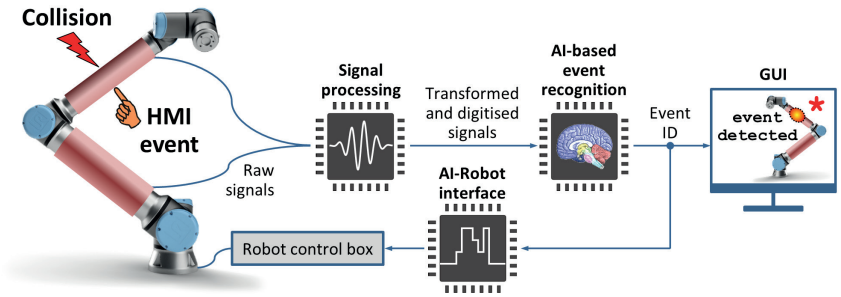


Fig. 01 Intended functionality of the sensor system: collision detection, recognition and interpretation of touch events including touch force measurement, "tactile sense" of robots.

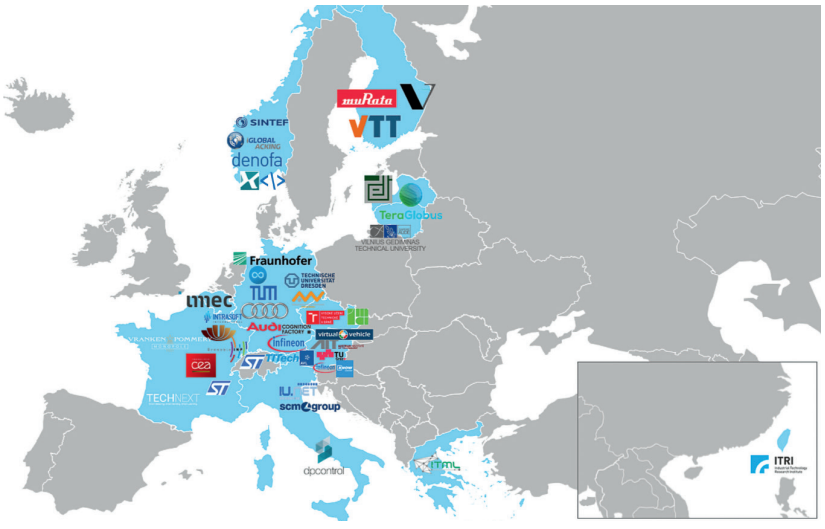


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Fig. 02 Map of the project partners involved

Period

01.01.2020 – 30.03.2022

Project management

Prof. Dr.-Ing. Niels Modler
Prof. Wolfgang E. Nagel

Contact

Dr.-Ing. Anja Winkler
Dr.-Ing. Pawel Kostka

Project partners

see map below

Funding

Supported by:

Federal Ministry of Education and Research

on the basis of a decision by the German Bundestag

Federal Ministry of Education and Research (BMBF)

Funding code: 16ESE0341S

European Union

ECSEL Joint Undertaking
Electronic Components and Systems for European Leadership

This project has received funding from the ECSEL Joint Undertaking (JU) under grant agreement No. 826060. The JU receives support from the European Union's Horizon 2020 research and innovation programme.

Managed by:

VDI|VDE|IT

VDI/VDE Innovation + Technology GmbH

iclimabuilt

Functional and advanced insulating and energy harvesting/storage materials across climate adaptive building envelopes

Fig. 01 CarbonConcrete Technical Center, HTWK Leipzig.
* © Photo: Otto Grauer, FG Sustainable Constructing, HTWK Leipzig

Buildings account for around 40 % of total energy use and 36 % of CO2 emissions in Europe. Due to the high savings potential, the iclimabuilt project specifically aims at the construction sector in order to significantly reduce the energy consumption of buildings and the associated CO_2 emissions.

In order to reach the goal of „Nearly Zero-Energy and Emission"-Buildings, the iclimabuilt project focuses on the development of novel and functionally integrated façade elements. In addition to the increased structural load capacity and improved thermal insulations, the Life-Cycle-Assessment (LCA) and the circulation of the used materials are also in the foreground. To validate the novel façade elements, they are installed in fully monitored so-called living labs and extensively tested under real conditions of use. Due to the strong regional fluctuations in climatic conditions, living labs in Spain, Italy, Norway and Germany are used to cover all climate zones occurring in Europe. One of these innovative living lab-houses will be the „Cube" at the TU Dresden, whose construction was finished in 2022. This first carbon concrete house in Europe was developed and implemented as part of the Carbon Concrete Composite (C^3) Research Cluster at the TU Dresden.

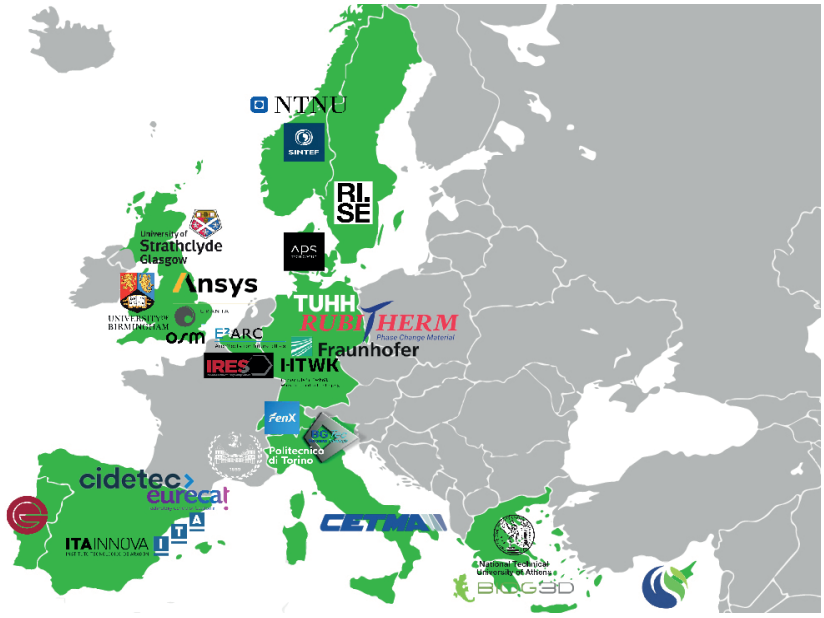


Fig. 02 Map of the European project partners involved in the iclimabuilt project.

Period

01.01.2021 – 31.12.2024

Project management

Prof. Dr.-Ing. Niels Modler

Contact

Hannes Peller
Dr.-Ing. Mike Thieme

Project partners

- AIDEAS OU
- Kaneka Belgium NV (associated partner)
- see map below

Funding

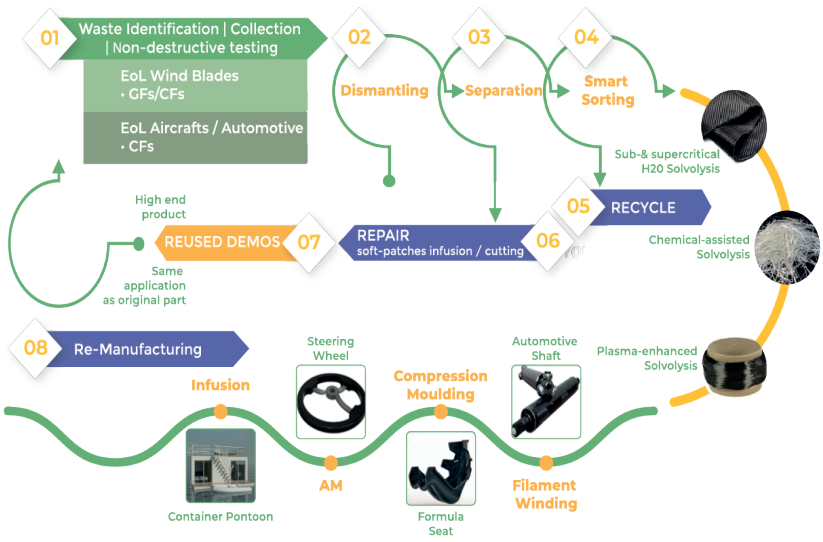
Horizon2020
European Union Funding
for Research & Innovation

This project has received funding from the Horizon 2020 research and innovation programme under European Union grant agreement No. 952886 and Germany, Italy, Spain, Portugal, Greece, Cypress, Belgium, Denmark, Sweden, Norway.

EuReComp

European recycling and circularity in large composite components

Currently, about 60 % of waste from fibre-reinforced composites is disposed of in landfills across all industrial sectors. The reason is that there are few market-ready concepts and technologies for the efficient recycling of this waste. In particular, the dissolution of the matrix and the separation of the individual recyclable materials create major challenges for the recycling industry. The EuReComp project, which is funded by the EU, is therefore dedicated to the question of high-quality recycling of fibre composite structures. EuReComp aims to provide sustainable methods for the reuse and recycling of composite materials from large structures in aviation and wind energy industry. Six different recycling routes are being investigated (R6 strategy) to improve the recycling of components that have reached their EoL. By converting them into products with high added value and high-quality recycling, waste is to be avoided and materials are to be kept in the cycle. In the project, the ILK is focusing on the one hand on the identification and analysis of value-added networks in the recycling of composite structures. On the other hand, solvolysis technology is being investigated to research a promising recycling approach for the recovery of high-quality fibres and matrix polymer. By using subcritical and supercritical water as a solvent, it is intended to avoid the use of additional chemical additives in the solvolysis process.



Overview of the EuReComp project concept.

Period

01.04.2022 – 31.03.2026

Project management

Prof. Dr.-Ing. Niels Modler

Contact

Dr.-Ing. Robert Kupfer
Paul Schulz

Project partners

- National Technical of Athens
- Institute of Science and Innovation in Mechanical and Industrial Engineering (INEGI)
- Elbe Flugzeugwerke GmbH (EFW)
- B&T Composites
- Innovation in Research and Engineering Solutions (IRES)
- Leipzig University of Applied Sciences (HTWK)
- Kunststoff-Zentrum Leipzig gGmbH (KUZ)
- Dallara Automobil
- Silesian University of Technology
- ITAINNOVA - Aragon Institute of Technology (ITA)
- Politecnico di Torino
- AIMEN Centro Tecnológico
- University of Patras
- BioG3D New 3D Printing Technologies
- EASN Technology Innovation Services (ESAN-TIS)
- Stratagem Ltd
- Anthony, Patrick and Murta Exportacao
- Fraunhofer-Institute for Process Engineering and Packaging (IVV)
- Circularise

Funding

European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme and Germany, Poland, Italy, Spain, Portugal, Greece, Cyprus, Belgium.

Funding code: 101058089

Managed by:

HaDEA

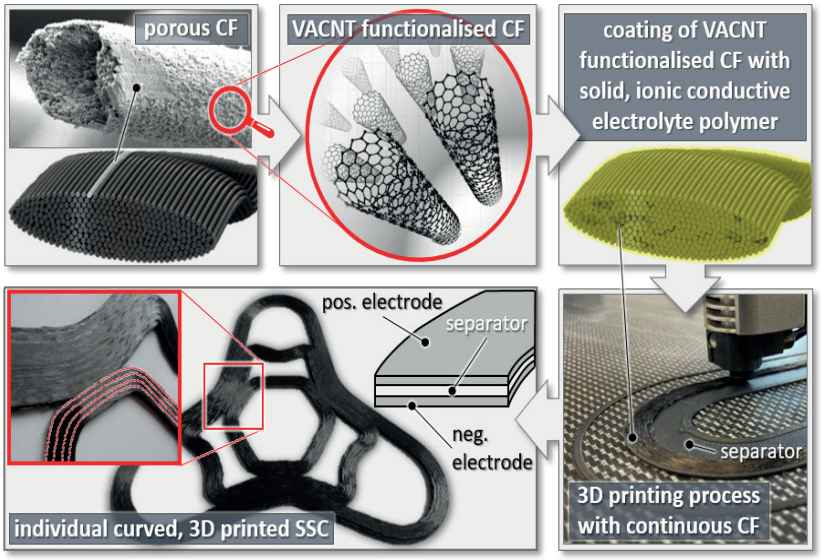
European Health and Digital Executive Agency (HaDEA)

PrintCap

Design concept: From porous carbon fibre to 3D printed structural supercap

Against the background of current global megatrends such as climate change, the scarcity of natural resources and an increasingly individualized lifestyle, innovative electromobility concepts are key technologies for a sustainable future. In this context, energy storage and lightweight construction play a particularly important role in the development of new high-tech products in the fields of electronics, bicycle-based mobility concepts, automotive engineering, rail transport, and aerospace. Electrically powered transportation systems have many advantages. Most importantly, they are free of local CO2 emissions and therefore form the backbone of the European Union's climate framework. However, such CO2-free mobility systems require the provision of efficient, lightweight and durable energy storage solutions. Current advanced energy storage solutions contribute to a significant portion of the overall weight of the systems and can therefore lead to limitation in design or deployment options.

Novel solutions for efficient energy storage, based on a fusion of supercapacitors, composites and additive manufacturing, are expected to enable an important breakthrough in this field. This is where the PrintCap project comes in, offering industrial solutions for composite materials with integrated energy storage functions as part of an interdisciplinary project consortium. This is where the PrintCAp project takes up the challenge by offering industrial oriented solutions for composite materials with integrated energy storage functions as part of an interdisciplinary project consortium.



Design concept: From porous carbon fibre to 3D printed structural supercap.

Period

01.04.2022 – 31.03.2025

Project management

Prof. Dr.-Ing. Niels Modler

Contact

Daniel Wolz
Robert Seidel

Project partners

- Institute of Textile Machinery and High Performance Material Technology (ITM) at the TU Dresden
- Thales S.A. Research & Technology (TRT)
- NAWATechnologies
- Leipzig University of Applied Sciences (HTWK)

Funding

Supported by :

M-ERA.NET

Initiative/Netzwerk M-ERA.NET
M-ERA.NET JOINT CALL 2021
Reference number: 100634598

This measure is co-financed with tax funds based on the budget approved by the Saxon state parliament.

DigiKunst

The virtual injection moulding machine

Virtual models of real technologies offer the potential to communicate the complex physical-technical processes of plastics technologies at a new level and to enable practical understanding outside the laboratory or production. In the DigiKunst research project, a realistic and steerable 3D model of an injection molding machine with an associated mold and process model was developed, implemented in a learning app and then evaluated in training and continuing education.

- In lessons, a video tutor introduces the functionality of the injection molding machine and the physical-technical interrelationships of the process (cf. fig. a-c).
- The machine atlas with detailed explanatory texts allows learners to explore the geometry and function of the machine components (d).
- A question module helps to repeat and consolidate knowledge.
- In the troubleshooting module, manufacturing parameters can be set and the effects on process and component quality can be studied (e).

The application of the software in student and vocational education and training shows that the animated real-time model and the interactive operation of the machine, which are both based on 3D game environment, enable a playful approach to the complex injection molding technology and significantly improve the learning outcome. A free trial version of the software can be provided on request.

Screenshots of the DigiKunst software.

Period

01.06.2019 – 31.05.2022

Project management

Prof. Dr.-Ing. habil. Maik Gude

Contact

Dr.-Ing. Robert Kupfer
Alexander Liebsch

Project partners

- 3D Interaction Technologies GmbH
- Bildungswerk der Sächsischen Wirtschaft gGmbH
- FEP Fahrzeugelektrik Pirna GmbH

Funding

Europäische Union
Europa fördert Sachsen.
ESF
Europäischer Sozialfonds

Europäischer Sozialfonds für regionale Entwicklung (ESF)

Funding code: 01ME18001H

This measure is co-financed with tax funds based on the budget approved by the Saxon state parliament.

