EDITION NOVEMBER 2021

AVK COMPOSITES REPORT 04

CONTENT

CONTENT

REPORT 04

Dear reader,

When plastics and sustainability are mentioned in the same breath, many people find this combination rather unlikely. Yet anyone with an understanding of the plastics industry as a whole knows that plastics solutions can be highly sustainable. Even fibre-reinforced plastics can compete perfectly well in this area.

This includes qualities such as lightweight construction, durability, low maintenance and the recyclability of composites. We are pleased that so many of our member organisations have agreed to share some of their research and development with us for this issue. Nevertheless, we'd also like to draw attention to several innovations that are well-known already: the winners of the prestigious AVK Innovation Award. We wanted to know what has become of their innovations. This issue starts with IVW (the Leibniz Institute for Composite Materials) and the company M. A. Dieterle, which both received a joint award in the category Innovative Products or Applications for their customised thermoplastic reinforcement.

If you've been one of the winners of the AVK Innovation Award for your innovation, either recently or several years ago, and you'd like to share with us the rest of your success story, we'd be delighted to hear from you. Just drop us an email at info@avk-tv.de. But we'd also welcome a message if you have any comments or suggestions for topics in our next issues.

Kind regards,
Elmar Witten, PhD,
AVK Managing Director

AVK INNOVATION AWARD

AWARD WINNING

What happened to the previous innovations? We asked around! Today we present for the first time one of the former awardees (see following pages). Since 1995, the AVK, the German Federation of Reinforced Plastics awards innovations in fibre-reinforced plastics (FRP) / composites covering the following categories:

Innovative products/ components or applications

Innovative procedures/ processes

Research and science

One goal of the AVK Innovation Award is to promote new products/components and applications made from fibre-reinforced plastics (FRP) and to promote new processes and methods for the manufacturing of FRP products. A further award is given to universities, colleges and institutes for outstanding work in science and research. In each of the categories special emphasis will be placed on the issue of sustainability.

Another goal of the AVK Innovation Award is to give prominence to the innovations and also to the companies and institutions that are behind them, thus publicising their performance throughout the industry.

INFORMATION

Further details and assessment criteria can be found at **www.avk-tv.de** The next innovation award will be announced in January 2022. Please contact the AVK: **info@avk-tv.de**

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INNOVATIVE PRODUCTS

INDIVIDUALIZED THERMO-PLASTIC REINFORCEMENT

Authors: Ulrich Blass, Dr. Nicole Motsch-Eichmann (IVW), Dr. Bettina Schrick (M&A Dieterle GmbH)

AVK INNOVATION AWARD

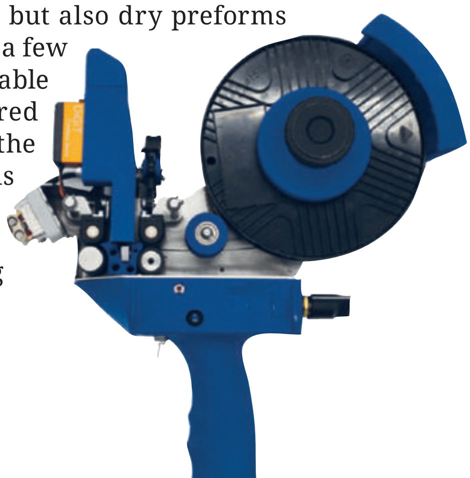
M&A DIETERLE MASCHINEN- & APPARATEBAU GMBH

In 2019, Leibniz-Institut für Verbundwerkstoffe GmbH (IVW) received the prestigious AVK award, together with M&A Dieterle GmbH, for the development of a hand lay-up device (HLG) which enables the manual deposition of thermoplastic fiber tapes on simply curved surfaces.

This device was developed as part of a research project to reinforce customized 3D-printed ankle orthoses in a load-path-compliant manner. The goal was to provide orthopedic technicians with a tool for quickly and inexpensively adapting individualized orthoses to a patient's load profile.

At the time of the award ceremony, M&A Dieterle had already produced five HLG prototypes which were extensively tested by orthopedic technicians as well as motor sports technicians under practical conditions, connected with the goal to develop further the prototypes with the help of the applicants' practical tips and to adapt them to the requirements of the respective industry.

In order to be able to offer a process for the automated application of fiber tapes in addition to manual tape deposition, M&A Dieterle's HLG was extended to include a programmable portal. In addition, the depositing head was adapted so that not only pre-impregnated fiber tapes can be deposited, but also dry preforms can be produced in just a few work steps. The automatable depositing unit is offered by M&A Dieterle under the name "CrossLayer" and is preferably purchased by medium-sized companies that are looking



for a cost-effective entry option into automated preform production. The experience gained during the HLG development has enabled IVW to acquire further research projects; for example, the ZIM project „Flexible Production of High-Performance Thermoplastic Composites Based on Powder-Impregnated Tapes“ was won, in which IVW – together with M&A Dieterle – is working on powder-impregnated fiber tapes.

For both, the institute and the industrial partner, the development of the hand-held laminator and the associated success by winning the AVK Innovation Award has resulted in significant benefit which can be quantified in follow-up projects, new contacts and orders.

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FRAUNHOFER INSTITUTE FOR CASTING, COMPOSITE AND PROCESSING TECHNOLOGY – IGCV

INNOVATIVE WETLAYING TECHNOLOGY

FURTHER PROCESSING OF RECYCLED CARBON FIBRES INTO SEMI-FINISHED NONWOVEN MATERIALS

Authors: Violetta Schumm, Michael Sauer, Jakob Wölling

Fig. 1: Wetlaid nonwoven line at Fraunhofer IGCV
© Fraunhofer IGCV

At the Fraunhofer IGCV in Augsburg, a state-of-the-art and unique pilot-scale wetlaid nonwoven line has been build up, to push the development of processing nonwovens made out of recycled carbon fibres.

In the field of fibre composite recycling, the production and further processing of semi-finished nonwoven products from recovered carbon fibres represents a promising processing route. The technologies used must be able to fulfill a wide range of requirements, such as reproducibility, availability and cost efficiency. An efficient and sustainable recycling strategy also requires semi-finished material properties that are as homogeneous as possible. In order to advance precisely these aspects, the Fraunhofer IGCV has invested in the future-oriented wetlaying technology and set up a state-of-the-art and unique pilot-scale wetlaid nonwoven line in Augsburg. This is constantly being developed and researched, both on the basis of publicly funded projects and within the framework of direct industrial cooperation.

The wetlaying technology is basically very similar to the classic paper production. The principle is based on dispersing fibres in a water-based solution and dissolving them down to individual fibres. With the help of a coordinated process, a homogeneous fibre-water suspension is directed onto a rotating inclined sieve belt. This enables a defined fibre deposition with simultaneous drainage. After an optional impregnation and drying unit, a functional wetlaid nonwoven with a reproducible and very defined property profile is produced. Very different fibre materials such as natural, regenerated and synthetic fibres - including recycled and technical fibres - can be processed on the customized pilot machine. The wetlaying technology is therefore optimized for producing homogeneous semi-finished nonwoven products from recycled carbon fibres (rCF).

Development of high-performance wetlaid nonwovens

In the next few years, many exciting research topics in the field of wetlaid technology - especially rCF recycling - will be advanced at Fraunhofer IGCV. However, new developments or applications in the field of medical and filtration technology are also in the IGCV's area of interest. In addition to topics such as the optimization of macroscopic nonwoven homogeneity in the processing of discontinuous staple fibres having different fibre length distributions, the use of different binder systems and their influence on the semi-finished product and fibre composite properties also plays a major role. Furthermore, another aim of the technology development is to produce wetlaid nonwovens based on technical fibres with very variable area weights, from very thin functional materials to high grammages for particularly economical processing concepts.

There is also a special focus on the influence of the fibre orientation on the nonwoven properties as one of the most decisive parameters in relation to the subsequent mechanical performance spectrum. Overall, this offers the opportunity to establish a key technology for the economically viable implementation of rCF recycling solutions. With the help of a modification or expansion of the machine system, e.g. through online process monitoring, the individual research projects are monitored during the process and can thus also make an important contribution to a digital circular economy. These quality assurance measures play a certain role, especially in the handling of recycled fibre materials and the associated quality fluctuations.

If you would like to learn more about the advantages of the wetlaying technology or the wide range of possibilities offered by the Fraunhofer IGCV pilot line in Augsburg, please feel free to contact us at any time.

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ABOUT FRAUNHOFER IGCV

Fraunhofer IGCV stands for application-oriented research with a focus on efficient engineering, networked production and intelligent multi-material solutions. The 160 scientists generate interdisciplinary solutions for casting, composite and processing technology, which can sustainably secure the competitiveness of Germany and Europe.

DLR – DEUTSCHES ZENTRUM FÜR LUFT- UND RAUMFAHRT

DIGICOMP:

smart approach for more sustainable composite structures

Author: Mark Opitz

Future Mobility

Composite structures are essential for future energy-efficient mobility because of their high lightweight potential and the possibility for functional integration combined with great freedom of design. Aerospace applications will become more innovative and thus more heterogeneous. The focus is on demand-driven individual transport. In addition to civil passenger transport by air cabs, unmanned aerial vehicles are being used for freight transport, rescue operations and scientific purposes.

The final characteristics of composite components are generated during production, which is why the production parameters have a dominating impact on the exploitable structural properties. Consequently, for today's aerospace structures, only the lowest possible performance is considered for qualification. Furthermore, this potential is reduced even more by probability factors that include unknown effects during operation and production.