Managed by:

SAB

Sächsische Aufbaubank (SAB)

LITAPROP

Light-weight composite structures with tailored mechanical, electrical and thermal properties

Fibre reinforced plastics (FRP) have established themselves as high-performance materials in many industries thanks to their excellent mechanical properties. However, the use in mobility applications, e.g. hybrid-electric drives, requires an enhancement of the property profile of the FRP. In addition to high mechanical properties high electrical and thermal conductivity are required for key components in mobility application. Thus, the main objective of LITAPROP is to investigate appropriate methods for the development of novel fibre reinforced thermoplastics (FRT) with significantly increased electrical and thermal properties for high performance function-integrative composite structures. A promising solution for highly conductive composites, especially with regard to high manufacturing efficiency, is offered by novel intermediate products in the form of non-wovens and strips (NMFVS) modified with nano and micro fillers like carbon nanotubes (CNT) or cristobalite powder (CP). A further unique aspect of this project is that the aspired material development is not carried out in the usual "trial and error" method. Instead, an innovative systematic approach for a new interlinked material development process (iMDP) is being developed. This enables a significant increase in efficiency and effectiveness of the development process especially of product-specific materials.

Thermoplastic non-woven with carbon nanotubes (CNT).

Period

01.07.2021 – 30.06.2024

Project management

Prof. Dr.-Ing. habil. Maik Gude

Contact

Rafał Stanik
Dr.-Ing. Anja Winkler
Dr.-Ing. Andreas Hornig

Project partners

- Faculty of Material Science and Engineering at the Warsaw University of Technology
- TMBK Partners Sp. z. o. o.

Funding

Supported by:

M-ERA.NET

Initiative/Netzwerk M-ERA.NET
M-ERA.NET JOINT CALL 2021

Reference number: project8283

This measure is co-financed with tax funds based on the budget approved by the Saxon state parliament.

Managed by:

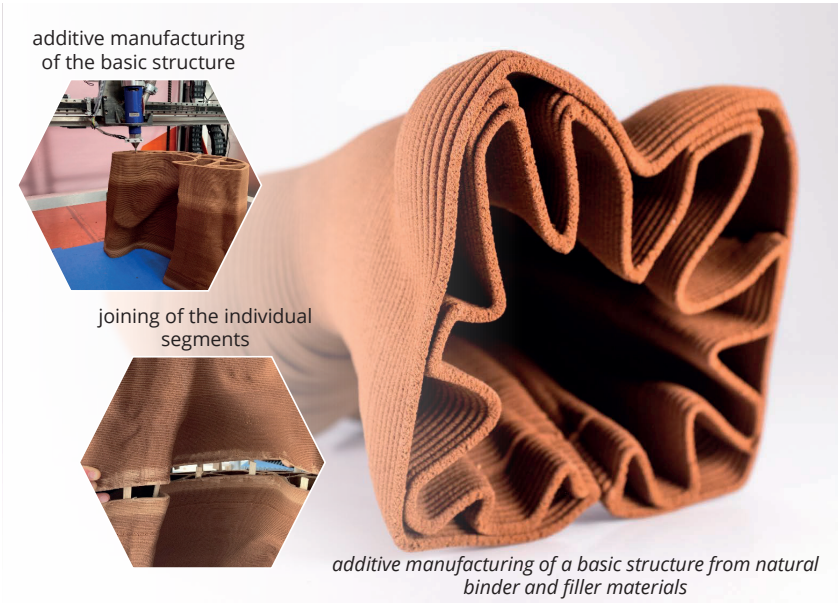
SAB

Sächsische Aufbaubank (SAB)

GreTA

Additive manufacturing of recycable structures for theatre sculptures

Due to the manufacturing of sculptures, figurines, as well as parts for reliefs, architecture, and landscape in theatrical scenography, a large amount of plastic waste is created. Especially the manufacturing of large sculptures from foamed polystyrene requires additional material to extract the desired shape out of the larger volume before additional steps like surface reinforcements can be performed. This leads to a large amount of mixed and therefore not recyclable waste. A significant reduction of environment polluting waste while maintaining the current method of production is therefore difficult to achieve. The aim of the research project "GreTA" is substitution of conventional, synthetic plastics with naturally occurring filler and matrix material with a low grade of processing in combination with an adapted additive manufacturing process. This will allow the fast and efficient manufacturing of recyclable structures without waste and without compromising the further individualization using current manual processing techniques.



Conventional production of a theatre sculpture from foamed polystyrene and production using additive manufacturing from recyclable materials.

Period

01.09.2021 – 31.08.2024

Project management

Prof. Dr.-Ing. Niels Modler

Contact

Johanna Maier

Project partners

- Sector Theater Sculpture at the Dresden Univeristy of Fine Arts (HfBK)

Funding

Supported by:

STAATSMINISTERIUM FÜR WISSENSCHAFT KULTUR UND TOURISMUS | Freistaat SACHSEN

Saxon State Ministry of Science and Art (SMWK): Research area TG 70

Funding code: WI63

This measure is co-financed with tax funds based on the budget approved by the Saxon state parliament.

Managed by:

SAB

Sächsische Aufbaubank (SAB)

SaxonHy

System-integrated H_2 pressure tank assemblies for general aviation and feeder aircraft

The aim of the project is to successfully transfer proven approaches of Model-Based System Engineering (MBSE) from software development to the development of lightweight solutions. In this regard, a system model was created for the specific application, serving as a basis for the development of H_2 pressure storage assemblies. A practical development methodology for the system integration of H_2 pressure tank assemblies was developed to ensure efficient and high-quality processes. This included the development of configuration and design methods for the assemblies, particularly regarding load introduction and connection areas. Additionally, manufacturing processes for tank assemblies were expanded by integrating load introduction elements. Demonstrator tank assemblies were manufactured to conduct experimental system investigations and test the developed technologies.

A specially designed testing facility enabled experimental investigations on scaled H_2 pressure tank assemblies under realistic installation conditions. The project aimed to optimize the development of H_2 pressure storage assemblies for the aviation industry, increase their efficiency, and validate the technologies for broader practical applications. The results contribute to the development of innovative and sustainable solutions for aviation and the promotion of hydrogen utilization as an energy carrier.

In-wing integrated high-pressure hydrogen tanks using the example of the APUS i-5 'H' (conceptual representation).

Period

01.12.2021 – 31.05.2023

Project management

Prof. Dr.-Ing. habil. Maik Gude

Contact

Dr.-Ing. Sebastian Spitzer
Florian Schmidt

Project partners

- Consortium leadership: Leichtbau-Zentrum Sachsen GmbH (LZS)
- EAST-4D Carbon Technology GmbH (E4D)
- Institute of Aerospace Engineering (ILR) at the TU Dresden
- Institut of Power Engineering (IET) at the TU Dresden
- Rolls-Royce Deutschland Ltd. & Co. KG (associated partner)
- APUS-Aeronautical Engineering GmbH (associated partner)
- IMA Materialforschung und Anwendungstechnik GmbH (associated partner)
- COTESA GmbH (associated partner)

Funding

European Union
Europe funds Saxony. EFRE European Regional Development Fund

European Regional Development Fund (EFRE) in Saxony: Funding guideline "EFRE-RL Forschung InfraPro"

Project number: 100558500

This measure is co-financed with tax funds based on the budget approved by the Saxon state parliament.

Managed by:

SAB
Sächsische Aufbaubank (SAB)

Project Overview (Selection)

1000KM+	Scalable European Powertrain Technology Platform for Cost-Efficient Electric Vehicles to Connect Europe
ABSOLUT	Automatic bus shuttle – self-organizing between Leipzig and the BMW terminal
ADAPT	Self-adapting cutting system and in-process quality assurance in the CFRP processing process
ADHYBAU (ex. BASELA)	Development of additive processes and fiber composite-metal hybrid designs for the Use in cryogenic environments (AdHyBau) SP: Novel designs for structures in electric drives with cryogenic cooling
AI4CSM	Artificial Intelligence for/at Connected Shared Mobility
AI4DI	Artificial Intelligence for Digitalizing Industry
AMTWIN	Data-driven process, material and structure analysis for additive manufacturing
ARCHITECT	Trustable architectures with acceptable residual risk for the electric, connected and automated cars
BIIAX	Description of the fatigue behavior of fabric-reinforced fiber-plastic composites under combined interlaminar shear and out-of-plane compressive stress
BRYSON	Space-efficient hydrogen storage with optimised usability SP: Process development for the manufacturing of thermoplastic warp tank systems
CECO	Development of a manufacturing process for injection moldable cellulose-based composites
CHANGE!	Change! From resource efficiency towards neutrality
CIRCECON	Survey concept for the Trilateral Research Centre for circular and organic economy of the Saxon Technical Universities Chemnitz, Dresden and Freiberg in Lusatia
COMFYTPU	Development of electrically heatable TPU-based components from continuously producible sheets TP: Entwicklung von elektrisch beheizbaren TPU-basierten Bauteilen aus kontinuierlich herstellbaren Platten
COMPOLL	Combating environmental pollution through internationalisation of education in Germany and India
DAHLIA	Digital technologies for hybrid lightweight structures SP: Fusion of the material and process models into a digital twin
DCIM@WROC	Towards the international visibility of DCIM and its strategic cooperation on Materials Science with Wroclaw science region

Project management	Expert group	Start	End	Funding	Project executing agency
Prof. Dr.-Ing. Niels Modler	Function Integration	01/2019	06/2022	EU	
Prof. Dr.-Ing. Niels Modler (Prof. Dr. rer. nat. Hubert Jäger)	Lightweight Design	01/2019	09/2022	BMWK	DLR
Prof. Dr.-Ing. habil. Maik Gude	Thermoset Processing and Preforming	11/2018	04/2021	BMBF	PTKA-PFT
Prof. Dr.-Ing. habil. Maik Gude	Joining Technologies	05/2020	04/2023 VL bis 12/2023 beantragt	BMWK	DLR
Prof. Dr.-Ing. Niels Modler	Function Integration	07/2021	04/2024	EU/BMBF/SAB	VDI/VDE
Prof. Dr.-Ing. Niels Modler	Function Integration	05/2019	11/2022	EU/BMBF	VDI/VDE
Prof. Dr.-Ing. habil. Maik Gude	Testing Methods and Material Models	12/2019	06/2022	SAB	
Prof. Dr.-Ing. Niels Modler	Function Integration	07/2020	06/2023	EU/BMBF	VDI/VDE
Prof. Dr.-Ing. habil. Maik Gude	Testing Methods and Material Models	03/2021	02/2024	DFG	
Prof. Dr.-Ing. habil. Maik Gude	Thermoplastic Processing	12/2019	05/2023	BMWK	PTJ
Prof. Dr. rer. nat. Hubert Jäger	Neutral Lightweight Engineering	08/2019	01/2022 VL bis 4/2022 beantragt	AiF	DECHEMA
Prof. Dr.-Ing. habil. Maik Gude	Neutral Lightweight Engineering	10/2021	12/2024	SMWK	
Prof. Dr.-Ing. Niels Modler (Prof. Dr. rer. nat. Hubert Jäger)	International	09/2022	12/2022	SAB	
Prof. Dr.-Ing. habil. Maik Gude	Thermoset Processing and Preforming	01/2022	12/2023	AiF	FILK
Prof. Dr.-Ing. habil. Maik Gude	International	07/2020	06/2024	DAAD	
Prof. Dr.-Ing. habil. Maik Gude	Calculation Methods and Simulation Function Integration	02/2020	09/2022	SAB	
Dr.-Ing. Angelos Filippatos		01/2022	12/2022	TUD/SG 8.3 Internationalisation	

DDTRUST	Implementierung eines Datentreuhandmodells für den sächsischen Wissenschaftsraum an der TU Dresden
DIDE4REC	Digital design 4 recycling process for fiber-reinforced lightweight structures
DIGI-KUNST	Digital learning tools in the training of process mechanics for plastics and rubber technology for securing the next generation of professionals
DIWA	Analysis of the influence of production-related fibre misalignments on the material behaviour of thick-walled fibre-reinforced plastic composites
EACPLUS	Sustainable Electric Architecture Casings
EDI:TUD	Successful – Digital – Integrated: Studying at TU Dresden
ELAN-FELL	Electric power units for hybrid electric propulsion systems TP: Funktionsorientierter Einsatz von Leichtbautechnologien für hochintegrative elektrische Leistungseinheiten
ELVIS	Entwicklung und Erprobung ultraleichter Verbundstrukturen mit integrierter elektrischer Speicherfunktion TP: Bauweisenentwicklung, Herstellung und experimentelle Charakterisierung
EURECOMP	European recycling and circularity in large composite components
FATIIGUE	Experimental analysis and numerical modelling of microcrack induced delaminations under cyclic loading with load reversals
FAVILEIT	Development of a test stand for the simultaneous characterization of fibers and yarns, regarding their electrical and mechanical properties
FELISA	Automated production of fibre-thermoplastic composite profiles for open and closed aerospace structures in series application SP: Tape-Braid-Patch Preforming for Complex Shaped Fibre Thermoplastic Composite Profiles
FLEUR	Aktive Flächen mit Reaktionsstrukturen für urbane Räume SP: Entwicklung von Modellen zur Auslegung hybrider aktiver Tragwerksstrukturen mit Funktionsintegration
FLIER	Flexible wall structures for acoustic LInERs
FURNIER	Development and technological implementation of load-bearing profile structures based on wood veneers for an ultra-light tripod for photographic applications SP: Characterization and modeling of material and structural behavior
GABRIELA	Ganzheitliche Bearbeitung von Kunststoffrecyclingpfaden für ressourceneffiziente und kreislauffähige Leichtbau□Batteriegehäuse TP: Alterung und Eigenschaftsanalyse
GEPART	Development of efficient process technologies within the closed particle foam material cycle SP: Virtual and experimental material characterisation for rEPP and EPP particle foam

Project management	Expert group	Start	End	Funding	Project executing agency
Prof. Dr.-Ing. habil. Maik Gude	Calculation Methods and Simulation Function Integration	01/2022	01/2024	BMBF	VDI/VDE
Prof. Dr.-Ing. habil. Maik Gude	Novel Materials and Special Processes	05/2022	04/2025	BMWK	DLR
Prof. Dr.-Ing. habil. Maik Gude	Joining Technologies	06/2019	08/2022	SAB	
Prof. Dr.-Ing. habil. Maik Gude	Testing Methods and Material Models	04/2020	03/2023	DFG	
Prof. Dr.-Ing. habil. Maik Gude	Neutral Lightweight Engineering	12/2021	11/2024	BMWK	PTJ
Prof. Dr.-Ing. Niels Modler	International	01/2021	12/2023	DAAD	
Prof. Dr.-Ing. habil. Maik Gude	Lightweight Design	01/2022	12/2024	BMWK	DLR
Prof. Dr.-Ing. habil. Maik Gude	Novel Materials and Special Processes	05/2022	04/2025	BMWK	DLR
Prof. Dr.-Ing. habil. Maik Gude	Neutral Lightweight Engineering	04/2022	03/2026	EU	
Prof. Dr.-Ing. habil. Maik Gude	Testing Methods and Material Models	09/2021	08/2023	DFG	
Prof. Dr.-Ing. Niels Modler	Function Integration	04/2021	03/2023	AiF	AiF
Prof. Dr.-Ing. habil. Maik Gude	Thermoplastic Processing	04/2019	12/2022	BMWK	DLR
Prof. Dr.-Ing. Niels Modler	Material Models	04/2019	06/2022	SAB	
Prof. Dr.-Ing. Niels Modler	Function Integration	06/2020	08/2023 VL bis 03/2024 beantragt	BMWK	DLR
Prof. Dr.-Ing. habil. Maik Gude	Thermoset Processing and Preforming	10/2019	06/2022	BMEL	FNR e. V.
Prof. Dr.-Ing. habil. Maik Gude	Neutral Lightweight Engineering	07/2022	06/2025	BMWK	PTJ
Prof. Dr.-Ing. habil. Maik Gude	Calculation Methods and Simulation	12/2020	11/2023	BMWK	PTJ