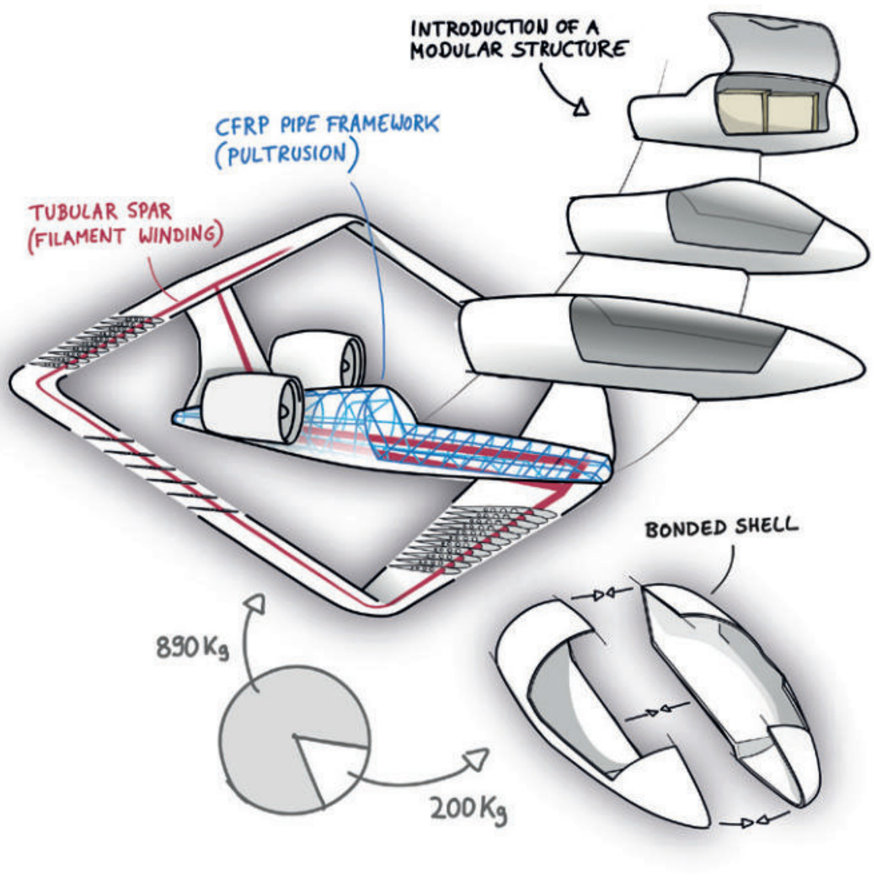

Fig. 1: Modularity and structural diversity of future mobility applications

The smart composite production: DigiComP

Digitalization offers a new way of qualification by controlling quality relevant effects throughout the individual product history. Technically this means that during production all quality related chemical and physical parameters need to be recorded and analyzed by use of suitable and informative sensor systems.

To further develop performance-based qualification the DLR Institute of Composite Structures and Adaptive Systems (FA) has set up a fully digital processing environment for production processes: DigiComP.

Fig. 2: The smart composite production: DigiComP

the major reason for geometrical scatter caused by PIDs (Process induced Deformations). Another application for interconnected production systems is tracking and simulating resin flow by SCOPRA and RINSE for manipulating process parameters at the digitized infusion center to eliminate dry spots and surface defects. Demonstrated in the Clean Sky 2-project HLFC-Win this service approach offers the potential to reduce scrap as well as subsequent QA-measures and enable holistic sustainable lightweight solution.

Besides the digital communication infrastructure our research focuses on sensor development and integration as well as software applications for real-time data analysis and control decisions. The baseline for the digitalization approach is that hardware and software features are designed as network services with dedicated application programming interfaces (API). This enables that heating units can directly communicate to each other reducing the energy demand by 50 % and the plant occupancy time by 75 % as verified in the EU-funded project EFFICOMP. Combined with cure simulation CURESIM a reproducible and precise curing process can be realized, which eliminates

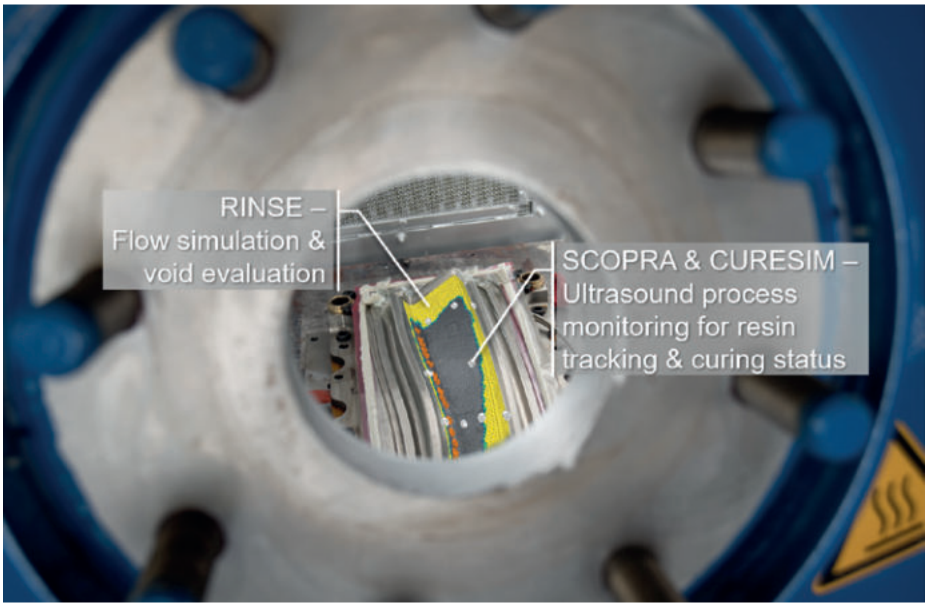

Fig. 3: Reduced effort and scrap through hybrid, In-situ qualification

NEUE MATERIALIEN BAYREUTH GMBH

Continuous life cycle assessment

ALONG THE PROCESS CHAIN FROM UD TAPE TO FINISHED COMPOSITE PART

Author: Christian Cornejo Runge

In recent years, continuous fiber-reinforced thermoplastic composites (primarily organosheets) have found their way into automotive series production. UD tapes can be used complementary, as they enable load-oriented preforms and reduce waste contour dependent. Their advantages, such as short cycle times, function integration via injection molding and their recyclability, also show high potential for other applications.

In recent years, continuous fiber-reinforced thermoplastic composites (primarily organosheets) have found their way into automotive series production. UD tapes can be used complementary, as they enable load-oriented preforms and reduce waste contour dependent. Their advantages, such as short cycle times, function integration via injection molding and their recyclability, also show high potential for other applications. In terms of sustainability, the ecological footprint of the entire production chain (fig. 1) of new lightweight parts must also be considered. Only an extensive life cycle assessment (LCA), starting from material production up to the finished component (cradle to gate), can identify the key parameters of the CO_2 footprint of lightweight parts.

The demonstrator[1] (fig. 2a), developed together with Brose Group and REHAU AG + Co, consists of a fabric organosheet and a UD multilayer structure. A pure carbon fiber reinforced (CF) and an optimized preform (CF/GF hybrid) were compared. The preforms were produced using the FORCE process chain (fig. 1) with included molding and function integration by injection molding in a "one-shot" process on a 2,500 t injection molding press.

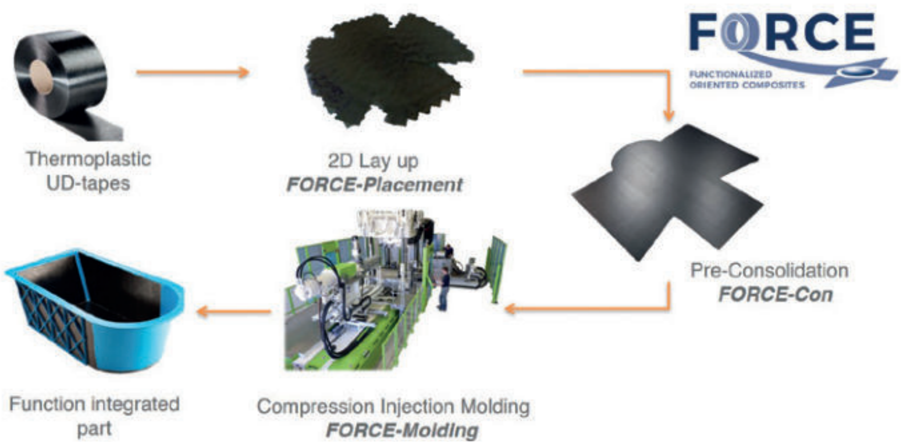

Fig. 1: FORCE - Process chain for continuous fiber reinforced thermoplastic fiber composite parts at Neue Materialien Bayreuth GmbH

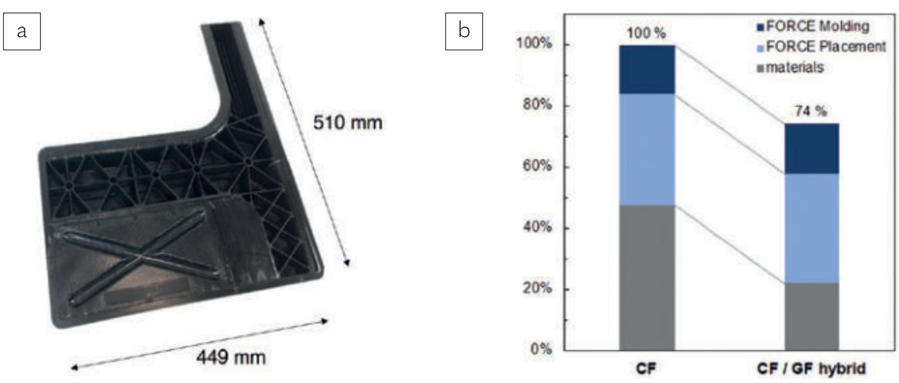

Fig. 2: (a) demonstrator and (b) the global warming potential of a pure CF compared to CF/GF hybrid preform.

For the LCA, the media consumption along the process chain is measured and evaluated using the GaBi software (Sphera Solutions, Inc.) starting from the raw material up to the finished component. Fig. 2b shows for a pure CF part that material and manufacturing contribute similarly to the carbon footprint. If the laminate structure is optimized, the process dominates with almost 70 %. The largest contribution to the carbon footprint is then made by the lay-up process.

The main emissions of the lay-up process originate in electricity consumption and material waste. Narrower tapes can reduce waste but lead to increased machine utilization. Economically as well as ecologically, the optimum tape width is a compromise between the lowest possible waste cuttings and the shortest possible machine running time. For optimization purposes, the CAESA® TapeStation software was extended together with SWMS GmbH to include a digital twin of the FORCE laying system. The digital twin optimizes the laying strategy (tape width, laying sequence, etc.) for a given contour in terms of costs or CO_2 footprint by means of an algorithm.[2] For the 2D preform shown in fig. 1, the CO_2 eq. could be reduced by 7.4 % through clever laying strategies (tab. 1).

	relative costs [%]	material scrap [%]	CO_2-eq. [kg CO_2e]	CO_2 reduction [%]
Benchmark	100	15,7	14,29	0,0
CO_2 optimized	94,9	8,4	13,23	-7,4
Cost optimized	94,0	9,7	13,55	-5,2

Tab. 1: Results of the tape laying simulation for PA6-CF UD tape for the preform from fig. 1

The results show that in order to minimize the CO_2 footprint, two points need to be considered: Material savings potentials (offcuts, load-adapted hybrid structures) and the energy optimization of the manufacturing process. The combination of a digital twin and a LCA model of the manufacturing process makes it possible to optimize economic and ecological aspects early on in part development. Neue Materialien Bayreuth GmbH offers interested companies to work together on customized solutions for more sustainable FRP lightweight structures.

The projects were funded by: StMWi Bayern
[1] "2DMultiMat" (FKZ: NW-1506-0008) within the framework of "Neue Materialien" and BMWi
[2] "OptiTape" (FKZ: ZF4064612PO8) within the framework of the "Zentrales Innovationsprogramm Mittelstand" (ZIM).

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European Union
European Regional Development Fund
ZIM Zentrales Innovationsprogramm Mittelstand
PtJ Projektträger Jülich Forschungszentrum Jülich

FRAUNHOFER INSTITUTE FOR CHEMICAL TECHNOLOGY – ICT

Polyurethane Seating Structure

A case study for holistic product development

New, sustainable products can be developed through a holistic product development using economic, ecological and product requirements, taking into account all phases of the product's life cycle.

Authors: Dr. Carl-Christoph Höhne, Dr. Rudolf Emmerich, Dr. Thomas Reichert

The greatest challenge of a sustainable, recyclable product is currently the step between product end of life and the new product generation - the recycling step.

As part of the Clean Sky 2 programme, Fraunhofer ICT is developing a sustainable seating structure for aviation. These structures usually consist of a load-bearing metal structure and soft plastic seating cushions. At the end of the product's life, both materials undergo a complex separation process into metal and plastic fractions, whereby the plastic fraction in particular contains metal contaminants. A seating structure consisting of only one of the two materials is therefore desirable. Since the flexible seating foam cannot be made of metal, a substitution of the metal structure is necessary. Upholstery foam is usually made of polyurethane resin (PUR). Since plastic separation is also a challenge, almost all parts of the investigated seating structure are made of PUR (mono-material approach). Figure 1 shows the development focus. Here, a holistic product development is used, taking into account all phases of the product's life cycle - from raw material extraction to end of life. In addition to economic advantages and product properties, the ecological impact is integrated into the product development as a third optimisation parameter - so a demonstrably sustainable product is developed.

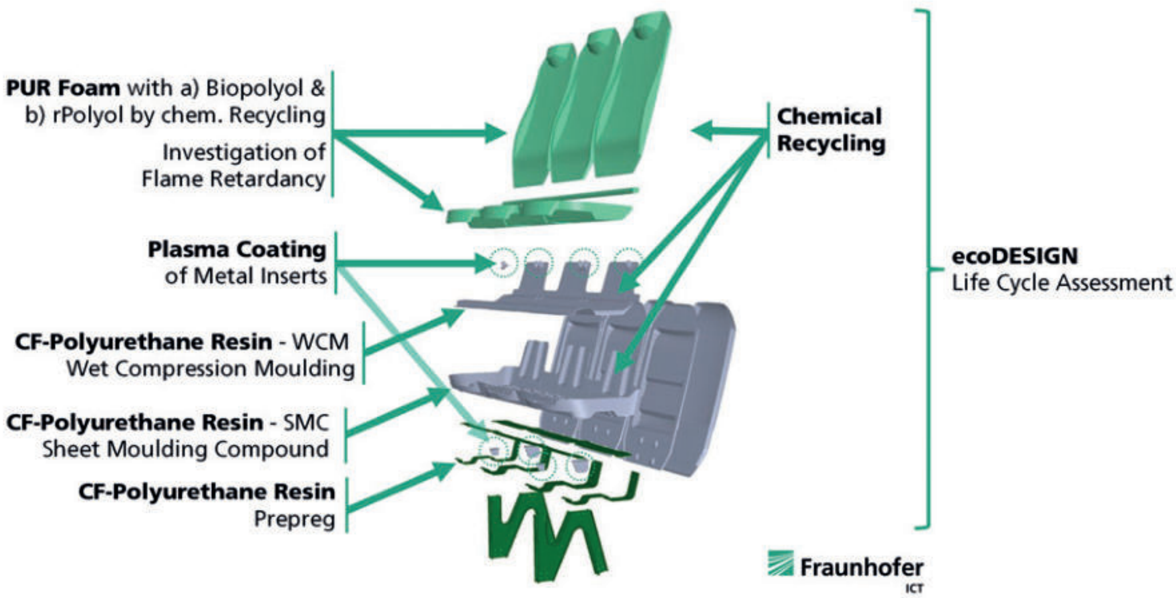

Fig. 1: Research focuses during the development of the PUR based seating structure for aircraft applications.

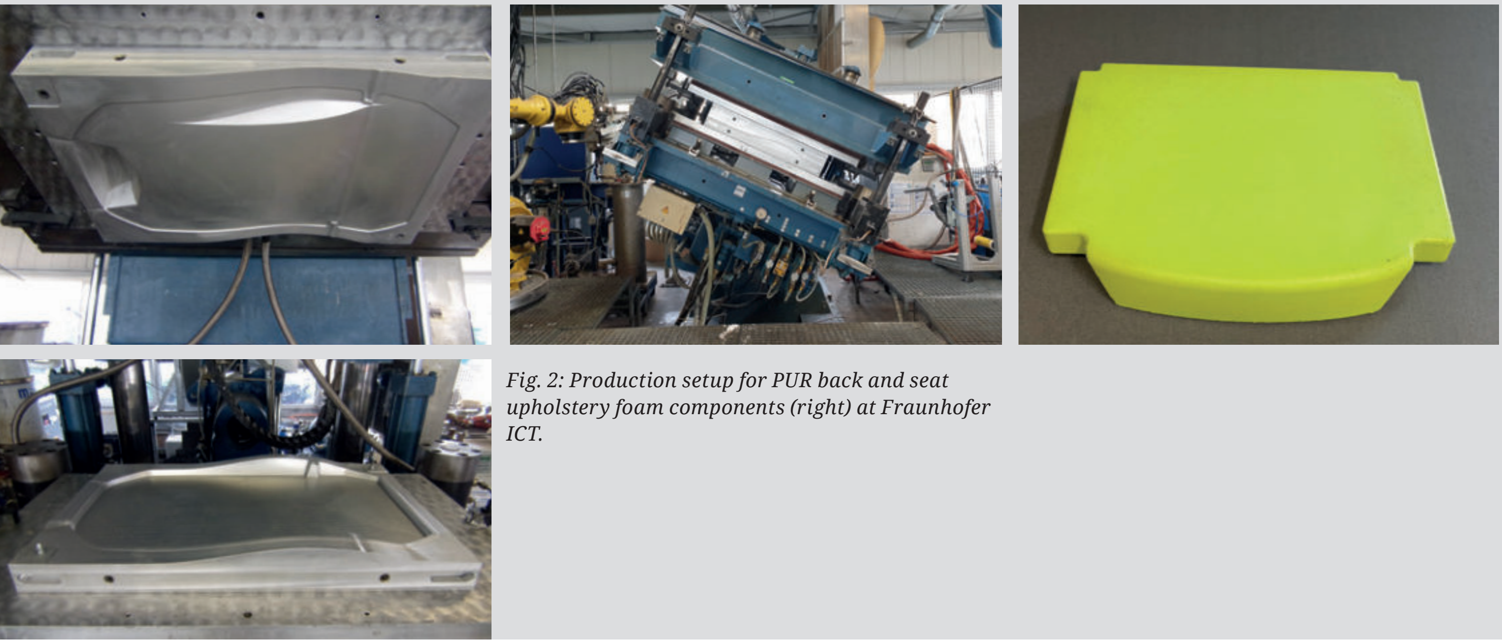

Fig. 2: Production setup for PUR back and seat upholstery foam components (right) at Fraunhofer ICT.

Sustainable PUR seating foam

The development of the sustainable PUR foam was supported by a life cycle assessment. A life cycle assessment of different oil plants and the subsequent chemical conversion process from oil to polyol was used to identify ecologically beneficial polyols. From these polyols, foams were produced and analysed according to foam properties. Thus, a PUR foam formulation was developed that was suitable with regard to ecological impact as well as foam properties, see figure 2. The PUR foam meets the flame retardant requirements of aviation without additional flame retardant, which is an advantage from an economic and ecological point of view, as well as for the recyclability of the foam.