GESCHA II	Investigation of the regularities of foam structure formation in freeze foaming processes of biocompatible ceramic foams
GRETA	Generative production of recyclable basic structures for theatre sculpture from natural-based materials
GRK 2430 **I-FEV**	Research Training Group 2430 Interactive Fiber Rubber Composites
H2GA	Hydrogen fuel cell technology as a hybrid-electric drive in the demonstrator Antares E2 TP: Bauraumangepasste Hochdruck-Wasserstoffspeichersysteme zur Int egration in die Außenlastbehälter der Antares E2
HORA	High-performance radial impellers in modular metal-fibre composite design
HYBSCH	Design development and technology synthesis for the production of cellular hybrid plastic structures for application in acoustic resonators
HYDRUN	Boundary layer analysis for the inline hybridization of metal die casting and plastic injection molding
HYFOTOOL	Hybrid Forming Tool - Development of an ultra-light, high-performance steel/plastic hybrid tool for deep-drawing sheet metal, including a first-time integration of RVDT sensor technology for recording the tool stresses. SP: Investigation of the material properties and development of the reinforcement structures for the HyFo tool on the basis of FE simulations.
HYPRO	Holistic implementation of hybrid design in series production
HYSTERESIS	Cyclic-dynamic properties of particle foams
I³-SPINE	Development of individualized function integrated spinal implants
ICLIMABUILT	Functional and advanced insulating and energy harvesting/storage materials across climate adaptive building envelopes
I-DETEKT	Intelligent battery protection system for electric vehicles for detection of undesired mechanical damage SP: Development e-Preform
ILK @UMASS	Towards strengthening the collaboration of TU Dresden and the University of Massachusetts Amherst on the topic of intelligent evaluation methods of aging infrastructure
IMEM	Development of an innovative membrane press for the efficient manufacturing of fibre composite components made of thermoplastic semi-finished products in small and medium series sizes. SP: Development of an optimised process control as well as a temperature management for the efficient manufacturing of composite fibre components in the innovative membrane press

Project management	Expert group	Start	End	Funding	Project executing agency
Prof. Dr.-Ing. habil. Maik Gude	Novel Materials and Special Processes	01/2020	12/2022	DFG	
Prof. Dr.-Ing. Niels Modler	Novel Materials and Special Processes	09/2021	08/2024	SAB	
Prof. Dr.-Ing. Niels Modler	Calculation Methods and Simulation	11/2018	04/2023	DFG	
Prof. Dr.-Ing. habil. Maik Gude	Lightweight Design	12/2021	11/2024	BMDV	PTJ
Prof. Dr.-Ing. habil. Maik Gude	Lightweight Design	06/2021	05/2023	AiF	FK Maschinenbau
Prof. Dr.-Ing. Niels Modler	Function Integration	04/2020	09/2023	DFG	
Prof. Dr. rer. nat. Hubert Jäger	Novel Materials and Special Processes	06/2021	11/2023	BMBF	PTJ
Prof. Dr.-Ing. Niels Modler	Testing Methods and Material Models	04/2019	03/2022	AiF	AiF
Prof. Dr.-Ing. habil. Maik Gude	Joining Technologies	05/2020	07/2023	BMBF	PTJ
Prof. Dr.-Ing. habil. Maik Gude	Thermoplastic Processing	12/2020	11/2023	DFG	
Prof. Dr.-Ing. Niels Modler	Function Integration	01/2022	12/2023	TU Dresden – Else Kröner-Fresenius Center for Digital Health	
Prof. Dr.-Ing. Niels Modler (Prof. Dr. rer. nat. Hubert Jäger)	Testing Methods and Material Models	03/2021	02/2025	EU	
Prof. Dr.-Ing. Niels Modler	Function Integration	12/2020	11/2023	BMWK	PTJ
Prof. Dr.-Ing. habil. Maik Gude	Internationalisation	07/2022	10/2023	TUD/Graduate Academy	
Prof. Dr.-Ing. Niels Modler	Thermoplastic Processing	01/2020	12/2022	AiF	AiF

INDIRA	Integration of customized load introduction elements in a single-stage manufacturing process suitable for SMEs for complex-shaped sandwich composite structures SP: Development and implementation of material and functionally adapted insert elements for highly loaded sandwich composite structures
INPRO	Integral lightweight profile systems made of fibre-thermoplastic composite functionalised in the injection moulding process SP: Concept, design and process-technological description of functionalised fibre-thermoplastic composite hollow profiles
INSERT	Simulation-assisted development of material-, load- and process-specific inserts for thermoplastic composites
JOIFLO	Experimentelle und numerische Analyse des Fließverhaltens von hochviskosen Wärmeleitstoffen im Fertigungsprozess
KOBRA	Compact X-ray tube made of fibre reinforced ceramics for mobile computer tomographs SP: Structural mechanical design and experimental testing of a rotation unit made of fibre composite ceramics for compact X-ray tubes
KODAV	Simulation-supported research of novel textile-based adaptive fiber plastic composite structures with shape memory alloy elements for complex deformation patterns
KOKOMAG	Development and evaluation of a corrosion-protected, non-combustible carbon fibre reinforced magnesium material for aeronautical applications
KOLIBRI-S	Complex lightweight structures for electronic applications in mobility SP: Simulation methods for the coupled thermo-structure-flow behavior
KOPFORTHESE	Additiv gefertigte, telemedizinisch überwachbare Kopforthese mit integrierter Sensorik TP: Sensorik sowie die optische Erfassung der Schädelform
KORESIL	Strategies for the resource-efficient and reliable production of lightweight structures SP: Cyber-physical interfaces for mobile injection moulding
LAST-BELL	Lastgerechte Faserverläufe auf gekrümmten Strukturen am Bsp. eines bauraumkonformen und aerodynamischen Typ-V Wasserstoff-Drucktank und einer Triebwerk-Ringstruktur mit Entwicklungsprozessbegleitender Validierungsstrategie TP: Belastungsgerechte Leichtbaustrukturen im Kontext effizienter Luftfahrtsysteme
LE2GRO	Lightweight multi-material carrier for performance enhancement of large-area fertiliser spreaders SP: Development and experimental validation of a design system for functionalised fibre thermoplastic profiles based on a large-area fertiliser spreader
LEVADI	Fatigue analysis for adhesively bonded joints in large FRP structures with varying adhesive layer thicknesses
LIGNOBRAID	Biobased lightweight hollow profiles with braided wood tapes SP: Lightweight hollow profiles
LIKE	Lightweight construction technologies in cross-life cycle products of the energy transition SP: Digitally networked design methodology for recyclable lightweight structures
LITAPROP	Light-weight composite structures with tailored mechanical, electrical and thermal properties

Project management	Expert group	Start	End	Funding	Project executing agency
Prof. Dr.-Ing. habil. Maik Gude	Thermoset Processing and Preforming	11/2019	06/2022	AiF	AiF
Prof. Dr.-Ing. habil. Maik Gude	Thermoplastic Processing	08/2020	07/2023	BMWK	DLR
Prof. Dr.-Ing. habil. Maik Gude	Joining Technologies	07/2019	03/2022	DFG	
Prof. Dr.-Ing. habil. Maik Gude	Testing Methods and Material Models	07/2022	06/2024	AiF	FV Automobiltechnik (FAT)
Prof. Dr.-Ing. habil. Maik Gude	Novel Materials and Special Processes	10/2019	12/2023	BMBF	VDI
Prof. Dr.-Ing. habil. Maik Gude	Calculation Methods and Simulation	09/2021 (01/2022)	08/2024 (12/2024)	DFG	
Prof. Dr.-Ing. habil. Maik Gude	Novel Materials and Special Processes	08/2020	07/2023	BMWK	DLR
Prof. Dr.-Ing. habil. Maik Gude	Calculation Methods and Simulation	12/2021	11/2024	BMWK	PTJ
Prof. Dr.-Ing. Niels Modler	Lightweight Design	07/2022	12/2024	AiF	VDI/VDE
Prof. Dr.-Ing. habil. Maik Gude	Calculation Methods and Simulation	02/2021	01/2024	BMBF	PTKA-PFT
Prof. Dr.-Ing. habil. Maik Gude		07/2022	06/2025	BMWK	DLR
Prof. Dr.-Ing. habil. Maik Gude	Thermoplastic Processing	01/2021	12/2023	BMWK	PTJ
Prof. Dr.-Ing. habil. Maik Gude	Testing Methods and Material Models	04/2020	03/2023	AiF	DVS
Prof. Dr.-Ing. habil. Maik Gude	Neutral Lightweight Engineering	03/2021	08/2023	BMEL	FNR e. V.
Prof. Dr.-Ing. habil. Maik Gude	Lightweight Design	01/2021	12/2023	BMWK	PTJ
Prof. Dr.-Ing. habil. Maik Gude	Thermoset Processing and Preforming	07/2021	06/2024	SAB	

LIWEKO	Weight-reduced lightweight clamping devices, tools and components for efficient, highly dynamic machining processes. SP: Development of hybrid designs as well as design and testing of weight-reduced rotors for highly dynamic grinding processes
LRVTWIN	Light Rail Vehicle Twin, A digital light rail twin
MAQINTO	Machine-trained quality sensor, intelligent process control and ML framework for resource-efficient, customized carbon fiber production TP: Experimentelle Analyse und Validierung der Prozess-KI
MEGRAV II	Model building for the design of Metal-Graphite Composites under consideration of application-related service conditions
METEOR	Methods and technologies for validating and optimizing the ressource efficiency of process networks in the production of hybrid lightweight structures SP: Set up process network and virtual process chain
MINDENDO2	Development of miniaturised fibre-reinforced composite structures for ultrasonic-based decontamination of non-shedding surfaces within the human organism
MM4R	Recycling-friendly multi-material design for lightweight structures SP: Resource-saving material, component and process design
MONSTRAIN	Development of a novel spatially resolved carbon fiber-based strain measurement system for real-time structural health monitoring and validation of load assumptions
MUFUS	Development of multifunctional interfaces for joining FRP with metals using established joining processes
MULTCOMP	Towards a sustainable research cooperation on multifunctional nano-composites in multi-material design and beyond
NEAPEL	Numerische und experimentelle Analyse des Permeations- und Rissverhaltens von Faserkunststoffverbunden mit thermoplastischen Matrixsystem
NH3CRAFT	Safe and efficient storage of ammonia within ships
ORGON	Thermoplastic organic sheet structures with functional surfaces
PDOCFIL	Towards an excellent scientific career on engineering intelligent, multifunctional composites in multi-material design
PDOC-LIS	
PEM	Polymere electrolyte membranes (PEM) for vanadium redox flow batteries
PEP4.0	Digitally synchronised development architecture for the product development process 4.0

Project management	Expert group	Start	End	Funding	Project executing agency
Prof. Dr.-Ing. habil. Maik Gude	Novel Materials and Special Processes	10/2019	09/2022	BMWK	PTJ
Prof. Dr.-Ing. habil. Maik Gude	Testing Methods and Material Models	01/2022	12/2024	BMDV	TÜV Rheinland Consulting VDI VDE
Prof. Dr.-Ing. habil. Maik Gude	Novel Materials and Special Processes	05/2022	04/2025	BMBF	DLR
Prof. Dr.-Ing. Niels Modler	Joining Technologies	06/2021	02/2024	AiF	FK Maschinen-bau
Prof. Dr.-Ing. habil. Maik Gude	Novel Materials and Special Processes	12/2020	11/2023	BMWK	PTJ
Dr.-Ing. Martin Dannemann	Function Integration	05/2018	02/2022	DFG	
Prof. Dr.-Ing. habil. Maik Gude	Neutral Lightweight Engineering	12/2021	11/2024	BMWK	PTJ
Prof. Dr.-Ing. Niels Modler	Function Integration	01/2021	06/2024	BMWK	DLR
Prof. Dr.-Ing. habil. Maik Gude	Joining Technologies	10/2019	03/2022	AiF	EFB
Prof. Dr.-Ing. habil. Maik Gude	Function Integration	05/2021	12/2022	TUD/Graduate Academy	
Prof. Dr.-Ing. habil. Maik Gude	Thermoplastic Processing	03/2022	02/2025	DFG	
Prof. Dr.-Ing. habil. Maik Gude	Function Integration	06/2022	05/2025	EU	
Prof. Dr.-Ing. Niels Modler	Thermoplastic Processing	02/2020	12/2022	AiF	FVLK
Dr.-Ing. Angelos Filippatos		07/2021	12/2022	TUD/Graduate Academy	
Dr. Maria Lißner		01/2022	12/2023		
Dr. Uwe Gohs	Novel Materials and Special Processes	06/2019	05/2022	DFG	
Prof. Dr.-Ing. habil. Maik Gude	Lightweight Design	07/2018	06/2023	BMWK	DLR

PLRV	Development of a large-scale lightweight transportation box SP ILK: Development and application of test methods for material characterisation
PRILLIAND	Development of an additive production technology for manufacturing plastic-based components for maritime applications
PRINTCAP	Next Generation of 3D Printed Structural Supercapacitors
PRO-KI	KI-Demonstrations- und Transferzentrum Dresden
PROMI	Multi-funktionale Hochleistungs-Profilsysteme in intrinsisch hergestellter Faserverbund-Metall-Mischbauweise
PROPLUG	Development of a structurally integrated plug-in connection system for the electrification of functionalised fibre composite components SP: Integration concepts and technologies and mechanical characterisation
PULTIX	Novel pultrusion process for continuous production of thermoset rebars with helix profiling
RECAR	Development of a modular heating system based on recycled carbon fiber nonwovens for use in forming and preforming tools SP: Characterization of the properties of heating nonwovens made from recycled carbon fibers and research into possible applications in the preforming process of textile semi-finished products
ROBIN	Robot-assisted mobile injection unit for the process-integrated manufacturing of hybrid component structures (Robotised Injection Moulding)
ROSI	Untersuchung des Schädigungs- und Modalverhaltens von schnelldrehenden geometrisch komplexen Strukturen durch In-situ-Messtechnik
SAXONHY	System-integrated H2 pressure tank assemblies for general aviation and feeder aircraft SP: MBSE-based methods for the development, integration and certification of system-integrated H2 pressure tank assemblies
SCADS2	ScaDS.AI Dresden/Leipzig - Center For Scalabel Data Analytics And Artifical Inteligence
SMARTMEMBRANE-C	Smart membrane pressing technology for manufacturing of high performance composite components SP: Develoment of a smart membrane for manufacturing of high performance composites with high geometric variability
SNAPCURE 4.0	Innovative process chains with fast-curing polymer systems (Snap-Cure-Polymers 4.0) SP: Development and validation of combined information- and description-based structure and process chain models
SPIFA	SpinnennetzFaserverbund: Development of a new lightweight partition wall for aircrafts based on a novel load insert made of thermoset hardpoints as well as fiber composite tapes with spider web structure for weight savings of at least 5 %. SP: Investigation of process parameters of a holistic manufacturing process for aircraft partition walls for the development of a sensor-based production process automation with a response time below 1 sec
SPP 1897 - II. Phase	Complex-Shaped Lightweight Structures with Adaptive Dynamic Behaviour through Evanescent Morphing