CF-PUR

Supporting structures made from carbon-fibre-reinforced (CF) PUR are currently not established for aircraft application. For this reason, flame retardant materials and processing technologies of CF-PUR produced by WCM and SMC, including local prepreg reinforcements, are developed at ICT, see figure 3. Metal inserts, e.g. for seat belt attachment, are integrated during the moulding process and have an excellent bonding to the CF-PU structure due to a plasma coating developed at ICT.

Fig. 3: Production of the CF-PUR upper seating shell with metal inserts by wet compres-sion moulding (WCM). The CF-PUR lower seating shell (blue frame) is made of sheet moulding compound (SMC), including additional CF-PUR prepreg reinforcements.

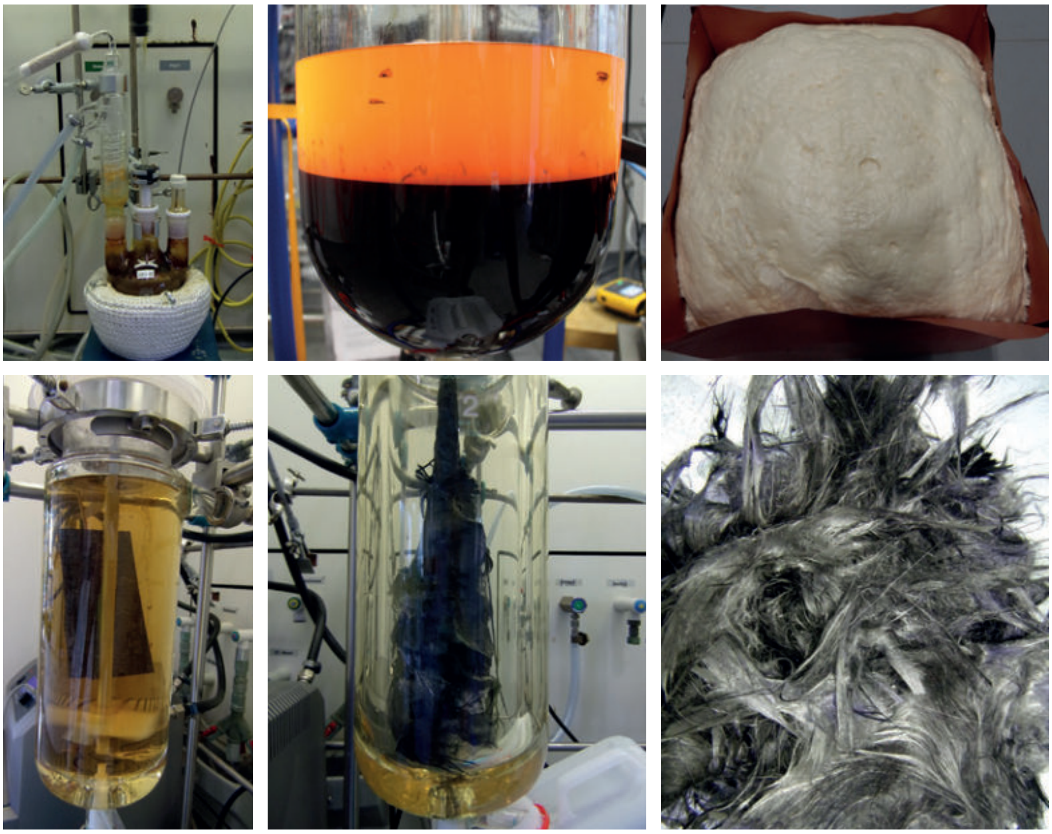

Fig. 4:
Above: Chemical recycling of PU foam of the seating structure up to 30 l scale (centre) and PU foam produced from the recycled polyol (right). Below: Chemical recycling of CF-PU and careful recovery of carbon fibres (right: rCF after solvolysis).

Recycling

Different recycling concepts involve mechanical as well as chemical recycling technologies using real components - for example the chemical recovery of PUR and CF, see figure 4. PUR can be chemically decomposed into polymer fragments by solvolysis. These fragments are used to produce new polymers (next product generation).

Life cycle assessment

The life cycle assessment (LCA) is closely linked to the technology development. This approach is intended to identify technological shortcomings whose elimination leads not only to ecological improvements but also to an economic benefit.

COMPETENCES & SCIENTISTS

The holistic product development requires the collaboration of experts along the whole life-time of a product:

› Life cycle assessment	Dr. Ana Salles
› Flame retardants	Dr. Carl-Christoph Höhne
› Plasma coating	Dr. Rudolf Emmerich
› WCM-technology	Felix Behnisch
› SMC-technology	Sergej Ilinzeer
› PU foam & chemical recycling	Dr. Ronny Hanich
› Mech. recycling & circular economy	Torsten Müller

FURTHER REFERENCES

1. Behnisch F, Höhne C-C, Manas L, Rosenberg P, Henning F. Flame retardant investigations on carbon fibre-reinforced polyurethane resin parts for aircraft applications produced by wet compression moulding. Fire and Materials. 2021;1–11. https://doi.org/10.1002/fam.2965

2. Höhne C-C, Hanich R, Kroke E. Intrinsic flame resistance of polyurethane flexible foams: Unexpectedly low flammability without any flame retardant. Fire and Mate-rials. 2018;42:394–402. https://doi.org/10.1002/fam.2504

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FRAUNHOFER INSTITUTE FOR CHEMICAL TECHNOLOGY – ICT

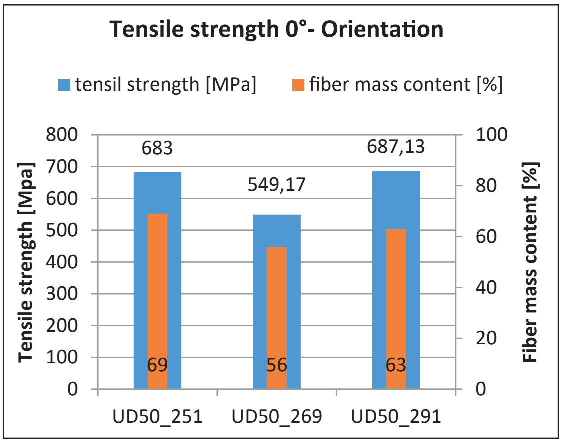
SUSTAINABLE LIGHT-WEIGHT SOLUTIONS

BASED ON PLA AND BASALT

Bio-based materials make a valuable contribution to achieving national and European climate protection and sustainability targets in transport technology.

Authors: Benjamin Tillner, Kevin Moser, Stefan Hanstein

As part of the Fraunhofer internal innovation program "Lightweight Materials 4 Mobility" (LM4M), fast-crystallizing, temperature-resistant and impact-modified polylactide (PLA) formulations were developed, which in the subsequent processing step, tape laying with basalt fibers, were processed into UD tape layers and finally transferred into a seat shell. For a holistic view of the developed sustainable lightweight solution, the PLA basalt fibers of the composites were completely recovered by an enzymatic and leach-based recycling approach while retaining the entire original fiber length.



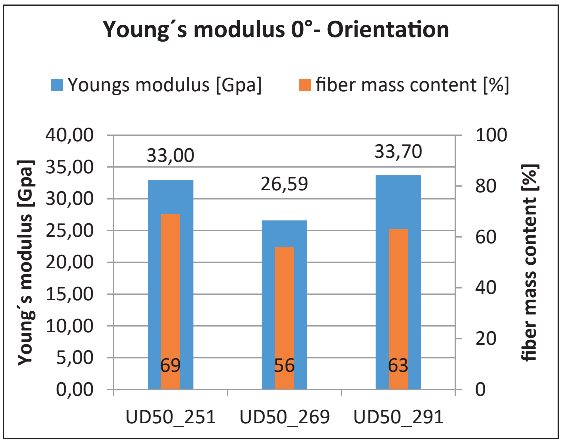


Fig. 1: Comparison of fiber mass fraction, tensile strength and Young's modulus of the semi-finished tape products based on the PP/BF reference system (UD50_251), PLA/BF system (UD50_267, commercial PLA batch) and the modified PLA/BF system (UD50_291).

Material development

Unmodified PLA is generally unsuitable for technically demanding applications due to its insufficient heat resistance, slow crystallization kinetics and low ductility, and therefore must be modified accordingly. In LM4M, these deficient properties were analyzed in detail and material development strategies for targeted modification were successfully developed. The formulations developed in LM4M feature heat resistance up to 140 °C, optimized crystallization kinetics and thus higher degrees of crystallization, increased ductility, and improved hydrolysis resistance compared to unmodified PLA. In addition to the material modification, the processing properties were also significantly improved. Thus, the modified PLA formulations can be easily converted into a homogeneous UD tape quality on conventional equipment.

Semi-finished product and component manufacturing

In the first step, continuous fiber-reinforced UD tapes are produced on the basis of the modified PLA grades by means of a melt impregnation process. This requires process-specific parameter optimization to ensure continuous processing of the basalt reinforcement fibers and the PLA matrix. Thus, fiber mass fractions of up to 63 % can be achieved in the semi-finished product. Figure 1 shows a comparison of the semi-finished product properties of unmodified PLA-Basalt-Tapes, modified PLA-Basalt-Tapes and PLA-Basalt-Tapes. The increase in performance of the modified PLA-Basalt-Tape compared to the unmodified PLA-Basalt-Tapes is clearly visible. Furthermore, the graph shows that the characteristic values determined for the modified PLA system even exceed the corresponding characteristic values for tensile strength and modulus of elasticity of the PP-Basalt-Tape.