Project management	Expert group	Start	End	Funding	Project executing agency
Prof. Dr.-Ing. habil. Maik Gude	Testing Methods and Material Models	08/2020	06/2023	AiF	AiF
Prof. Dr.-Ing. habil. Maik Gude	Novel Materials and Special Processes	04/2021	03/2024	BMWK	PTJ
Prof. Dr.-Ing. Niels Modler	Novel Materials and Special Processes	06/2022	05/2025	SAB	
Prof. Dr.-Ing. Niels Modler	Thermoplastic Processing	10/2022	12/2024	BMBF	
Prof. Dr.-Ing. habil. Maik Gude	Thermoplastic Processing	12/2022	11/2024	DFG	
Prof. Dr.-Ing. Niels Modler	Function Integration	12/2020	11/2023	BMBF	VDI/VDE
Prof. Dr.-Ing. habil. Maik Gude	Thermoset Processing and Preforming	10/2019	01/2022	AiF	Carbon Composites
Prof. Dr.-Ing. Niels Modler	Thermoset Processing and Preforming	01/2020	06/2022	AiF	AiF
Dr.-Ing. Michael Krahl	Thermoplastic Processing	03/2020	02/2022	BMWK	PTJ
Prof. Dr.-Ing. habil. Maik Gude	Testing Methods and Material Models	04/2022	09/2024	DFG	
Prof. Dr.-Ing. habil. Maik Gude	Lightweight Design	12/2021	05/2023	SAB	
Prof. Dr.-Ing. habil. Maik Gude	Calculation Methods and Simulation	10/2018	09/2021	BMBF	DLR
Prof. Dr.-Ing. habil. Maik Gude	Thermoset Processing and Preforming	01/2020	03/2022	AiF	FILK
Prof. Dr.-Ing. habil. Maik Gude	Thermoset Processing and Preforming	11/2018	03/2022	SAB	
Prof. Dr.-Ing. habil. Maik Gude	Thermoset Processing and Preforming	09/2021	02/2024	AiF	AiF
Dr.-Ing. Pawel Kostka	Function Integration	10/2019	06/2023 VL bis 12/2023 beantragt	DFG	

STYQZAHL	Structural metal-polymer hybrid design using the example of a bumper beam for electrified, large-scale automotive production – presentation of an economical manufacturing process through integration of on-line quality assurance and optimisation of material utilisation
SUMMER SCHOOL	Summer School "Intelligent Lightweight Systems" (26.–30.09.2022)
SWING	Modelling and simulation of the manufacture-dependent shrinkage behaviour of glass-fibrereinforced epoxy resins for the improved prediction of surface-waviness and warpage
TERESA	Thermoplastic final contour sandwich for innovative aerospace applications SP: Development of functionalised thermoplastic-based sandwich structures for aerospace application
THOPOL	Thermally highly resistant polymer structures for lightweight propulsion systems SP: Efficient processing technologies and robust design methods for rotating lightweight structures
TI-MMC-3D	Development of the innovative technology of the production of hybrid structures
TRAKUBE	Development of a transport-optimized small wastewater treatment plant SP: Development of a location-independent joining system for a transport-optimized tank system in small wastewater treatment plants
SFB/TRR285-A03	Calculation and evaluation of process-induced material structure phenomena in FRP-metal connections
SFB/TRR285-C04	Local and integral in situ analysis of process- and operation-related damage effects of joints
T-WU@TUD	Prediction of mechanical properties of CFRP: physics-based multiscale modelling, machine learning and uncertainty quantification
VEDUFO	Development of a new manufacturing process for fiber-reinforced plastics using a heatable vacuum membrane and epoxy resin films that can be stored for 3 months at 25 °C and cured under 120 °C SP: Development of the process concept and process parameter determination of a new RFI process with heatable vacuum membrane
VITSCHA	Novel transparent showcase hinge SP: Development of the simulation as well as the bonding technology for a transparent hinge

Project management	Expert group	Start	End	Funding	Project executing agency
Prof. Dr.-Ing. habil. Maik Gude	Thermoplastic Processing	05/2020	10/2022	BMBF	PTJ
Prof. Dr.-Ing. habil. Maik Gude	Function Integration	03/2020	12/2022	TUD/Bereich ING	
Prof. Dr.-Ing. habil. Maik Gude	Calculation Methods and Simulation	02/2019	07/2022	DFG	
Prof. Dr.-Ing. habil. Maik Gude	Thermoplastic Processing	05/2019	12/2022	BMWK	DLR
Prof. Dr.-Ing. habil. Maik Gude	Calculation Methods and Simulation	02/2019	12/2022	BMBF	PTJ
Prof. Dr.-Ing. habil. Maik Gude	Novel Materials and Special Processes	01/2021	12/2022	DAAD	
Prof. Dr.-Ing. habil. Maik Gude	Joining Technologies	05/2021	04/2023	AiF	AiF
Prof. Dr.-Ing. habil. Maik Gude	Calculation Methods and Simulation	07/2019	06/2023	DFG	
Dr.-Ing. Robert Kupfer	Joining Technologies	07/2019	06/2023	DFG	
Dr.-Ing. Tao Wu	International	01/2022	12/2023	TUD / SG 8.3 Internationalisation	
Prof. Dr.-Ing. habil. Maik Gude	Thermoset Processing and Preforming	11/2019	07/2022	AiF	AiF
Prof. Dr.-Ing. Niels Modler	Lightweight Design	12/2019	11/2022	AiF	AiF

Selected Publications

— Leopold, A-K., Müller, M. T., Zimmerer, C., Bogar, M. S., Richter, M., Wolz, D. S., & Stommel, M. (2022). Influence of temperature and dose rate of e□beam modification on electron□induced changes in polyacrylonitrile fibers. Macromolecular Chemistry and Physics, 224(1), [2200265]. https://doi.org/10.1002/macp.202200265

— Düreth, C., Hornig, A., Koch, I., & Gude, M. (2022). Application of machine learning methods on the defect detection in shearographic images. in A. P. Vassilopoulos, & V. Michaud (Hrsg.), Proceedings of the 20th European Conference on Composite Materials: Composites Meet Sustainability (Band 3, S. 492-501). Ecole Polytechnique Fédérale de Lausanne (EPFL). https://doi.org/10.5075/epfl-298799_978-2-9701614-0-0

— Kluger, J., Spitzer, S., Spickenheuer, A., Bittrich, L., Klaus, C., & Gude, M. (2022). Design and dimensioning of aerodynamic and structural vanes for jet engines made of multi-axial and variable-axial CFRP and comparison of these approaches with titanium vanes. in A. P. Vassilopoulos, & V. Michaud (Hrsg.), Proceedings of the 20th European Conference on Composite Materials: Composites Meet Sustainability (Band 4, S. 565-572). Ecole Polytechnique Fédérale de Lausanne (EPFL). https://doi.org/10.5075/epfl-298799_978-2-9701614-0-0

— Hoffeins, P., Spitzer, S., Reich, V., Dost, G., Weidermann, C., & Gude, M. (2022). Fluorescent marking of fibre reinforced plastic for component and material identification in the context of material flow canalization. in A. P. Vassilopoulos, & V. Michaud (Hrsg.), Proceedings of the 20th European Conference on Composite Materials: Composites Meet Sustainability (Band 1, S. 14-21). Ecole Polytechnique Fédérale de Lausanne (EPFL). https://doi.org/10.5075/epfl-298799_978-2-9701614-0-0

— König, R., Spitzer, S., Böhm, H., Bätzel, T., Rao, R. N., & Gude, M. (2022). Ice hail stone impact testing of tailored fiber placed composite structural vanes for novel CFRP-Ti intermediate cases of future jet engines. in A. P. Vassilopoulos, & V. Michaud (Hrsg.), Proceedings of the 20th European Conference on Composite Materials: Composites Meet Sustainability (Band 2, S. 294-301). Ecole Polytechnique Fédérale de Lausanne (EPFL). https://doi.org/10.5075/epfl-298799_978-2-9701614-0-0

— Spitzer, S., Schlegel, D., Tönnishoff, L., Lee, S., Lee, S-E., & Gude, M. (2022). Improvement potential for CFRP pressure vessels to reach future required gravimetric storage densities. in A. P. Vassilopoulos, & V. Michaud (Hrsg.), Proceedings of the 20th European Conference on Composite Materials: Composites Meet Sustainability (Band 5, S. 232-239) https://doi.org/10.5075/epfl-298799_978-2-9701614-0-0

— Würfel, V., Condé-Wolter, J., Pietsch, A-L., Scheitz, S., Schultz, D., Först, P., Garthaus, C., Lindenau, J., Weber, T., & Gude, M. (2022). Investigation of variothermal mould heating systems for processing of high temperature thermoplastic composites in short cycles. in A. P. Vassilopoulos, & V. Michaud (Hrsg.), Proceedings of the 20th European Conference on Composite Materials: Composites Meet Sustainability (S. 104-111). Ecole Polytechnique Fédérale de Lausanne (EPFL). https://doi.org/10.5075/epfl-298799_978-2-9701614-0-0

— Hacker, G., Brod, M., Just, G., Scheffler, S., Koch, I., Rolfes, R., & Gude, M. (2022). Numerical simulation of microcrack-induced delamination in cross-ply-laminates under static loading using cohesive zone models. in A. P. Vassilopoulos, & V. Michaud (Hrsg.), Proceedings of the 20th European Conference on Composite Materials: Composites Meet Sustainability (Band 4, S. 334-341). Ecole Polytechnique Fédérale de Lausanne (EPFL). https://doi.org/10.5075/epfl-298799_978-2-9701614-0-0

— Tittmann, K., Koch, I., Çavdar, S., Gude, M., & Meschut, G. (2022). Service strength analysis method for adhesively bonded hybrid structures under multiaxial loading. in A. P. Vassilopoulos, & V. Michaud (Hrsg.), Proceedings of the 20th European Conference on Composite Materials: Composites Meet Sustainability (Band 2, S. 730-739). Ecole Polytechnique Fédérale de Lausanne (EPFL). https://doi.org/10.5075/epfl-298799_978-2-9701614-0-0

— Folprecht, F., Bätzel, T., Kuhtz, M., Hoffeins, P., Gerlich, M., Spitzer, S., & Gude, M. (2022). Tailoring the structural behaviour of a composite gas-filled spring device for a switch in power grids. in A. P. Vassilopoulos, & V. Michaud (Hrsg.), Proceedings of the 20th European Conference on Composite Materials: Composites Meet Sustainability (Band 5, S. 274-281). Ecole Polytechnique Fédérale de Lausanne (EPFL). https://doi.org/10.5075/epfl-298799_978-2-9701614-0-0

— Condé-Wolter, J., Eckardt, S., Holländer, D., Lebelt, T., Gruhl, A., Rohkamm, A., Ruf, M., & Gude, M. (2022). Thermoplastic multi-cell pressure vessels for hydrogen storage – design, manufacturing and testing. in A. P. Vassilopoulos, & V. Michaud (Hrsg.), Proceedings of the 20th European Conference on Composite Materials: Composites Meet Sustainability (Band 5, S. 289-297). Ecole Polytechnique Fédérale de Lausanne (EPFL). https://doi.org/10.5075/epfl-298799_978-2-9701614-0-0

— Gottwald, R., Birke, M., Spitzer, S., Luft, J., Meyer, J., & Gude, M. (2022). Virtual-physical engineering of a graded CFRP/Titanium aircraft suspension strut. in A. P. Vassilopoulos, & V. Michaud (Hrsg.), Proceedings of the 20th European Conference on Composite Materials: Composites Meet Sustainability (Band 1, S. 1258-1265). Ecole Polytechnique Fédérale de Lausanne (EPFL). https://doi.org/10.5075/epfl-298799_978-2-9701614-0-0

— Busch, M., Köhler, D., Hausotte, T., Kupfer, R., Troschitz, J., & Gude, M. (2022). Approach to determine the characteristic dimensions of clinched joints by industrial X-ray computed tomography. The e-journal of nondestructive testing & ultrasonics, 27(12). https://doi.org/10.58286/27519

— Hentschel, U., Labitzke, F., Helwig, M., Winkler, A., & Modler, N. (2022). Aspects of foreign object detection in a wireless charging system for electric vehicles using passive inductive sensors. World Electric Vehicle Journal, 13(12), [241]. https://doi.org/10.3390/wevj13120241

— Borowski, A., Gröger, B., Füßel, R., & Gude, M. (2022). Characterisation of fibre bundle deformation behaviour - Test rig, results and conclusions. Journal of manufacturing and materials processing, 6(6), [146]. https://doi.org/10.3390/jmmp6060146

— Neubauer, M., Pohl, M., Kucher, M., Böhm, R., Höschler, K., & Modler, N. (2022). DMA of TPU films and the modelling of their viscoelastic properties for noise reduction in jet engines. Polymers, 14(23), [5285]. https://doi.org/10.3390/polym14235285

— Kupfer, R., Schilling, L., Spitzer, S., Zichner, M., & Gude, M. (2022). Neutral lightweight engineering: a holistic approach towards sustainability driven engineering. Discover Sustainability, 3, [17]. https://doi.org/10.1007/s43621-022-00084-9

— Dargel, A., Schlegel, D., Violet, J., Röth, M., & Gude, M. (2022). Safety-relevant composite structures for future resource saving jet engines. in SAMPE EUROPE Conference and Exhibition 2022: Composites – the gateway to green mobility? (Band 2022). SAMPE journal / Society for the Advancement of Material and Process Engineering

— Gröger, B., Römisch, D., Kraus, M., Troschitz, J., Füßel, R., Merklein, M., & Gude, M. (2022). Warmforming flow pressing characteristics of continuous fibre reinforced thermoplastic composites. Polymers, 14(22), [5039]. https://doi.org/10.3390/polym14225039

— Rytlewski, P., Gohs, U., Stepczyńska, M., Malinowski, R., Karasiewicz, T., & Moraczewski, K. (2022). Electron-induced structural changes in flax fiber reinforced PLA/PCL composites, analyzed using the rule of mixtures. Industrial crops and products : an international journal, 188, Part A, [115587]. https://doi.org/10.1016/j.indcrop.2022.115587

— Schramm, B., Friedlein, J., Gröger, B., Bielak, C., Bobbert, M., Gude, M., Meschut, G., Wallmersperger, T., & Mergheim, J. (2022). A Review on the modeling of the clinching process chain—Part II: Joining Process. Journal of Advanced Joining Processes, 6(6), [100134]. https://doi.org/10.1016/j.jajp.2022.100134

— Xiao, D., Zheng, M. T., Gohs, U., Wagenknecht, U., Voit, B., Xiao, X. Q., & Wang, D. Y. (2022). A sustainable green electron reactive processing for fire safety of polypropylene nanocomposites. Radiation physics and chemistry, 201, [110463]. https://doi.org/10.1016/j.radphyschem.2022.110463

— Liu, Y., Feldner, A., Kupfer, R., Zahel, M., Gude, M., & Arndt, T. (2022). Cellulose-based composites prepared by two-step extrusion from miscanthus grass and cellulose esters. Fibers and Polymers, 23(11), 3282-3296. https://doi.org/10.1007/s12221-022-0399-5

— Ponomarev, A. V., Gohs, U., T Ratnam, C., & Horak, C. (2022). Keystone and stumbling blocks in the use of ionizing radiation for recycling plastics. Radiation physics and chemistry, 201, [110397]. https://doi.org/10.1016/j.radphyschem.2022.110397