Based on the UD semi-finished products and the biopolymer system, the subsequent hybrid injection molding process could be optimized to produce a fully biopolymer-based seat demonstrator structure at the end of the process chain (Figure 2).

Recycling of basalt fibers

For the demonstration of recyclability, a recycling approach for the produced UD tapes based on leach or enzyme treatment was developed and validated. Both treatments resulted in dissolution of the PLA, with a large part of the dissolved substance being present as lactic acid. While the leach-based treatment allows PLA degradation within a few hours, enzymes allow degradation within two days. No impairment of the basalt fibers could be observed. Thus, the conclusion can be drawn that basalt fiber recovery is possible without a reduction in fiber length.

Fig. 2: Manufactured seat structure made of PLA and basalt

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RECYCLING UND NACHHALTIGKEIT

Circular Economy Strategie von

MITSUBISHI CHEMICAL ADVANCED MATERIALS COMPOSITES

Nachhaltigkeit, Gesundheit und Komfort sind bei MITSUBISHI CHEMICAL ADVANCED MATERIALS COMPOSITES die Werte unserer KAITEKI Firmen-Philosophie, die gleichermassen das Wohlergehen der Menschen, der Gesellschaft und unseres Planeten Erde anstrebt.

Als Hersteller thermoplastischer Verbundwerkstoffe sind wir uns daher unserer Verpflichtung bewusst, alternative Materialkonzepte mit dem besonderen Fokus auf Nachhaltigkeit für den Serieneinsatz zu entwickeln.

Mit unseren Kunden arbeiten wir gemeinsam an einem nachhaltigen Konzept, um deren Produktionsabfälle zurückzuführen und in der Materialherstellung wieder zu verwenden. MITSUBISHI CHEMICAL ADVANCED MATERIALS COMPOSITES strebt damit konsequent eine nachhaltige Kreislaufwirtschaft an.

Diese Entwicklungen verlaufen über unser gesamtes Produktportfolio, von den leichtgewichtigen SymaLITE® LWRT-Materialien für grossflächige Verkleidungsteile, über unsere semi-strukturellen GMT und strukturellen GMTex® Werkstoffen, die gewebeverstärkten QTex- und UD-verstärkten MTex-Organobleche, bis hin zu unseren MultiQ und SYTex Sandwich-Verbunden.

Als Matrixsysteme für nachhaltigere Thermoplast-Verbundwerkstoffe können anstatt Polypropylen oder Polyamid Neuware entsprechende Recyclate, aber auch Polylactic Acid (PLA) oder Polypropylen, für dessen Herstellung bio-basierende Kohlenwasserstoffe verwendet wurden, eingesetzt werden.

Als Verstärkungsfasern können Recycling-Glasfasern oder alternativ auch Basaltfasern verarbeitet werden.
Für unser Produktportfolio sind verschiedene Kombinationen der angegebenen Matrixsysteme und Verstärkungsfasern zur Herstellung nachhaltigerer Verbundwerkstoffe möglich.

Bei der Produktion eines SymaLITE® Materials kann der bisher zur Herstellung verwendeten Anteil Neuware von rund 91 % des Gesamtgewichtes auf bis zu unter 8 % reduziert werden.

Autor Informationen: Dr. Tilo Schimanski, Product Manager

SymaLITE® SL Ultra HP 1400 – Rezeptur I

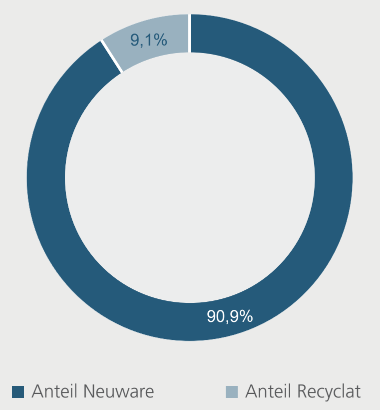

Bild 1: Materialeinsatz mit hohem Neuwarenanteil

SymaLITE® SL Ultra HP 1400 – Rezeptur II

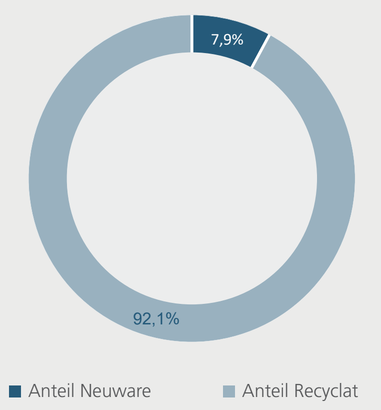

Bild 2: Materialeinsatz mit reduziertem Neuwarenanteil

FRAUNHOFER-INSTITUT FÜR PRODUKTIONSTECHNOLOGIE – IPT

PRODUCTIVE AND **RESOURCE-EFFICIENT** PRODUCTION PROCESSES

for thermoplastic fiber composites

Fiber-reinforced plastics (FRP) are excellent lightweight materials that have the potential to save CO_2 emissions, especially in mobility applications. However, taking into account the entire life cycle, FRP components generate a large environmental footprint in many other applications. This can be attributed, for example, to resource-intensive production processes or the disposal of material with high energy density. The "BioStrukt" and "Bio-FML" research projects are pursuing various strategies to increase the resource efficiency and productivity of thermoplastic FRPs through the use of bio-based raw materials and topology optimization

Authors: Jonathan von Helden, Thorsten Pillen

Resource efficiency thanks to bio-based raw materials

Natural fibers and thermoplastic bioplastics offer an eco-friendly alternative to conventional materials for composite applications. Within the "Bio-FML" project, it was possible to demonstrate the competitiveness of flax- and jute-reinforced polyactide with glass fiber-reinforced plastics: Flexural test specimens achieved a stiffness of 15.3 GPa. In addition to the good weight-specific bending properties, their production has a significantly reduced greenhouse potential.

For modern facade elements as well as air freight and residential containers, the Fraunhofer IPT, together with DIRKRA Sondermaschinenbau GmbH, has developed a production system that allows the low-cost production of fiber-metal-laminates based on natural and recyclable raw materials. During the impregnation and joining process, thin metal belts serve as heat- and pressure-transferring tools for material consolidation and finally form laminating layers of the hybrid material. Thanks to the sandwich construction, the material has a robust, paintable metal surface and can be formed into 3D components in conventional presses. Together with other partners, including Delcotex and the AZL of RWTH Aachen University, the project also investigates the production of semi-finished products, e.g., hybrid fabrics, as well as material recycling.

Fig. 1: Production system developed by DIRKRA Sondermaschinenbau GmbH and the Fraunhofer IPT for continuous consolidation of fibre-metal laminates

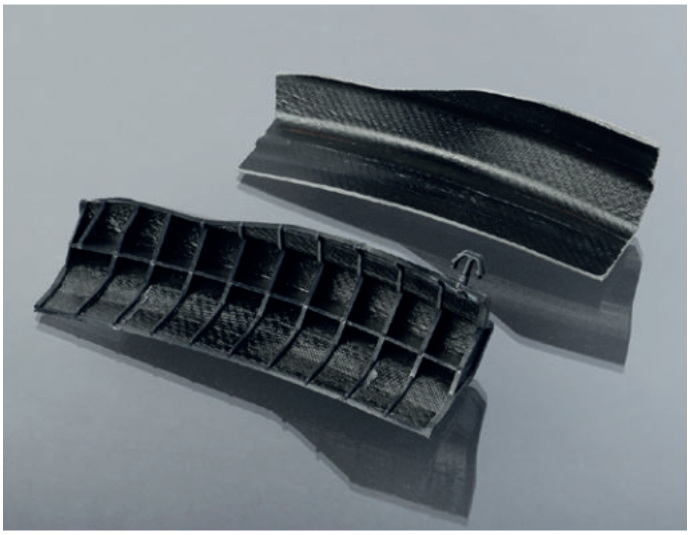

Fig. 2: Demonstrator produced as part of the „BioStrukt" project, which was designed with optimized topology and back-injected using the injection molding process

Resource efficiency through productive topology optimization

"BioStrukt" deals with a process chain for the production of topology- and material-optimized FRP components through targeted steering of the reinforcing fibers. The aim here is not only to ensure efficient material use, but also to manufacture a component in a load-case-appropriate and economical manner. The current state of the art does not allow continuous fibers to be laid down economically in curved paths, so that potentials in component weight and material waste are not optimally exploited. "BioStrukt" is intended to tap this potential. Organic sheets with curved fiber paths, which are subsequently formed by thermoforming, are produced automatically. For this purpose, a highly efficient process chain consisting of tape laying, thermoforming and back injection is being developed. The semi-finished products produced at the Fraunhofer IPT are back-injected by SK Industriemodell GmbH after forming. The targeted use of optical measurement technology, which was provided by Apodius GmbH, enables the continuous recording of the quality and digitization of the product. The interlinking of the production technologies along the value chain not only allows the production of a directly applicable demonstrator, but also the efficiency with regard to process safety, resources and productivity to be examined more closely.

2014 EFRE.NRW Investitionen in Wachstum und Beschäftigung

EUROPÄISCHE UNION
Investition in unsere Zukunft
Europäischer Fonds
für regionale Entwicklung

The projects »BioStrukt« and »Bio-FML« receive funding from the EFRE.NRW funding program. Funding codes: EFRE-08001248 and EFRE-0801475

LEIBNIZ-INSTITUT FÜR VERBUNDWERKSTOFFE – IVW

MARINECARE

Sustainable boats and water sports

Authors: Jan Janzen, David May, Peter Mitschang

Composite materials made of glass fibers and plastics are often used in the manufacturing of boats and water sports equipment. The energy-intensive production of fibers and components as well as the use of plastics (mainly petroleum-based) partly contradict the sustainability concept. To improve sustainability in the maritime sector the research project „MarineCare“ was created. The aim is to develop a sustainable composite sandwich material as well as a minimal-waste manufacturing process. The sandwich structure combines a foam core made of recycled PET (obtained from dis-posable bottles) with face sheets made of recycled carbon fibers (rCF) and a bio-based epoxy resin. So far, vacuum infusion processes are commonly used in boat manufacturing which require a significant amount of single-use auxiliary materials for the resin distribution. To minimize waste in the new process, the rCF textiles will be pre-impregnated with the resin in powder-form. The resulting semi-finished products are subsequently brought into a nearnet shape and are impregnated and consoli-dated in a vacuum-based process. This eliminates the former periphery for resin distribution and reduces the danger of incomplete impregnation.