— Böhm, H., Hornig, A., Gude, M., Högner, L., & Meyer, M. (2022). A methodology for a coupled structural-CFD analysis of compressor rotor blades subjected to ice impact with uncertain impactor parameters. in Proceedings of the ASME Turbo Expo 2022: Turbomachinery Technical Conference and Exposition (Band 8A). [GT2022-82383, V08AT23A005] https://doi.org/10.1115/gt2022-82383

— Gerritzen, J., Hornig, A., Gröger, B., & Gude, M. (2022). A data driven modelling approach for the strain rate dependent 3D shear deformation and failure of thermoplastic fibre reinforced composites: Experimental characterisation and deriving modelling parameters. Journal of Composites Science, 6(10), [318]. https://doi.org/10.3390/jcs6100318

— Gröger, B., Wang, J., Bätzel, T., Hornig, A., & Gude, M. (2022). Modelling and simulation strategies for fluid-structure-interactions of highly viscous thermoplastic melt and single fibres – A numerical study. Materials, 15(20), [7241]. https://doi.org/10.3390/ma15207241

— Xiao, D., Wang, Z. B., Gohs, U., Harre, K., & Wang, D. Y. (2022). A novel highly-efficient bio-based fire retardant for poly (lactic acid): Synthesis, preparation, property and mechanism. Chemical engineering journal, 446(1), [137092]. https://doi.org/10.1016/j.cej.2022.137092

— Faust, J., Geller, S., & Gude, M. (2022). In-situ integration of inserts into integrally manufactured sandwich structures. in CellMAT 2022 - 7th International Conference on Cellular Materials: Book of Abstracts (S. 78). DGM - Deutsche Gesellschaft für Materialkunde e.V.. https://dgm.de/fileadmin/DGM/Veranstaltungen/2022/CellMAT/Dokumente/CellMAT-2022-Book-of-Abstracts.pdf

— Slapnik, J., Liu, Y., Kupfer, R., Lucyshyn, T., Nardin, B., & Pinter, G. (2022). Low-temperature fibre direct compounding of cellulose fibres into PA6. Materials, 15(19), [6600]. https://doi.org/10.3390/ma15196600

— Troschitz, J., Füßel, R., Kupfer, R., & Gude, M. (2022). Damage analysis of thermoplastic composites with embedded metal inserts using in situ computed tomography. Journal of Composites Science, 6(10), [287]. https://doi.org/10.3390/jcs6100287

— Müller-Pabel, M., Rodríguez Agudo, J. A., & Gude, M. (2022). Measuring and understanding cure-dependent viscoelastic properties of epoxy resin: A review. Polymer Testing, 114, [107701]. https://doi.org/10.1016/j.polymertesting.2022.107701

— Gerritzen, J., Müller-Pabel, M., Müller, J., Gröger, B., Lorenz, N., Hopmann, C., & Gude, M. (2022). Development of a high-fidelity framework to describe the process-dependent viscoelasticity of a fast-curing epoxy matrix resin including testing, modelling, calibration and validation. Polymers, 14(17), [3647]. https://doi.org/10.3390/polym14173647

— Gebhardt, U., Schulz, P., Raßloff, A., Koch, I., Gude, M., & Kästner, M. (2022). Influence of CT image processing on the predicted impact of pores on fatigue of additively manufactured Ti6Al4V and AlSi10Mg. GAMM Mitteilungen, 45(3-4), [e202200017]. https://doi.org/10.1002/gamm.202200017

— Kupfer, R., Schilling, L., & Gude, M. (2022). Werkstofftechnologien für nachhaltigen Leichtbau. Nachhaltige Industrie : Forschung, Technologie, Wirtschaft, 2022(3), 8-13. https://doi.org/10.1007/s43462-022-0363-x

— Kucher, M., Dannemann, M., Böhm, R., & Modler, N. (2022). An experimental approach for the determination of the mechanical properties of base-excited polymeric specimens at higher frequency modes. Vibration, 5(3), 429-441. https://doi.org/10.3390/vibration5030024

— Kuźnia, M., Zygmunt-Kowalska, B., Szajding, A., Magiera, A., Stanik, R., & Gude, M. (2022). Comparative study on selected properties of modified polyurethane foam with fly ash. International Journal of Molecular Sciences, 23(17), [9725]. https://doi.org/10.3390/ijms23179725

— Hornig, A., Frohberg, R., Bätzel, T., Gude, M., & Modler, N. (2022). Embedded sensing and actuating in CFRP composite structures—concept and technology demonstration for tailored embeddable sensor-actuator layers (TEmSAL). Smart materials and structures, 31(9), [095007]. https://doi.org/10.1088/1361-665X/ac7d23

— Maier, J., Geske, V., Werner, D., Behnisch, T., Ahlhelm, M., Moritz, T., Michaelis, A., & Gude, M. (2022). Investigation of targeted process control for adjusting the macrostructure of freeze foams using In situ computed tomography. Ceramics, 5(3), 269-280. https://doi.org/10.3390/ceramics5030021

— Xiao, D., Lv, J. X., Wu, F. J., Wang, Z. B., Harre, K., Chen, J. H., Gohs, U., & Wang, D. Y. (2022). Development of multifunctional highly-efficient bio-based fire-retardant poly(lactic acid) composites for simultaneously improving thermal, crystallization and fire safety properties. International Journal of Biological Macromolecules, 215, 646-656. https://doi.org/10.1016/j.ijbiomac.2022.06.158

— Gude, M., Klimant, P., Putz, M., Rafaja, D., Weck, D., & Wüstefeld, C. (2022). AMARETO – Saxon Alliance for MAterial□ and Resource□Efficient TechnOlogies. Engineering Reports, 4(7-8), [e12548]. https://doi.org/10.1002/eng2.12548

— Wolf, A., Küsters, N., Bräunling, S., Weck, D., Kittner, C., Gude, M., Prahl, U., & Brosius, A. (2022). Modeling metal forming of a magnesium alloy using an adapted material model. Engineering Reports, 4(7-8), [e12540]. https://doi.org/10.1002/eng2.12540

— Zimmer, S., Helwig, M., Winkler, A., & Modler, N. (2022). One-way vs. two-way coupled simulation: Investigation of thermal management of wireless power transfer modules for electric vehicles. in 2022 Wireless Power Week, WPW 2022 - Proceedings (S. 84-89). IEEE, New York [u. a.]. https://doi.org/10.1109/wpw54272.2022.9854041

— Ziegs, J-P., Weck, D., Gude, M., & Kästner, M. (2022). Thermo□mechanical modeling of the temperature dependent forming behavior of thermoplastic prepregs. Engineering Reports, 4(7-8), [e12373]. https://doi.org/10.1002/eng2.12373

— Tzortzinis, G., Ai, C., Breña, S. F., & Gerasimidis, S. (2022). Using 3D laser scanning for estimating the capacity of corroded steel bridge girders: Experiments, computations and analytical solutions. Engineering structures, 265, [114407]. https://doi.org/10.1016/j.engstruct.2022.114407

— Troschitz, J., Gröger, B., Würfel, V., Kupfer, R., & Gude, M. (2022). Joining processes for fibre-reinforced thermoplastics: Phenomena and characterisation. Materials, 15(15), [5454]. https://doi.org/10.3390/ma15155454

— Köhler, D., Stephan, R., Kupfer, R., Troschitz, J., Brosius, A., & Gude, M. (2022). Investigations on combined in situ CT and acoustic analysis during clinching. Key Engineering Materials, 926, 1489-1497. https://doi.org/10.4028/p-32330d

— Zimmer, S., Helwig, M., Winkler, A., & Modler, N. (2022). Modeling electrical conductivity of metal meshes for predicting shielding effectiveness in magnetic fields of wireless power transfer systems. Electronics, 11(14), [2156]. https://doi.org/10.3390/electronics11142156

— Kuhtz, M., Grüber, B., Kirvel, C., Modler, N., & Gude, M. (2022). Virtuell^2 – Simulationspraktikum im digitalen Raum. Lessons Learned, 2(1). https://doi.org/10.25369/ll.v2i1.40

— Mäder, T., Heusinger, J. V., Senf, B., Zoch, M., Winkler, A., & Drossel, W-G. (2022). Calibration of piezoresistive shape-memory alloy strain sensors. Journal of intelligent material systems and structures, 33(11), 1465-1472. https://doi.org/10.1177/1045389X211057206

— Köhler, D., Kupfer, R., Troschitz, J., & Gude, M. (2022). Clinching in in-situ CT - A novel validation method for mechanical joining processes. in K. Inal, M. Worswick, C. Butcher, & J. Levesque (Hrsg.), NUMISHEET 2022: Proceedings of the 12th International Conference and Workshop on Numerical Simulation of 3D Sheet Metal Forming Processes (S. 833-840). The Minerals, Metals & Materials Series (MMMS) https://doi.org/10.1007/978-3-031-06212-4_75

— Vorderbrüggen, J., Köhler, D., Grüber, B., Troschitz, J., Gude, M., & Meschut, G. (2022). Development of a rivet geometry for solid self-piercing riveting of thermally loaded CFRP-metal joints in automotive construction. Composite structures, 291, [115583]. https://doi.org/10.1016/j.compstruct.2022.115583

— Xiao, D., Zheng, M-T., Gohs, U., Wagenknecht, U., Voit, B., & Wang, D-Y. (2022). Highly efficient flame retardant and smoke suppression mechanism of polypropylene nanocomposites based on clay and allylamine polyphosphate. Journal of applied polymer science, 139(23), [52311]. https://doi.org/10.1002/app.52311

— Lemmermann, T., Becker, M., Stehle, M., Drache, M., Beuermann, S., Bogar, M. S., Gohs, U., Fittschen, U. E. A., Turek, T., & Kunz, U. (2022). In situ and in operando detection of redox reactions with integrated potential probes during vanadium transport in ion exchange membranes. Journal of power sources, 533, [231343]. https://doi.org/10.1016/j.jpowsour.2022.231343

— Just, G., Koch, I., & Gude, M. (2022). Experimental analysis of matrix cracking in glass fiber reinforced composite off-axis plies under static and fatigue loading. Polymers, 14(11), [2160]. https://doi.org/10.3390/polym14112160

— Cuomo, S., Bätzel, T., Modler, N., Hornig, A., & Meo, M. (2022). High velocity impact on generic CFRP blade specimen: Baseline free method for impact localisation and damage assessment on complex structures. Smart materials and structures, 31(6), [065024]. https://doi.org/10.1088/1361-665X/ac6d90

— Köhler, D., Sadeghian, B., Troschitz, J., Kupfer, R., Gude, M., & Brosius, A. (2022). Characterisation of lateral offsets in clinch points with computed tomography and transient dynamic analysis. Journal of Advanced Joining Processes, 5, [100089]. https://doi.org/10.1016/j.jajp.2021.100089

— Kupfer, R., Köhler, D., Römisch, D., Wituschek, S., Ewenz, L., Kalich, J., Weiß, D., Sadeghian, B., Busch, M., Krüger, J., Neuser, M., Grydin, O., Böhnke, M., Bielak, C-R., & Troschitz, J. (2022). Clinching of aluminum materials – Methods for the continuous characterization of process, microstructure and properties. Journal of Advanced Joining Processes, 5, [100108]. https://doi.org/10.1016/j.jajp.2022.100108

— Gröger, B., Würfel, V., Hornig, A., & Gude, M. (2022). Forming process induced material structure of fibre-reinforced thermoplastics - Experimental and numerical investigation of a bladder-assisted moulding process. Journal of Advanced Joining Processes, 5, [100100]. https://doi.org/10.1016/j.jajp.2022.100100

— Mädler, J., Richter, B., Wolz, D. S. J., Behnisch, T., Böhm, R., Jäger, H., Gude, M., & Urbas, L. (2022). Hybride semi-parametrische Modellierung der thermooxidativen Stabilisierung von PAN-Precursorfasern. Chemie-Ingenieur-Technik, 94(6), 889-896. https://doi.org/10.1002/cite.202100072

— Meschut, G., Merklein, M., Brosius, A., Drummer, D., Fratini, L., Füssel, U., Gude, M., Homberg, W., Martins, P. A. F., Bobbert, M., Lechner, M., Kupfer, R., Gröger, B., Han, D., Kalich, J., Kappe, F., Kleffel, T., Köhler, D., Kuball, C-M., ... Wolf, M. (2022). Review on mechanical joining by plastic deformation. Journal of Advanced Joining Processes, 5, [100113]. https://doi.org/10.1016/j.jajp.2022.100113

— Pamporaki, C., Berends, A. MA., Filippatos, A., Prodanov, T., Meuter, L., Prejbisz, A., Beuschlein, F., Fassnacht, M., Timmers, H., Noelting, S., Abhyankar, K. G., Constantinescu, G., Kunath, C., Wang, K., Remde, H., Januszewicz, A., Robledo, M., Lenders, J., Kerstens, M., ... Eisenhofer, G. (2022). Machine Learning models for the accurate prediction of malignant pheochromocytomas and paragangliomas: (Conference Presentation). Endocrine Abstracts, 2022(81), [OC13.6]. https://doi.org/10.1530/endoabs.81.oc13.6

— Xiao, D., Gohs, U., Wagenknecht, U., Voit, B., Xiao, X-Q., Peng, X-F., & Wang, D-Y. (2022). Effect of high-energy electrons on the thermal, mechanical and fire safety properties of fire-retarded polypropylene nanocomposites. Radiation physics and chemistry, 194, [110016]. https://doi.org/10.1016/j.radphyschem.2022.110016

— Neubauer, M., Schwaericke, F., Radmann, V., Sarradj, E., Modler, N., & Dannemann, M. (2022). Material selection process for acoustic and vibration applications using the example of a plate resonator. Materials, 15(8), 1-15. [2935]. https://doi.org/10.3390/ma15082935, https://doi.org/10.14279/depositonce-15633

— Liokatis, P., Tzortzinis, G., Gerasimidis, S., & Smolka, W. (2022). Application of the lambda plate on condylar fractures: Finite element evaluation of the fixation rigidity for different fracture patterns and plate placements. Injury, 53(4), 1345-1352. https://doi.org/10.1016/j.injury.2022.01.032

— Tzortzinis, G., Gross, A., & Gerasimidis, S. (2022). Auxetic boosting of confinement in mortar by 3D reentrant truss lattices for next generation steel reinforced concrete members. Extreme Mechanics Letters, 52, [101681]. https://doi.org/10.1016/j.eml.2022.101681

— Lorenz, N., Müller-Pabel, M., Gerritzen, J., Müller, J., Gröger, B., Schneider, D., Fischer, K., Gude, M., & Hopmann, C. (2022). Characterization and modeling cure- and pressure-dependent thermo-mechanical and shrinkage behavior of fast curing epoxy resins. Polymer testing, 108, [107498]. https://doi.org/10.1016/j.polymertesting.2022.107498

— Groeger, B., Koehler, D., Vorderbrueggen, J., Troschitz, J., Kupfer, R., Meschut, G., & Gude, M. (2022). Computed tomography investigation of the material structure in clinch joints in aluminium fibre-reinforced thermoplastic sheets. Production Engineering, 16(2-3), 203-212. https://doi.org/10.1007/s11740-021-01091-x

— Cochrane, A. D., Serra, J., Lander, J. K., Böhm, H., Wollmann, T., Hornig, A., Gude, M., Partridge, I. K., & Hallett, S. R. (2022). Experimental investigation of high strain-rate, large-scale crack bridging behaviour of z-pin reinforced tapered laminates. Composites Part A: Applied Science and Manufacturing, 155, [106825]. https://doi.org/10.1016/j.compositesa.2022.106825