The use of this vacuum-based prepreg process provides the risk of air entrapments between the prepreg layers. These air entrapments lead to pores within the compo-nentswhich significantly reduce their mechanical properties. To minimize this risk of entrapped air, the textile is not impregnated with resin powder distributed over the entire surface, but in a sophisticated pattern

Fig. 1: Target demonstrator: Sustainable foil board made by GREENBOATS GmbH, approx. length: 1.4 m

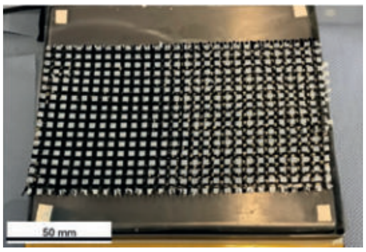

Fig. 2: Manufactured powder prepreg with a squared pattern

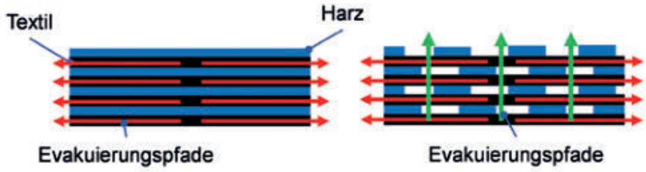

Fig. 3: Air evacuation in conventional prepregs (left) and prepregs with resin patterns (right)

design. The applied resin patterns create evacuation paths between the pattern elements as well as in the through-thickness direction of the prepreg stacks. In order to determine a reasonable preselection of samples for the experimental testing, flow simulations are carried out for the air flow out of the prepreg structures. Since the exact overlapping of the patterns cannot be guaranteed when stacking the individual layers, the prepreg layers are stacked with a realistic displacement in the model. Within the scope of the project, IVW is responsible for the development of the patterned prepregs as well as the

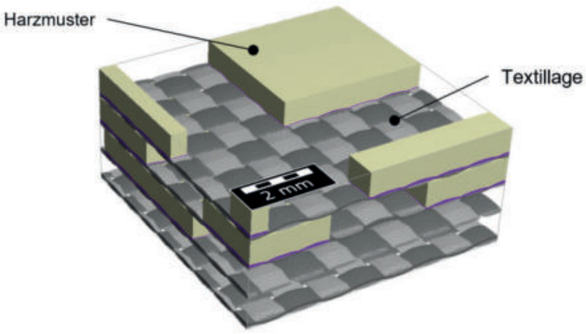

Fig. 4: Simulation model of a prepreg stack with four layers, the first layer represents the unit cell of the pattern.

impregnation and curing process. In cooperation with the project partners Swiss CMT AG (responsible for the development of the bio-based epoxy resin) and GREEN-BOATS GmbH (providing expertise in sustainable boat building) a demonstrator will be manufactured in form of a foilboard.

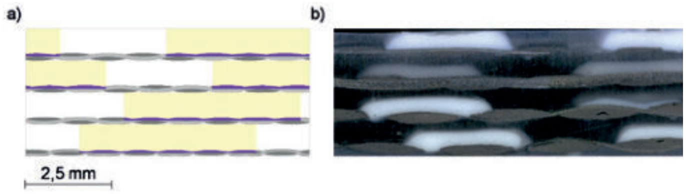

Fig. 5: Comparison between a) simulation model and b) micrographic sample (textiles fea-ture different areal weights)

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GEFÖRDERT VOM Bundesministerium für Bildung und Forschung · cmt · GREENBOATS · eurostars

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INSTITUT FÜR TEXTILTECHNIK DER RWTH AACHEN UNIVERSITY – ITA

New BANANA FIBRE POLYESTER COMPOSITE for the automotive industry

Authors: Anne Hennig, Lars Wollert, Maryam Sodagar, Deepak Sundar, Dr. Frederik Cloppenburg, Lennart Jacobsen, Univ.-Prof. Prof. h.c. (MGU) Dr.-Ing. Dipl.-Wirt.-Ing. Thomas Gries

The conversion from established fibre reinforced plastics made from petrochemical-based matrix systems and energy-intensively produced fibres to environmentally friendly alternatives is inevitable for a sustainably designed future. Recent studies show that the global bioplastics market will grow by 36 % over the next 5 years. Trends will be both the use of bio-based resources as well as a recyclability or biodegradability of the materials.

The Institut für Textiltechnik der RWTH Aachen University (ITA) was able to successfully support the student initiative BioInterio in participating in G-BiB 2020/2021 at the beginning of the year. After their success in the national pre-selection, the six researchers of different nationalities made it to the finals with their sustainable fibre composite and have now also been granted a start-up grant by the state of North Rhine-Westphalia. The team's goal is to use banana fibres and PLA to develop a hybrid nonwoven for the production of biodegradable automotive components.

Banana fibres from the plant's trunk are a residual material from food cultivation and are either burned, or processed traditionally into fishing nets and ship ropes due to their salt water resistance. Research shows that banana fibres are also suitable as a sustainable reinforcing fibre for plastics. In addition to a negative CO_2 footprint and biodegradability, banana fibres show high specific strength, a low density and excellent damping properties.

The use of PLA, one of the most established bio-based and biodegradable polymers, as a matrix material now enables the production of a fully biobased and biodegradable composite material. The BioInterio team had access to ITA's equipment park and expertise throughout the development process. The material provided by external partners was processed and consolidated into hybrid nonwovens on the laboratory equipment. Subsequently, the semi-finished product was brought into the desired geometry and consolidated in the hot press (figure 1).

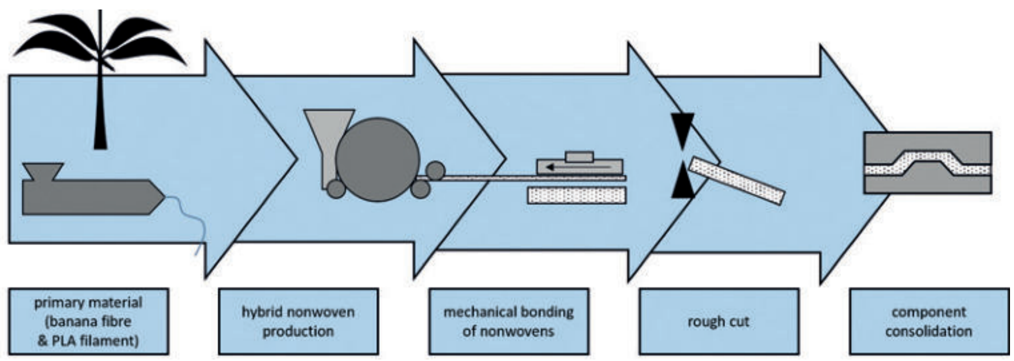


Fig. 1: Process chain for the production of the glove compartment lid from banana fibre PLA nonwoven.

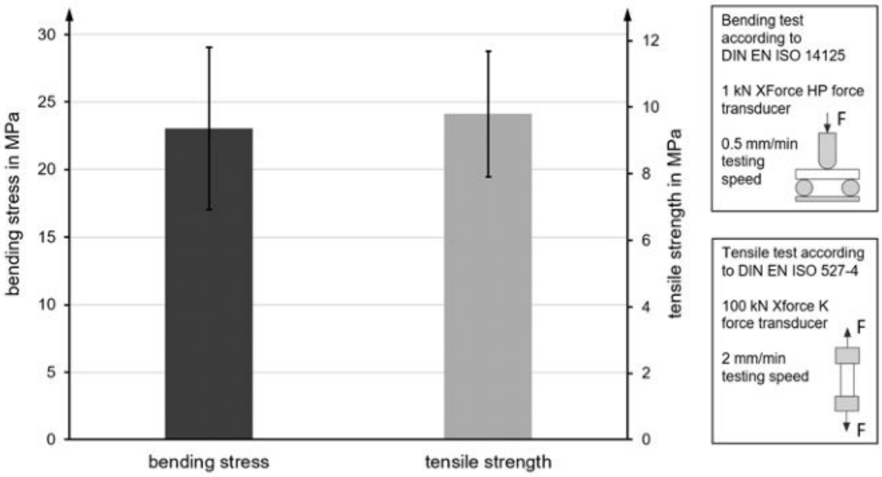


Fig. 2: Mechanical properties of banana fibre PLA composite

Fig. 3: Picture of a banana fibre PLA composite glove compartment lid

In bending tests, based on the DIN EN ISO 14125 standard, a bending strength of 23 MPa was achieved even without optimization of the materials and processes, which is only slightly below the requirements for the automotive industry. In the tensile test based on the DIN EN ISO 527-4 standard, a tensile strength of 10 MPa was also directly achieved, see figure 2.

Further development of the composite material will enable it to be used in crash-relevant parts of the automotive in the future. Parts for the interior can already be made from the innovative new composite material, as demonstrated by the glove compartment lid shown in figure 3.

SÄCHSISCHES TEXTILFORSCHUNGSINSTITUT – STFI

Epoxy-nonwovens

matrix layers for composites made from uncured resin-hardener systems

The standard process for thermoplastic based fibre reinforced composites is to insert matrix layer by layer in the form of films or nonwovens into laminate structure. Multiple repeatable softening and melting are undoubtedly an advantage over thermosets. One recent STFI research project investigated the production of nonwovens from powdered solid epoxies using meltblown processing as an alternative.