— Yadegari, A., Gohs, U., Khonakdar, H-A., & Wagenknecht, U. (2022). Influence of post-irradiation conditions on crosslinking and oxidation of microporous polyethylene membrane. Radiation physics and chemistry, 193, [109997]. https://doi.org/10.1016/j.radphyschem.2022.109997

— Neubauer, M., Dannemann, M., Herzer, N., Schwarz, B., & Modler, N. (2022). Analysis of a film forming process through coupled image correlation and infrared thermography. Polymers, 14(6), [1231]. https://doi.org/10.3390/polym14061231

— Raßloff, A., Schulz, P., Kühne, R., Ambati, M., Koch, I., Zeuner, A. T., Gude, M., Zimmermann, M., & Kästner, M. (2022). Experimental-numerical analysis of microstructure-property linkages for additively manufactured materials. Procedia Structural Integrity, 38, 4-11. https://doi.org/10.1016/j.prostr.2022.03.002

— Gohs, U. (2022). Nachhaltig härten. Farbe und Lack, 128(3), 40-45. https://360.farbeundlack.de/zeitschriften/farbe_und_lack--3.2022/nachhaltig_haerten--FUL__f719d5f515225ce628bdf157d62adba9dae5cab8

— Rothenhäusler, F., Meyer, N., Wehler, S., Hohberg, M., Gude, M., Henning, F., & Kärger, L. (2022). Experimental and numerical analysis of SMC compression molding in confined regions - A comparison of simulation approaches. Journal of Composites Science, 6(3), [68]. https://doi.org/10.3390/jcs6030068

— Cochrane, A. D., Serra, J., Lander, J. K., Partridge, I. K., Böhm, H., Wollmann, T., Hornig, A., Gude, M., & Hallett, S. R. (2022). Experimental investigation of large-scale high-velocity soft-body impact on composite laminates. International journal of impact engineering, 161, [104089]. https://doi.org/10.1016/j.ijimpeng.2021.104089

— Kraft, R., Kahnt, A., Grauer, O., Thieme, M., Wolz, D. S., Schlüter, D., Tietze, M., Curbach, M., Holschemacher, K., Jäger, H., & Böhm, R. (2022). Advanced carbon reinforced concrete technologies for façade elements of nearly zero-energy buildings. Materials, 15(4), [1619]. https://doi.org/10.3390/ma15041619

— Zschiebsch, W., Filippatos, A., & Böhm, R. (2022). A digital-based design methodology for the optimization of high-performance multi-material structures. IOP Conference Series: Materials Science and Engineering, 1226(1), [12078]. https://doi.org/10.1088/1757-899X/1226/1/012078

— Pohl, M., Spitzer, S., Grothe, R., Weidermann, C., & Gude, M. (2022). Intrinsic interfaces between additively manufactured metal and composite structures for use in electric propulsion engines. IOP Conference Series: Materials Science and Engineering, 1226(1), [012077]. https://doi.org/10.1088/1757-899X/1226/1/012077

— Xiao, D., Gohs, U., Wagenknecht, U., Voit, B., & Wang, D-Y. (2022). Thermal stability and pyrolysis behavior of an efficient fire-retarded polypropylene containing allylamine polyphosphate and pentaerythritol. Thermochimica Acta, 708, [179083]. https://doi.org/10.1016/j.tca.2021.179083

— Winkler, A., Modler, N., Gude, M., Xu, Y., Helwig, M., Dohmen, E., Dittes, A., Höhlich, D., & Lampke, T. (2022). Numerical investigation of the orientability of single reinforcement fibers in polymer matrices. Polymers, 14(3), [534]. https://doi.org/10.3390/polym14030534

— Werner, D., Maier, J., Kaube, N., Geske, V., Behnisch, T., Ahlhelm, M., Moritz, T., Michaelis, A., & Gude, M. (2022). Tailoring of hierarchical porous freeze foam structures. Materials, 15(3), 1-18. [836]. https://doi.org/10.3390/ma15030836

— Wollmann, T., Nitschke, S., Klauke, T., Behnisch, T., Ebert, C., Füßel, R., Modler, N., & Gude, M. (2022). Investigating the friction, wear and damage behaviour of plain bearing bushes of the variable stator vane system. Tribology international, 165, [107280]. https://doi.org/10.1016/j.triboint.2021.107280

— Kluger, J., Spitzer, S., Frase, G., Finger, L., Klaus, C., Friebe, S., & Gude, M. (2022). A digital process-data-assessment method for tailored fiber placement preforms in the manufacturing process of the structural composite guide vanes of a jet engine. in SAMPE EUROPE Conference and Exhibition 2022: Composites – the gateway to green mobility?

— Schlegel, D., Spitzer, S., Birke, M., Lange, A., & Gude, M. (2022). Aerodynamic high-pressure hydrogen CFRP vessels with Increased storage energy density for green aviation: Novel design and dimensioning method. in SAMPE EUROPE Conference and Exhibition 2022: Composites – the gateway to green mobility?

— Pohl, M., Troschitz, J., Kupfer, R., Gude, M., Lamm, A., Johne, V., & Füssel, U. (2022). Einsatz der Lochformungstechnologie zur Steigerung der Festigkeit von Verbindungen mit gewindeformenden Schrauben in faserverstärkten Thermoplastbauteilen. in Schraubenverbindungen 2022: Berechnung, Gestaltung, Montage, Anwendung (S. 477-484). VDI Verlag, Düsseldorf. VDI-Berichte Band 2403 https://doi.org/10.51202/9783181024034-477

— Liu, S., Zhang, H., Ahlfeld, T., Kilian, D., Liu, Y., Gelinsky, M., & Hu, Q. (2022). Evaluation of different crosslinking methods in altering the properties of extrusion-printed chitosan-based multi-material hydrogel composites. Bio-design and manufacturing / Zhejiang University. https://doi.org/10.1007/s42242-022-00194-3

— Ehrig, T., Müller-Pabel, M., Modler, N., & Kostka, P. (2022). Experimental investigations on compressed nonwovens as damping material for enhanced constrained layer damping. in ICSV. L. C. I. Singapore (Hrsg.), Proceedings of the 28th International Congress on Sound and Vibration Society of Acoustics.

— Regner, S., Ehrig, T., Modler, N., Großer, K., Drechsler, K., Sentpali, S., & Dannemann, M. (2022). Experimental study on the structural damping of fiber-filled hollow profiles. in ICSV. L. C. I. Singapore (Hrsg.), Proceedings of the 28th International Congress on Sound and Vibration Society of Acoustics.

— Eckardt, S., Liebsch, A., Liu, Y., Kupfer, R., Gude, M., Korn, C., Siegel, C., & Wagenführ, A. (2022). Herstellung und Verarbeitung von kontinuierlichen Furnierbändern zu geflochtenen Hohlprofilen. in A. Wagenführ (Hrsg.), Tagungsband des 20. Holztechnologischen Kolloquiums Dresden 28.-29. April 2022 Technische Universität Dresden . Schriftenreihe Holz- und Papiertechnik Band 33

— Ehrig, T., Hildebrand, C., Modler, N., & Kostka, P. (2022). Modelling and experimental verification of a curved lightweight structure with adaptive dynamic behaviour. in ICSV. L. C. I. Singapore (Hrsg.), Proceedings of the 28th International Congress on Sound and Vibration Society of Acoustics.

— Pohl, M., Grothe, R., Spitzer, S., Troschitz, J., & Gude, M. (2022). Welle-Nabe-Verbindung zwischen additiv gefertigter metallischer Welle und Faser-Kunststoff-Verbund Rotor eines Hochleistungs-Elektromotors für Luftfahrtantriebe. in Welle-Nabe-Verbindungen 2022: Dimensionierung – Fertigung – Anwendungen und Trends (S. 223 - 230). VDI Verlag, Düsseldorf. VDI-Berichte Band 2408 https://doi.org/10.51202/9783181024089-223

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- Verfahren zur Herstellung poröser Kohlenstofffasern und deren Verwendung > DE 10 2020 119592, WO 2022/017714

Doctorates

Doctorate Dr.-Ing. Sirko Geller

Process-integrated production and embedding of piezoelectric sensor modules in spray-manufactured fibre composite structures

Supervising Professor: Prof. Dr.-Ing. habil. Maik Gude

Condition monitoring and damage detection of lightweight structures made of fibre-reinforced plastic (FRP) composites by means of integrated sensor systems, for example based on piezoceramic transducers, is becoming increasingly important. However, the use of such integrated systems is associated with an increase in the complexity of both the component and the manufacturing process and often requires additional manufacturing steps.

Due to their process characteristics and moderate process conditions, polyurethane spray processes are predestined for the embedding of piezoceramic transducers and electronic functional elements. Spraying the fibre-matrix mixture enables gentle embedding of the components to be integrated.

Within the scope of the thesis, a series-ready process was developed that enables the process-integrated production and embedding of new types of piezoelectric sensor modules in spray-manufactured FRP. For the first time, the previously separate process steps of component manufacture, sensor manufacture and sensor embedding were combined into an efficient overall process and, in addition, the process-specific advantages of the long-fibre injection process (LFI process) used were utilised for the integration of the associated evaluation electronics.

Based on a systematic analysis of the influence of fibre length, fibre mass content and resulting composite density on the material-mechanical properties of spray-manufactured LFI composites, investigations were carried out into the integration of textile reinforcement semi-finished products, whereby the impregnation of the semi-finished products takes place solely using the expansion pressure of the foamable polyurethane matrix.

The process-integrated manufacture of the embedded piezoelectric sensor modules was carried out using free-flowing starting components, which at the same time made it possible to realise a recycling option for production residues, for example from the manufacture of piezo fibres (Fig. 01).

Suitable concepts were developed and technologically implemented for the process sub-steps for sensor assembly and integration. After the associated plant technology was set up, production studies were carried out on the innovative overall process. To realise the sensor function, solutions for both downstream and process-integrated contacting and polarisation were developed and technologically implemented, based on numerical studies of the polarisation behaviour of the embedded sensors. The functional verification of the integrated piezo modules and the characterisation of the sensor function were carried out using test plates and a specially developed test methodology. With the final implementation of demonstrator structures, the transferability of the developed solutions and thus the high application potential of the developed process technology could be demonstrated.

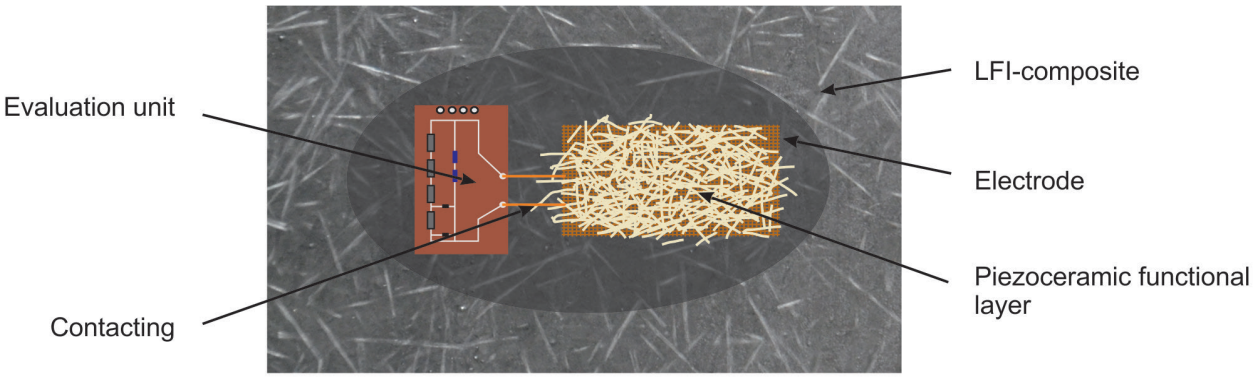

Fig. 01: Schematic on an embedded piezoelectric sensor and evaluation unit.

Doctorate Dr.-Ing. Juliane Troschitz

Contribution to the embedding of inserts into continuous fibre reinforced thermoplastic components

Supervising Professor: Prof. Dr.-Ing. Niels Modler

When developing modern lightweight structures, the selection of joining technology and the design of load application zones are of particular importance. For the local introduction of forces into fibre-reinforced plastic composites (FRP), metallic inserts are established in many application areas. They can increase the load-bearing capacity of classic bolt connections and offer a wide range of functionalization options. Such inserts are usually integrated into the FRP structure in a separate process step after component manufacture. The pilot hole required for this is typically made by drilling, which damages the reinforcing fibers. Alternatively, in the case of thermoplastic FRP, the pilot holes can be created with a pin tool by means of warm hole moulding, whereby the reinforcing fibres in the plasticized composite are reoriented instead of being cut.

Fig. 01: FRP specimen with embedded insert and pin tool.

As part of the doctoral thesis, a technology was developed in which a metallic insert is integrated into the thermoplastic FRP simultaneously with the warm hole moulding. The moulding process by means of a pin tool leads to a material structure modified in a characteristic way with locally varying properties. Based on the phenomenological description of the material structure, a quantitative analysis of the local material structure parameters was carried out using computed tomography (CT).

For the design of components with warm-embedded inserts, it is necessary to consider the local material structure in the FE analysis. For this purpose, a methodology for the automated transfer of the local material structure information determined by CT into an FE model was developed with regard to efficient modeling, using specially developed mapping algorithms.

In order to develop basic design guidelines for embedded inserts, the load-bearing behavior was comprehensively characterized in pull-out, torsion and in-plane tension tests. The interaction of insert design, local material structure and load-specific load-bearing capacity was worked out. A significant influence of the locally modified material structure in the embedding zone on the load-bearing behavior was demonstrated.

The application potential of embedded inserts was demonstrated by their high load-bearing capacities compared with established, subsequently integrated load introduction elements. In addition, the simultaneous embedding of several inserts was successfully tested on the basis of curved, practice-oriented structures. The technology for process-integrated embedding also allows great freedom of design for the inserts, resulting in a wide range of applications. This was demonstrated in the PhD thesis using inserts which serve as joining interfaces for the downstream joining processes clinching and resistance spot welding.

The developed practice-oriented embedding technology and the associated inserts provide a novel and flexible joining system for a wide range of applications.

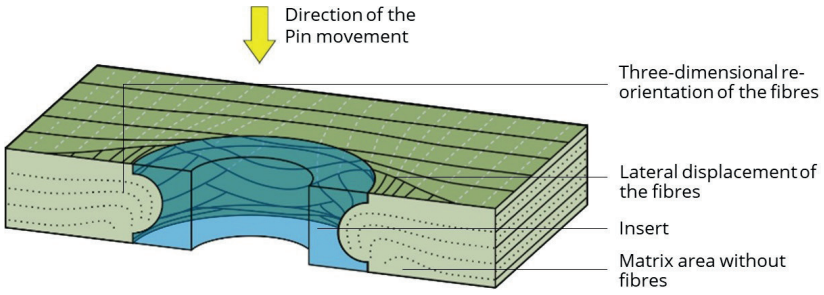

Fig. 02: Schematic representation of the characteristic material structure resulting from the embedding of inserts into bidirectionally reinforced thermoplastics.

Doctorate Dr.-Ing. Marton Kardos

Improving the Paintability of Sheet Molding Compounds for High-Volume Production

Supervising Professor: Prof. Dr.-Ing. Niels Modler

This doctoral dissertation was conceived from the co-operation between Volkswagen AG and TU Dresden. Sheet Molding Compounds (SMC) present a promising alternative for sheet metal in automotive exterior body panel applications. They offer excellent specific mechanical properties, improved design freedom and a cost-efficient manufacturing process. However, the paintability of SMCs is challenging and this issue has kept the material from a more widespread application, in spite all inherent advantages.

This work investigated the underlying reasons of paint defect occurrence and proposed novel solutions to improve upon state-of-the-art technology. It was found that the inherent porosity of SMC materials leads to sub-surface air inclusion in molded parts, which in turn causes characteristic paint defects (blisters, pin-holes, craters, etc.) during the high-temperature paint curing process. The X-ray computer tomography (XCT) images in Figure 1 show the porosity inside the SMC material prior to and after compression molding.

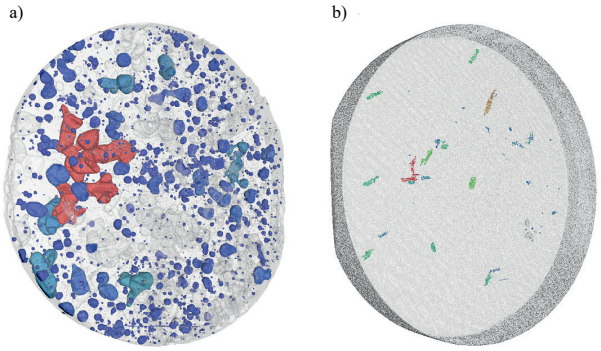

Fig. 1. XCT reconstruction of 25mm diameter samples of the benchmark SMC material showing the (a) initial and (b) final porosity structure inside the material, prior to and after molding, respectively.

It was found, that the porosity is trapped within the complex network of reinforcement fiber strands. Through the significant reduction of fiber fraction, an improved surface compound was proposed. This leads to better paintability, but lower mechanical performance.

A novel manufacturing process was also proposed, denoted Co-Compression-Molding, which enables the molding of two individual compounds in a single step. Through the careful selection of processing parameters, laminar flow can be ensured and thus, the individual compounds do not mix while filling the tool cavity. This allows for the improved surface compound to be molded with a stronger, higher fiber fraction compound, to counteract the reduced mechanical performance. The outcome is a hybrid SMC part having a side with improved paintability, while the others side ensures mechanical performance. Figure 2 shows two sides of a hybrid demonstrator, a combination of a 10 wt % glass fiber (black) and a 30 wt % compound (white) without any preferential flow (both sides are completely undisturbed by the other material). It was molded with a 50 % mold coverage and a 1:1 ratio of compounds.

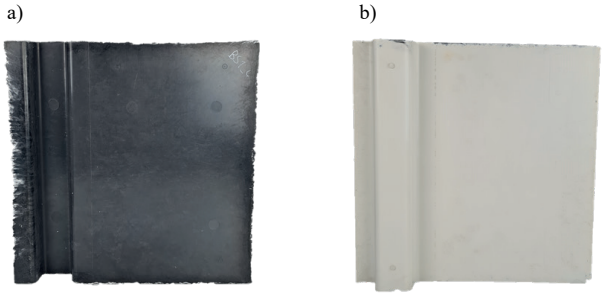

Fig. 2. Bottom (a) and top (b) view of co-compression molded SMC part showcasing undisturbed surface layers.

The work offers insight into appropriate molding parameter selection to ensure a flawless co-compression molding process. Additional processing steps are proposed to further improve manufacturing, such as thermography for the early detection of sub-surface voids, and post-processing via electron beam curing.

The outcomes of this work are highly relevant for the automotive industry and support the application of SMC materials.

Teaching in pandemic times: Digital versus on-site?

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Since the beginning of the summer semester 2020, we unfortunately had to forego any presence in lectures, tutorials and even practical courses due to the pandemic. With the firm intention of making more face-to-face teaching possible again for our students in the winter semester 2021/22, we have pulled out all the stops to develop and use new hybrid teaching formats within the framework of the hygiene rules that have been set. Thus, despite the spacing rules in the lecture halls, we were able to offer face-to-face teaching for a large proportion of students at the beginning of the semester, while at the same time streaming or recording the lecture events at great technical expense. However, the rising incidence figures and the subsequent emergency decree in Saxony from the end of November 2021 forced the well-prepared lecturers back into purely digital teaching, so that disillusionment and frustration on both sides of the cathedron could not be avoided.

So what lessons can be learned from the past months? And can digital teaching replace on-site teaching in the future? As part of the internal evaluation, we conducted an anonymous survey with both students and teachers in order to obtain as open an opinion as possible. In the following, we would like to present two replies that give a good impression of the challenges of teaching in 2021 and can serve as examples for the multitude of feedback.

Reply of a student (7th semester)

The sudden changeover from face-to-face to digital teaching in the summer semester of 2020 posed great challenges for teachers, but certainly also for students. How did you perceive the changes at that time? And how are you coping after almost 4 semesters without continuous face-to-face teaching?

In the first Corona Wave 2020 – still started at the kitchen table – we have settled quite well into studying from home over the last four semesters. Commitment and flexibility are the key qualities required of students and lecturers. However, if both groups brought these skills with them, good teaching took place despite all adversities.

What do you miss most? Do you think there is actually a need for face-to-face lectures in order to get the study content across well?

Lectures that have been well adapted to the digital format over the last four semesters should not be forced back into the classroom. Clear explanatory videos supplemented by regular consultations can certainly keep up with earlier face-to-face formats, if they do not even surpass them in some cases.

Which changes were particularly serious for you? Which would you describe as advantageous?

A suitable workspace at home is a basic prerequisite for digital teaching. Without it, no learning success is possible. However, setting it up costs time, space and money. Once the set-up is in place and you have found your personal way of acquiring knowledge in digital teaching, you can definitely draw advantages from it. For example, commuting times are eliminated. Also freer time management and repetitive learning with recorded lectures are possible.

Have you attended hybrid lectures, if offered in your degree programme? What, if anything, has prevented you from doing so?

There was offer of hybrid lectures in my degree programme in 2021. At the beginning of the semester, I was very happy to be allowed to sit in the lecture hall with fellow students again. However, as the semester progressed, this turned out to be a rather unplannable pleasure. Illnesses, quarantine or the compulsory stop around Christmas made continuous participation on site difficult. Therefore, parallel videos of the classroom events or lecture videos from previous semesters proved to be important learning tools when another Corona wave intervened.


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What alternative teaching formats did your lecturers use? Which of them do you consider particularly useful?

In digital teaching, a clear, well-structured course calendar at the beginning of the semester is worth its weight in gold. This is the most effective way to design the curriculum for studying from home. In teaching itself, good lecture videos are sufficient if they are supplemented by consultations. For tutorials, much depends on the complexity and degree of freedom of the task. Simple calculations can be taught well with a video or a detailed solution via PDF. Using simulation software, on the other hand, requires a live event.

Would you like to see some of the alternative formats also used in regular teaching? Which formats do you consider suitable for this?

Questions tend to be better formulated after you have thought about the lecture material. In the lecture hall, it was sometimes difficult to take notes, think and then formulate a suitable question simultaneously, which often resulted in the question "Do you have any questions?" being answered by the sound of crickets only. Lecture videos supplemented by consultations can really be an improvement on this point.

How important is personal contact (in face-to-face events) with teachers for you? Can social networks, e-mail, video conferences, etc. well or even fully substitute this? Were your lecturers always available for you? What means of communication, if any, did you use?

For communicating technical questions, e-mail and video-conferences are suitable tools and have proven their worth. With questions that are more complex and require calculations or sketches, it was a more difficult task. It is sometimes hard to formulate the question so clearly that it can be understood without three follow-up e-mails. This is then a considerably time-consuming matter.

What major advantages, if any does in your opinion digital teaching or learning offer to you as a student? What would you not want to do without in the future?

Location-flexible working offers considerable advantages and I would not want to do without it. Especially the elimination of commuting times.

How did you get to know or keep in touch with fellow students? In general, how does networking work for you without face-to-face teaching?

Establishing contact with each other only via digital formats is complicated. Many people still draw on existing friendships or learning communities from the times before Corona. Group work during the course is one way of breaking things up, which in a purely digital format can provide the necessary impetus for joint learning and exchange.

Have you found (good) substitutes for the limited or even temporarily suspended sports courses offered by the university sports centre?

Especially after a whole day of digital teaching in front of the computer at home, the urge for movement and exchange with friends is huge. The discontinuation of the previously broad sports programme at the University Sports Centre was a considerable loss.

Reply of a lecturer (46 years)

The sudden changeover from face-to-face to digital teaching in 2020 demanded a lot of additional work from lecturers. Not only did complete lecture series have to be made available as video formats, exercises and practical courses had to be partially redesigned. In addition, a large part of the face-to-face lectures were cancelled last year due to the ongoing pandemic or had to be held as so-called hybrid lectures. How well were you able to profit from the preparatory work of the first pandemic year? What impression or opinion, if any, did you gain from the hybrid events?

On the one hand, it is convenient to be able to rely on already existing videos and instructions. On the other hand, it is particularly difficult to incorporate changes and extensions, which are always part of scientific teaching. In my experience, students also lack direct contact with the lecturers.

Have you perhaps discovered and used completely new formats or didactic methods for yourself?

The integration of data, the transfer of larger amounts of data, and the use of freeware or open source software was new and inspiring for me. Even beyond the pandemic, students will now be better able to practise on their own with digitally influenced teaching content. Where we previously used the CAD pools once for exercises with expensive special software and there was hardly any further practicing time afterwards, now it simply continues at home.

How well were your teaching contents and methods received by the students? Was there any opportunity at all to get feedback?

The students obviously engaged with the provided content. The exercises conducted via video conferencing were received well. However, there was some "fatigue" towards the end of the semester. It can also be assumed that it is generally easier to criticise digitally, for example in surveys, than live in the course.

Would you also adopt digital formats in a regular course largely determined by face-to-face lectures, and if so, which ones?

As already indicated above, I will try to use the newly gained digital possibilities – software, experimental data evaluation, video lectures, etc. – for follow-up work in an appropriate way.

What major advantages, if any does in your opinion digital teaching offer for students?

The biggest advantage is probably the possibility of repeating and precisely analysing the learning content. Possibly, the freedom in time management is greater than before, since you can receive a lecture "on demand" rather than at the given time.

How important is personal contact (in face-to-face events) with students for you? Are social networks, e-mail, video conferences, etc. a fully-fledged substitute on this point?

Personal interaction is important for both students and teachers, but it is always challenging as well. You stand in front of the students with your whole personality and cannot hide. However, the higher effort involved seems to be worth it.

Even if the focus is somewhat different in each case, both statements show clear advantages of the much-maligned digital teaching. Teaching videos, for example, which are available at all times, are a considerable added benefit for both sides. Students with limited language skills in particular benefit from the ability to repeat rhetorically and substantively demanding passages of a lecture as often as they like. In addition, everyone benefits from greater flexibility in the timing of their daily study routine. Teachers can use the elaborately created lecture videos repeatedly and thus expand the consultation offer for understanding and deepening the subject matter. In this way, better teaching results can be achieved compared to regular lectures.

Both parties are painfully aware, however, that exclusively digitally-led teaching or pure distance learning cuts off direct contact. Thus, the isolation and loneliness of students is one of the biggest problem areas of the past semesters, because there is a pronounced desire for networking and personal and social development during the study period. In this context, the "faceless" teaching also makes communication across courses and semesters more difficult. The social losses of digital studies affect international students and freshmen who have just moved to Dresden in particular. After four semesters of digital teaching, there is a widespread concern that a personal network will not develop in an adequate form, which academics would normally develop in the course of their studies and which would then often sustain them throughout their entire professional lives. The lecturers also lack the direct, unfiltered feedback of a face-to-face event. In the end, one can only tell whether a break-up is effective, whether a repetition works out, or how the general attention suffers in a (necessary) debauchery, in front of the assembled audience. Without this feedback, both the contentual and the didactic improvement of the courses are noticeably held back. Overall, it is the "atmosphere" or the "study feeling" that is massively changed by digital teaching and is missed by both students and lecturers. "The flair of the university is lost through digital teaching. Getting a taste of campus air in the summer and entering the lecture hall is missing," we read in almost all replies.

In the future, we would like to address this most frequently mentioned shortcoming of digital teaching by focusing on small face-to-face events and also offering a non-university setting, such as barbecue evenings, scavenger hunts, and regulars' tables. Together with the students, we must create experiences that remain positively in the memory and inspire networking. After all, the most memorable and important moments of the whole study time are not only the exams that students pass, but also the experiences they have with their fellow students. They contribute in a special way to a successful graduation and essentially determine the network formation for individual professional development. On the surface, this does not seem to be the task of the institutes, but in times of the pandemic, it is becoming our new responsibility, which we are happy to accept.

Theses

Name	Type	Theme
Andrä, Jonathan	DA	Method for finding and evaluating several design results within one topology optimisation
Bartuschka, Anna	BA	Identifizierung von FPGAs für die produktionstaugliche Integration in Verbundstrukturen als Teil von intelligenten Systemen
Bieder, Julia	DA	Testing and validation of a support structure-free stereo lithography process
Bier, Alexander	DA	Investigation of the bonding behavior of generatively manufactured multi-material structures with both rigid and elastic components
Brückner, Jan	DA	Development of an inline rheometer for thermoplastic mel
Chandgude, Akhilesh Prataprao	MA	Material model calibration for improved pressure estimation in injection molding simulation
Chen, Yu-Lun	DA	Investigation of processability and solubility of a vitrimer resin system
Dahrmann, Lisa	DA	Investigations on the recirculation of injection molding compounds
Ding, Yihao	DA	Experimental validation of a fatigue life model for fiber composites on tubular specimens
Dong, Jing	DA	Analyses of the suitability of optical methods for the fiber volume fraction determination in glass fiber reinforced plastics
Dornick, Marvin	DA	Application of various LCA programs and databases for applied lightweight research
Dünkel, Lisa	DA	Multi-layer, plastic hybrid composite structure with intrinsic cavities for pneumatic applications
Fan, Junyan	DA	Modeling of particle foams taking into account a hierarchical structure foam bead and foam cell and cell walls
Geis, Tobias	DA	Analysis of anchoring structures created by laser pre-treatment for direct thermal joining of metals and plastics
Geißler, Paul	DA	Development and testing of a test specimen for the determination of mechanical proper-ties of additively processed plastics
Gelencsér, Anton	DA	Characterization of the impregnation behavior of braided wooden veneers with thermoplastic matrix
Hahn, Rene	DA	Process line optimisation for the production of metal-FRP-overmoulding-hybrid structures in series production
Han, Yu	DA	Development of a cutting unit for 3D-printing with continuous fiber reinforcement
Helle, Philipp	DA	Development of methods for predicting the local strengths of intrinsic plastic-metal joints based on inline-measured temperature fields