Authors: Günther Thielemann, Ralf Taubner – Sächsisches Textilforschungsinstitut e. V., Bernhard Baumann – Emil Frei GmbH & Co. KG

Solid systems made by Emil Frei GmbH, Döggingen, were used. These systems were conditioned to start curing only above 150 °C. Therefore, a wide temperature range was available, in which epoxy material is in molten state and can be processed into fibres.

During meltblown processing (Fig. 1), pellets or powder are melted in an extruder. The epoxy melt is then forced through tiny nozzles and further drawn down to diameter of 10 – 1 µm by air streaming. Emerging filaments, which have not yet cooled down, are deposited on a transport belt and stick together slightly to form a random oriented fibre web.

The meltblown process is well established in the thermoplastic industry, but on new territory regarding processing of curable moulding compounds. There was no uncon-trolled curing of reactive compounds in the extruder. Processing of epoxy-solid-systems into nonwovens is applicable in principle (Fig. 2). Further research will be needed to reduce fibre brittleness, which is still obvious.

After fabrication of the EP-nonwoven, laminates based on glass- and carbonfibers with EP-nonwoven as matrix were hot-pressed (Figs. 3 and 4). The laminate properties were in the range of classical liquid resin systems.

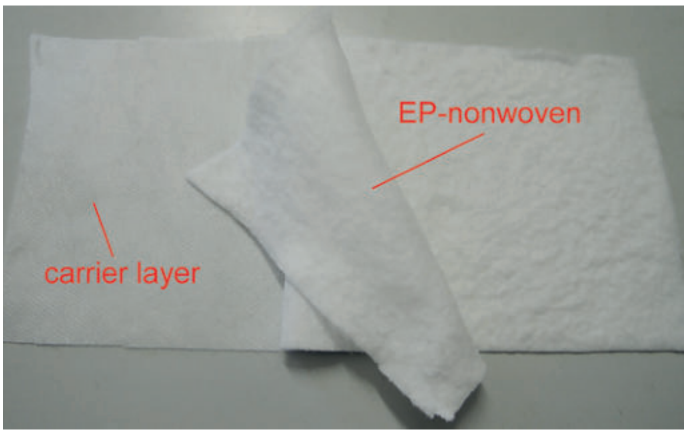


Fig. 2: Epoxy nonwovens

Fig. 1: Meltblown production of EP-nonwovens

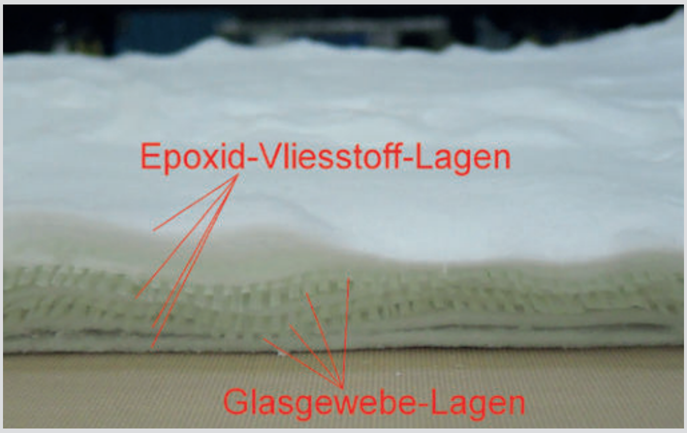


Fig. 3: Stacking of layers before pressing

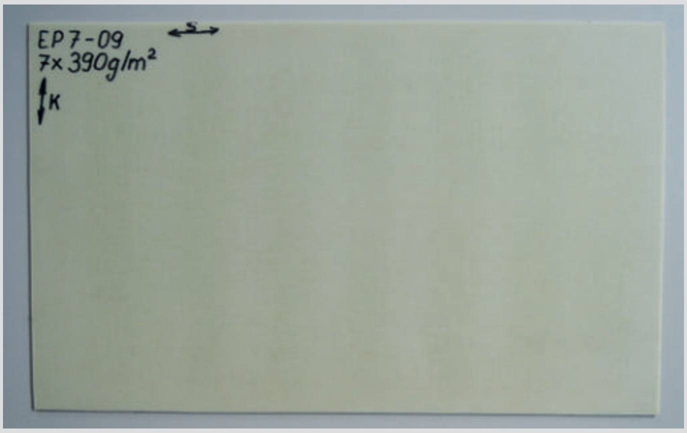


Fig. 4: Laminate, consisting of glass fibre fabric and epoxy-nonwoven

After fabrication of the EP-nonwoven, laminates based on glass- and carbonfibers with EP-nonwoven as matrix were hot-pressed (Figs. 3 and 4). The laminate properties were in the range of classical liquid resin systems.

EP-NONWOVENS OFFER MANY ADVANTAGES FOR APPLICATIONS IN THE COMPOSITES INDUSTRY:

- potential extensive replacement of liquid resin technologies
- resin-hardener blending and dosing operations are upstream in precise industrial processes
- contribution to sustainability by eliminating:
  - → oresidual resin in blending cups
  - → ocleaning of brushes and other laminating tools with solvents
  - → opollution of people and environment during manufacturing processes
- short impregnation paths across laminate wall thickness at high speed compared to infusion or injection processes
- melting processes can be repeated several times in safe temperature range for:
  - → recycling of cutting residues into material cycle
  - → opotential capacity for preform production
- reduced safety requirements because of solid material transport
- storage at room temperature possible compared to prepregs

Therefore, EP-nonwovens could seriously contribute to careful use of material re-sources. Nonwoven basis weights can be adjusted to desired fibre volume content in laminate structures by means of various process parameters.

Patent application has been filed for this development.

Gefördert durch:

Bundesministerium für Wirtschaft und Energie

aufgrund eines Beschlusses des Deutschen Bundestages

stfi

FreiLacke

EURONORM

The „EP-nonwovens“ project was funded by BMWi within the framework of INNI-KOM (VF160010).

INSTITUT FÜR TEXTILTECHNIK OF RWTH AACHEN UNIVERSITY – ITA

SUSTAINABLE SOLUTIONS

for fiber-reinforced plastics using the example of an electric scooter

Fiber reinforced composites for lightweight applications will play a crucial role in the future goal of greenhouse gas neutrality – yet there are significant differences in the life cycle assessment.

Author: Ben Vollbrecht

Agricultural waste products as a high-performance material?

Braided structures are frequently used in industrial lightweight design as reinforcing structures for fiber-reinforced plastics (FRP) subject to high mechanical loads. These are made from continuous filament rovings based on glass, carbon or aramid. However, the use of these materials requires a high energy input in fiber production and thus leads to high CO_2 emissions in the production of FRP. Reducing CO_2 emissions is both economically and environmentally necessary. In contrast to glass fiber production, natural fiber production has a 90% better CO_2 footprint. Compared to the production of glass fiber reinforced plastics, natural fiber based composites emit about 30% less CO_2 and save about 40% in energy.

The main disadvantage of composites made from renewable fibers is their still low mechanical properties, but the natural fiber appearance visibly enhances a product and, as a bio-composite, is also fully recyclable. Therefore, natural fiber-reinforced plastics (NFRP) are used for selected non-structural components with low mechanical properties, such as the interior door panels in the Mercedes-Benz A-Class or the interior panels of the BMW i3. Pineapple leaf fibers have the potential to be used in highly load-bearing components as well, as they have a much higher specific stiffness in the unprocessed state and a comparable specific strength to glass fibers.

Joint project with the Sub-Saharan Africa region

In the trilateral joint project WasteDrive with the University of Dar es Salaam (Tanzania) and the University of Mauritius (Mauritius), ITA is developing an eco-friendly fiber composite solution for the use case of an electric scooter. Pineapple leaf fibers obtained from waste products of the local food industry are biologically treated and then processed into a bio high-performance composite.

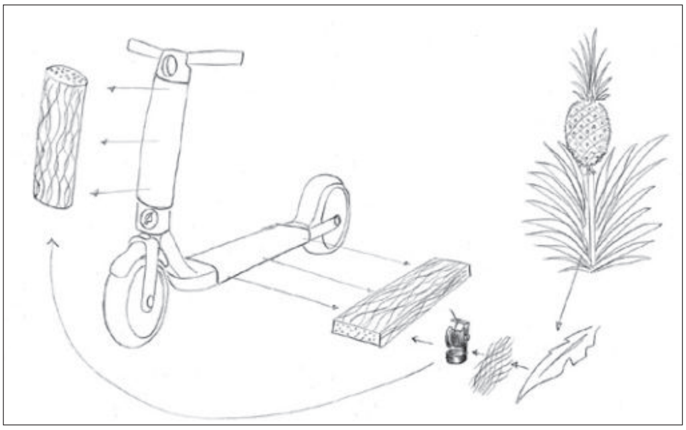


Fig. 1: Development of a fiber-reinforced electric scooter based on high-performance natural fibers from agricultural waste products

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

DAAD Deutscher Akademischer Austauschdienst German Academic Exchange Service

We would like to thank the German Federal Ministry of Education and Research and the German Academic Exchange Service for funding this research project.

FRAUNHOFER INSTITUTE FOR CASTING, COMPOSITE AND PROCESSING TECHNOLOGY – IGCV

MAI ÖkoCaP

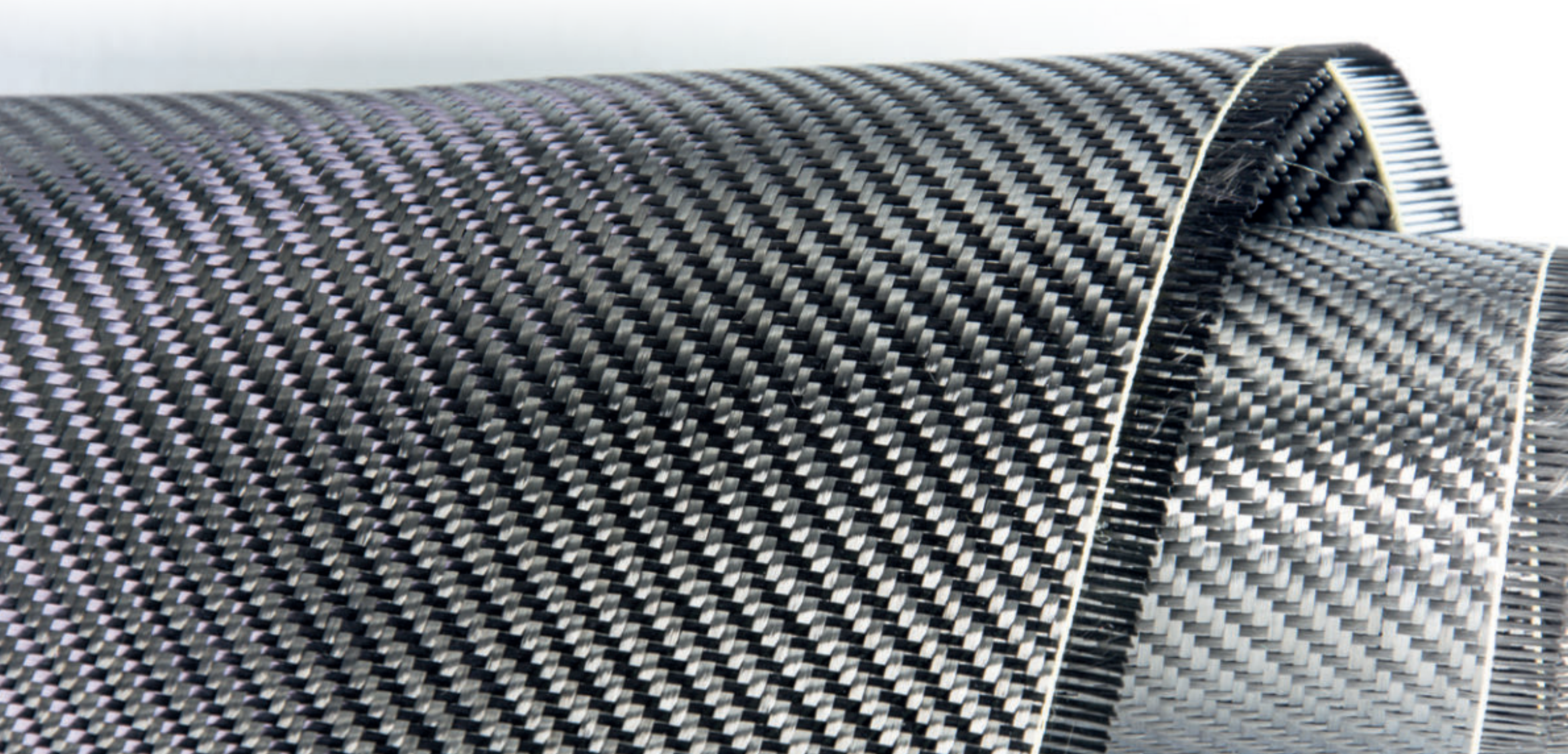
Economic, technical and life cycle assessment of recycled carbon fibres in industrial processes

The MAI ÖkoCaP project, which is being carried out by the Fraunhofer IGCV in collaboration with the Institute of Textile Technology Augsburg (ITA), is investigating a range of recycling and processing methods for recycled carbon fibre reinforced plastic (rCFRP), taking into account economic, technical and ecological aspects..

Authors: Kerstin Angerer, Fabian Rechsteiner

The central objective of the research project "MAI ÖkoCaP" is to show under which production boundary conditions the ecological, economic and functional (mechanical) benefits of recycled carbon fibres (rCF) are given and which interactions exist between these levels. At the end of the project, the results obtained will serve as a transparent and reliable basis for the industry to make decisions regarding the use of rCF. In this way, the project contributes to overcoming the obstacles, which currently prevent the use of recycled carbon fibres and to achieving a real closure of a sustainable material cycle. Previous research shows that despite the potentials presented for the use of rCF, the risk is too high for the industry to implement this material into everyday production. The reasons for this are the insufficient knowledge and uncertainties regarding the achievable material properties and resulting component qualities, the possible quality fluctuations, the achievable cost reduction and the resulting environmental impacts compared to conventional construction methods. The various source materials available, the multitude of different processing options and the contradictory and complex target values make it difficult to make a clear statement.

The focus of "MAI ÖkoCaP" is on the production and further processing of rCF nonwovens. Both dry carbon fibre cut-offs and recycled carbon fibres are considered as input materials. In addition to the dry and wet non-



woven production process, a range of thermoplastic and thermoset processing options are being investigated. Of interest are both the individual process steps and the holistic consideration of the entire process routes from the recycling process up to and corresponding component manufacture. Components made of glass primary fibres and aluminium are used as a corresponding benchmark.

However, the development of the necessary multi-criteria evaluation model requires a corresponding data basis. This is being developed within the framework of the project in cooperation with the project steering committee. The component quality, the environmental impacts and the product costs are identified and compared. By systematically varying relevant material, process and production parameters, the range of these three decision variables and the corresponding interactions will be shown and the most important levers identified. The knowledge gained from this will be made available to industry at the end of the project in the form of a guide and an intuitive, web-based app.

So far, a comprehensive requirements analysis has been prepared with the help of the project steering committee in the three working groups of shredding and recycling, textile processing as well as further processing and applications. From this, the scope of the research project was focussed and targeted to the industrial needs. This ensures that the research results can be applied in everyday industrial life. In the next step, various sub-steps of the CFRP recycling process will be investigated and measured in order to determine technical, ecological and economic characteristics. The “MAI ÖkoCaP” research project is funded by the German Federal Ministry for Economic Affairs and Energy (BMWi).

CONTACT

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PROJECT STEERING COMMITTEE:

Gefördert durch:

Bundesministerium für Wirtschaft und Energie

ÖkoCaP

aufgrund eines Beschlusses des Deutschen Bundestages

ABOUT AVK

YOUR **COMPOSITES** NETWORK

The AVK – Federation of Reinforced Plastics is the oldest interest group in the plastics industry in Germany and exists since 1924. Members include raw material producers and suppliers as well as processors, mechanical engineers, engineering firms, audit offices and scientific institutes and cover together the entire value chain in the field of reinforced plastics.

The tasks and objectives of the AVK can be divided into five central areas:

- Image building
- Promotion of innovation
- Training
- Strengthening the sustainability
- Networking

With a wide range of services, the AVK supports its members in practice-oriented ways.

The Expert Task forces

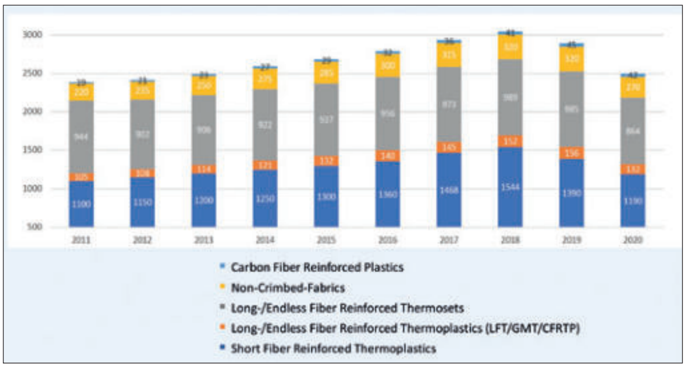
The AVK members can engage in subject-specific expert task forces and work out solutions for key issues in the industry. Task force members benefit directly from new contacts. The task forces provide comprehensive, additional knowledge, which is directly integrated into the company. In addition, in the expert task forces joint marketing activities are planned and implemented.

CURRENT EXPERT TASK FORCES:

- Analysis of Fibers and semi-finished Products
- Composites Recycling
- Continuous Fiber-Reinforced Thermoplastics
- EATC – European Alliance for Thermoplastic Composites
- Environment and Occupational Safety
- EPTA – European Pultrusion Technology Association
- Euro-RTM-Group
- GRP in Pipe-/Tankwork and Plant Engineering
- GRP Profiles and Reinforcement Systems
- GRP Safety Tanks
- GRP Swimming Pools
- Joining of Composites
- Material Testing
- Material Properties and Requirements for E-Mobility
- Natural Fiber-Reinforced Plastics
- Open Mould
- PUR Composites
- Reparation of Composites
- SMC/BMC
- Statics – Earthquake Assessment and Connector Charges
- Sustainability
- Thermoplastic Composites Tubes & Profiles
- Thermal Analysis

Market Data

AVK regularly publishes market reports and articles on the latest technologies, developments and trends, with information that is of great value to its members and the composites market. The market data on glass-fibre reinforced plastics (GRP) mainly concern the German and European markets, although they also indicate global developments.



Information

The members of the AVK regularly receive newsletters with the latest industry and association news. Moreover, we participate in trade fairs and industry events and organize seminars, conferences and congresses. Especially the field of training and education has a high priority for the AVK. The professional AVK seminars are developed in collaboration with users, experts and scientific institutes. AVK staff would be pleased to help you both practically and with advice. You may be interested in becoming a member, or you may have questions about the specific services we provide, or you may require more details about any of our forthcoming events: Whatever your needs, the AVK office will be happy to assist. AVK is also the right point of contact if you have queries about a technical issue.

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