Name	Type	Theme
Herzer, Niklas	DA	Development and evaluation of a test rig for replicating and optimizing mold filling in the MoldJet® technology
von Heusinger, Jonas Leander	DA	Effects of direct resistance heating of semi-finished carbon fiber products on the mecha-nical properties in an automated fiber placement process
Hong, Pengbo	DA	Investigations to model the influence of the cell size distribution on the com-pression behavior of particle foams
Hong, Yuxiang	DA	Development of load-adapted vehicle components in fibre composite-metal hybrid design with improved side crash behaviour by using numerical optimi-zation methods
Hu, Guanglei	DA	Development of a material model for the description of thermoset polymers in the non-linear viscoelastic range
Hu, Lingyun	DA	Development of a methodic procedure for the qualitative characterisation of recycled plastic materials
Hu, Yize	DA	Investigation of the rotordynamic behavior of electric drive motors for vehicles
Jiang, Haitao	DA	Numerical investigation of the failure behaviour of interface-modified, im-pact-loaded fibre-reinforced plastic composite structures
Jin, Zhengyi	DA	Investigations on screen printing of high-silicon electrical sheets to increase the efficiency of electric motors
Kaya, Şeyma Helin	MA	Development of an iterative method for creating data sets using model-as-sisted labelling and synthetic data generation
Ke, Cheng	DA	Modelling and validation of the property variation determined by digital image correlation of SMC-structures
Keil, Johannes	DA	Analysis of the mechanical behaviour of tape-braided composite structures with varying coverage
Kengelbacher, Vincent	DA	Contribution to the determination of the influence of partial stiffness reduc-tions in spatial beam structures on the deformation and load behavior of the structure
Krahmer, Paul	DA	Characterisation of fibre-matrix interfaces of thermoplastic composites with modified fibre sizing and matrix materials
Kuhlmey, Johannes	DA	Investigation of the foam structure properties of biocompatible ceramic foams by computed tomography
Kuhne, Robert	DA	Development and validation of a hot transfer process for the continuous appli-cation of powder binders
Lan, Di	DA	Characterization of the impregnation behavior of veneers and their influence on the properties of the composites
Lehnert, Florian	DA	Development of a technology for load introduction of tensile and compressive forces into a strut made of braided thermoplastic hybrid yarn
Lerbs, David	DA	Development of a test rig for determining the gas permeation characteristics of fiber-rein-forced composites

Name	Type	Theme
Li, Jiajia	DA	Development of a Bandage for Reinforcing an In-situ CT Clinching Tool
Li, Shiyu	DA	Description of the profiling process of magnesium alloys to thin-walled profiles under consideration of process monitoring
Liebich, Maximilian	DA	Design of a composite boom for a material handling device
Liu, Bowen	DA	Structure elucidation and analysis of an injection moulded bike frame
Liu, Huifang	DA	Analysis and optimization of joint strength in continuous wood tapes
Liu, Yadong	DA	Automation of grey value analyses for quality assurance of fibre reinforced ceramic matrix composites
Liu, Yang	DA	Integrated level and temperature sensors in 3D-printed bioreactor
Lyu, Yi	DA	Development of an optimization method to determine material parameters of complex specimen geometries by means of full-field strain comparison of experiment and simulation
Müller, Tom	BA	Pre-development of a modular system for cargo transport on bycicles
Nguyen, Trung Kien	DA	Development and validation of a graph-based design language for manufacturing technologies of high-performance helicopter components made of fibre composites
Oldewurtel, Sven Alexander	DA	Conception of a hydrogen range extender and installation space studies for integration in a work vehicle
Pu, Zihao	DA	Analysis of fiber-matrix-interaction during cross-linking of thermosetting resins
Ritter, Laura	DA	Investigations into the use of chemical adhesion promoter systems in compounds for hybridisation in mobile injection moulding
Savas, Oguzhan	MA	Application of Machine Learning methods to assist optimization procedures in the synthesis of path generating compliant mechanisms
Schmidt, Oliver Henry	DA	Conceptual design and investigation of methods for the evaluation of pultrusion processes with multi-axis moving forming processes
Schmidt, Thomas	DA	Analysis and characterization of the thermal durability of CFRP molds in the RTM process
Schwab, Simon	DA	Contribution to an online identification method for ice accretion at composite blades for wind energy applications
She, Xiaojuan	DA	Development of a process sequence for the production of sensor-integrated sandwich components in the wet pressing process and analysis of the structural influences of integrated electronics
Shen, Hang	DA	Sensitivity analysis of structural parameters for a hybrid metal-composite profile
Si, Xiaoang	DA	Development of a methodology for the efficient generation and cal-ibration of complex LS-DYNA material cards for fiber-reinforced composites using LS-OPT
Stumpf Ayala, Carla	BA	Potential analysis for crash absorbers of wood-based materials

Name	Type	Theme
Tönnishoff, Linus	DA	Design and development of a mechanical concept for the stator of a hydrogen-cooled lightweight electric motor
Walter, Jakob	DA	Analysis of X-ray based methods for crack detection in thermoplastic composites
Wang, Aoran	DA	Development of a software-based tool for the evaluation of surface scans
Wang, Jingjing	DA	Development of a simulation method for the numerical description of a fluid structure interaktion of filaments in shear flows
Wieja, Nils Frederik	DA	Development of an evaluation method for spatially resolved carbon fiber strain sensors using artificial neural networks
Wittig, Jan	DA	Ice detection on composite blades using artificial neural networks under different icing conditions based on their vibration behaviour
Wu, Kaixin	DA	Development and construction of conveying equipment and a pre-molding unit for processing thermoplastic films
Wüsteney, Julian Paul	DA	Process analysis and design of highly stressed, double-curved sandwich panels for rail transportation
Xu, Xiaohe	DA	Analyzing the cure-dependent deformation behavior of epoxy resins by means of LAOS method
Xuan, Yiqin	DA	Development of a numerical model for the description of the fibre lay-down behaviour during the braiding process
Yang, Fenghua	DA	Development of a numerical model for the analysis of the surface quality of foil-laminated organic sheets
Yu, Aiting	DA	Determination of Measurement Deviations Between In- and Ex-situ Methods and the Numerical Modell of a Clinched Shear Test Specimen
Zhang, Zhaoyu	DA	Development of speckle based phase contrast in x-ray imaging
Zhao, Zhikai	DA	Investigations for the development of an adaptive semi-soft lightweight structure using active polymers
Zhang, Zhilun	DA	Pre-Dimensioning of a Composite gas spring for high speed switching devices

Academic Club Lightweight Engineering at the TU Dresden

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Academic Club Lightweight Engineering (Akademischer Club Leichtbau an der TU Dresden e. V., ACL) is an association of alumni, scientists and sponsors of the ILK at the TU Dresden. Highly complex lightweight system developments also require a sustainable network of science and industry. Against this background, the ACL since its foundation in the year 2003 sees itself as a discussion platform for the exchange of experience and knowledge transfer from young graduates through proven experts. The aims of the association are the non-material and material support of teaching and research in the field of lightweight engineering and related areas, as well as the support of a cooperation network of alumni of the course in lightweighting at the TU Dresden. This is achieved both by publishing research results at lectures and discussion conferences for the scientific exchange of ideas between university and practice, and by establishing and maintaining personal contacts between students, graduates, employees and sponsors of the ILK.

Ceremony of the ACL Young Talent Award at the Lightweight Engineering Symposium 2022.

Annually during the International Dresden Lightweight Engineering Symposium, the ACL Young Talent Award is presented. For this prize, Students and graduates of TU Dresden can apply with outstanding papers or diploma theses in the field of lightweight engineering. In 2022, after the end of the pandemic, the awarding ceremony could again take place in person, and the prize winners, Dipl.-Ing. Lisa Dünkel, Dipl.-Ing. Richard König, Dipl.-Ing. Zhenbi Wang und Dipl.-Ing. Nils Frederik Wieja, received their prizes in the course of plenary session of the symposium in the new facilities of the National Lightweight Validation Centre (LEIV).

Apart from that, the core of the activities is the regular ACL Round Table. It is the discussion platform for the exchange of knowledge and technology between industry and research. In addition to talks by regional players in the field of lightweighting or ILK staff, it also serves as a stage for the presentation of the finalists of the ACL Young Talent Award. The ACL also contributes by supporting various network events held annually at the ILK, such as the alumni meeting or the student meeting evening. Students and staff meet here in the relaxed atmosphere of the ILK's test hall. In this way, the "junior lightweight engineers" can exchange experiences beyond the boundaries of their year and get to know the ILK staff and professors personally outside the official framework. In addition, the ACL provides financial support for the annual excursions to lightweight manufacturing partners in industry and research. However, such activities of the ACL had to pause due to the pandemic and gradually restarted in 2022.

Promotion of Young Talents

To support budding talents in 2022, the ILK concentrated on multiple projects to increase the appeal of lightweight construction and plastics technology among the younger generation.

In March 2022, as part of the career guidance campaign **SchauRein! Saxony**, a group of students were guided through the ILK's institute building. The aim of the event was to give the students an insight into the diverse opportunities and prospects in the field of lightweight engineering and to attract potential students interested in studying at a later stage. At the Johannstadt campus, they were given a insight into the institute's manufacturing and testing methods. During a guided tour of the ILK's technical halls, the students had the opportunity to come into direct contact with scientists and technicians and ask questions. The exchange enabled the girls and boys to take a closer look at the challenges and options of studying at the ILK.

In addition, the students were able to witness practical demonstrations in the field of lightweight engineering, including the braiding and winding of carbon fibre components or geometries that will later be processed into composite components. These practical insights gave the students a realistic picture of the exciting tasks and activities they could expect to undertake as part of a professional career in the field of lightweight engineering and polymer technology.

During the "Schau Rein! Saxony" event, the ILK not only opened the doors to fascinating fields of research and application for the girls and boys, but also created an inspiring platform for an intensive exchange between the students and the dedicated staff of the institution. The event will undoubtedly have left a lasting impression on all the children and will certainly have a positive impact on their future education and career choices. Despite the pandemic, "Look Inside! Saxony" was a resounding success!

The **Girls' Day** is a great opportunity for young women to explore careers. On this nationwide day of action in April 2022, schoolgirls were introduced to STEM professions and subjects in which the proportion of women is less than 40 per cent. At the ILK, ten girls were able to immerse themselves in the world of lightweight engineering and polymer technology and dispel the prejudices and stereotypes associated with this field.

Dr. Anja Winkler and Dipl.-Ing. Rebecca Bräuer told the girls about their careers as engineers and answered their numerous questions. During a tour of the ILK's technical halls at the Johannstadt campus, the schoolgirls gained a deep insight into various manufacturing and testing methods.

They experienced daily operations in the Lightweight Structures Innovation Centre (LIZ), the Polymer

Application Centre (KAZ) and the Process Development Centre (PEZ), and watched exciting live experiments in the drop tower, where crash structures were tested using high-speed measurement technology. Another highlight was a visit to the 3D printing laboratory, where highly customised lightweight structures were produced. At the end of the day, all participants successfully completed a lightweight design course and were awarded the "Junior Engineer" title. The students were also able to make their own composite buttons as a small souvenir. An all round successful day for the participants!

Promotional poster for Girls' Day 2022.

At the TU Dresden's **UNI Day** in May 2022, pupils, students and other interested parties had the opportunity to discover the field of lightweight engineering at the ILK stand. The institute presented unique 3D printed components, demonstrators and fibre-reinforced structures with integrated sensors and LED displays for experimentation – all produced at the ILK. A particular eye-catcher was the e-bike in fibre-reinforced lightweight construction with numerous measuring devices. It was lifted by the visitors and some of them noticed that, at 23 kg (without exhibition equipment), it is actually lighter than it seems. The stand demonstrated to the young people that lightweight engineering is represented in a wide variety of industries. It is not only an issue for the purely technical sectors such as aerospace and automotive, but also has many applications in the leisure, sports, medical, furniture and even art sectors.

But how can you also make four-year-old children enthusiastic about technology and science?
The Association of German Engineers (VDI) addresses this guiding question with the **VDI-ni-Clubs**, where girls and boys are confronted with the world of technology in an entertaining and playful way. According to the principle of independent discovery, children should make their experiences as freely and uncontrolled as possible. In keeping with this motto, the ILK, together with the Institute for Solid Mechanics (IFKM) at the TU Dresden and juniorIng. Sachsen e.V., welcomed around 30 young Leipzig VDInis aged between four and twelve with their accompanying adults and the head of the VDIni Club Leipzig Falk Graupner to the Johannstadt Lightweight Engineering Campus in Dresden at the beginning of September 2022. After the children had been introduced to the TU Dresden and research at the ILK by Dr. Anja Winkler and at the IFKM by Prof. Markus Kästner in short lectures and a tour of the laboratories, the children were able to try things out for themselves at several stations. In a lightweight engineering course, the older ones tested their newly gained knowledge. With augmented reality goggles, the children tested interactive applications for workplace support with Dr. Daniel Weck from the ILK, which are being developed in the FOREL project KORESIL. Personalised engraved straws were a coveted highlight. Finally, the inner courtyard was transformed into an eBike test track, where the kids tried out the ePredict bikes under the instruction of Prof. Kästner and Dr. Peter Hantschke (IFKM) and generated a lot of measurement data on riding behaviour.

As part of the TU Dresden's **tryING** trial programme, five female high school graduates were able to experience the ILK up close in September and immerse themselves in the world of a lightweight engineer. In two exciting days, the young ladies learned how components are designed, materials developed and fibre plastic parts manufactured and tested. The production of the fibre composite panels was embedded in an exemplary problem from everyday engineering life: The task was to design and lay out a lightweight but highly stressable component. Despite the new formulas and the initially unknown solution, the STEM-interested students mastered this task creatively. In this way, they laid the foundation for the analytical way of thinking of an engineer.

The main focus of the two days was the exchange between the prospective students and the staff of the institute. There was a great deal of enthusiasm for the exchange of information about everyday working life, individual careers and other diverse interests in the engineering profession.

The tryING project not only illustrates the opportunities opened up to prospective female students through the trial study programme, but also highlights the importance of successful and contemporary promotion of young talent. It underlines how important it is to enter into dialogue together and learn from each other in order to secure a promising future for aspiring talents.

juniorIng.

Association for Engineering and Natural Sciences
Junior Education Saxony

The non-profit Asscociation for Engineering and Natural Science Junior Education Saxony (Verein für ingenieur- und naturwissenschaftliche Juniorenbildung Sachsen e. V.) – short: juniorIng. Sachsen e. V. – was founded by employees of the ILK already 2009. Our activities focus on the long-term encouragement of the technical interest of children and young people. To this end, we cooperate closely with with sponsors of scientific and cultural events in Dresden and all over in Saxony.

To our goal, we are organizing informative but also practically oriented events on a variety of topics from lightweight engineering, with a wide range of target audience: pre-school children, schools, technical high schools and colleges, but also open for the wide society. The addressed issues at these events go around the type and structure of lightweight materials, possible design methods or constructions as well as the integration of additional functionalities and especially the sustainability of lightweight materials and structures.

Moreover, our futher activities support educational staff by knowledge transfer in engineering and natural sciences, concerning primarily the age-appropriate and practice-oriented teaching in this fields. This is the spirit of e.g. our project days and weeks or of the supervision of scientific school term papers at the ILK. Additionally, we develop and provide informative and experimental working materials addressing lightweight materials, design concepts and processing technologies. In close cooperation with the ILK, we also organize child-friendly experiments with the respective target groups directly.

In the course of these activities, we have already experienced many interesting, exciting and hilarious moments with a lot of children and young people, as well as their parents, teachers or other caregivers. Thus, we have imparted knowledge in a playful way and gained educational experiences on both sides.

In 2022, we were once again able to offer many opportunities for young people in particular to get a taste of the world of lightweight engineers. These included project days with school classes, participation in SchauRein! and Girls' Day, as well as support for pupils from the Martin-Andersen-Nexö-Gymnasium in preparing and defending their scientific theses (KOLL and BELL) and the tryING trial program for prospective female students on the production and testing of fiber reinforced plastics. In addition, our association has been represented on the board of the Landesverband Sächsischer Jugendbildungswerke e. V. (LJBW) since 2021 and supports it in the Saxony-wide coordination of STEM activities and social work at schools.

Tension test with fiber-reinforced plastics.

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Experiencing lightweight materials.

Imprint

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