cu reports

#01 | 2020

ISSN 2699-4569

The International Composites United Member Magazine

COMPOSITES UNITED

ENGLISH EDITION

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Dear members,

Prof. Dr. Dieter Meiners

Prof. Dr. Hubert Jäger

you are now holding in your hands – just in time for the JEC World 2020 – the first issue of your new CU reports.

CU reports is published twice a year, both in German and English. CU reports is the first of a whole series of new formats with which Composites United e.V. presents itself as the world's leading network for composites both nationally and internationally.

CU reports replaces the former Carbon Composites Magazine of Carbon Composites e.V. and the Innovation Report of CFK Valley e.V. As a member magazine, CU reports will continue to be part of the services of Composites United e.V. for all of you. With a fresh design and a revised structure, we set new standards. The abundance of your contributions already shows that you want to be part of it!

In addition to many current innovations from our network, including this year's focus topic ‚Additive Manufacturing' and the complex ‚Future Factory', you will also find a first summary of our previous activities as Composites United in this CU reports. Our contribution to sustainability in particular will be crucial for the future success of many companies in the global marketplace. With our broad experience in this area, we can make ourselves the voice of the industry.

> »All our network activities are always aimed at creating added value for our members.«
>
> **Prof. Dr. Hubert Jäger, CU presidium chairman**

This edition of the CU reports is rounded off by an outlook on the highlights of the coming event year 2020, above all LightCon 2020, which will take place on 23 and 24 June in Hanover in cooperation with Deutsche Messe AG ... in line with the strategy of the German government to focus on lightweight construction across all material groups as a key technology of the future.

With the CU reports we will continue to support you on your innovation path. We hope you enjoy reading it.

Your CU presidium chairmen

Prof. Dr. Hubert Jäger

Prof. Dr. Dieter Meiners

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CU Joint Booth
JEC World 2020

JEC WORLD
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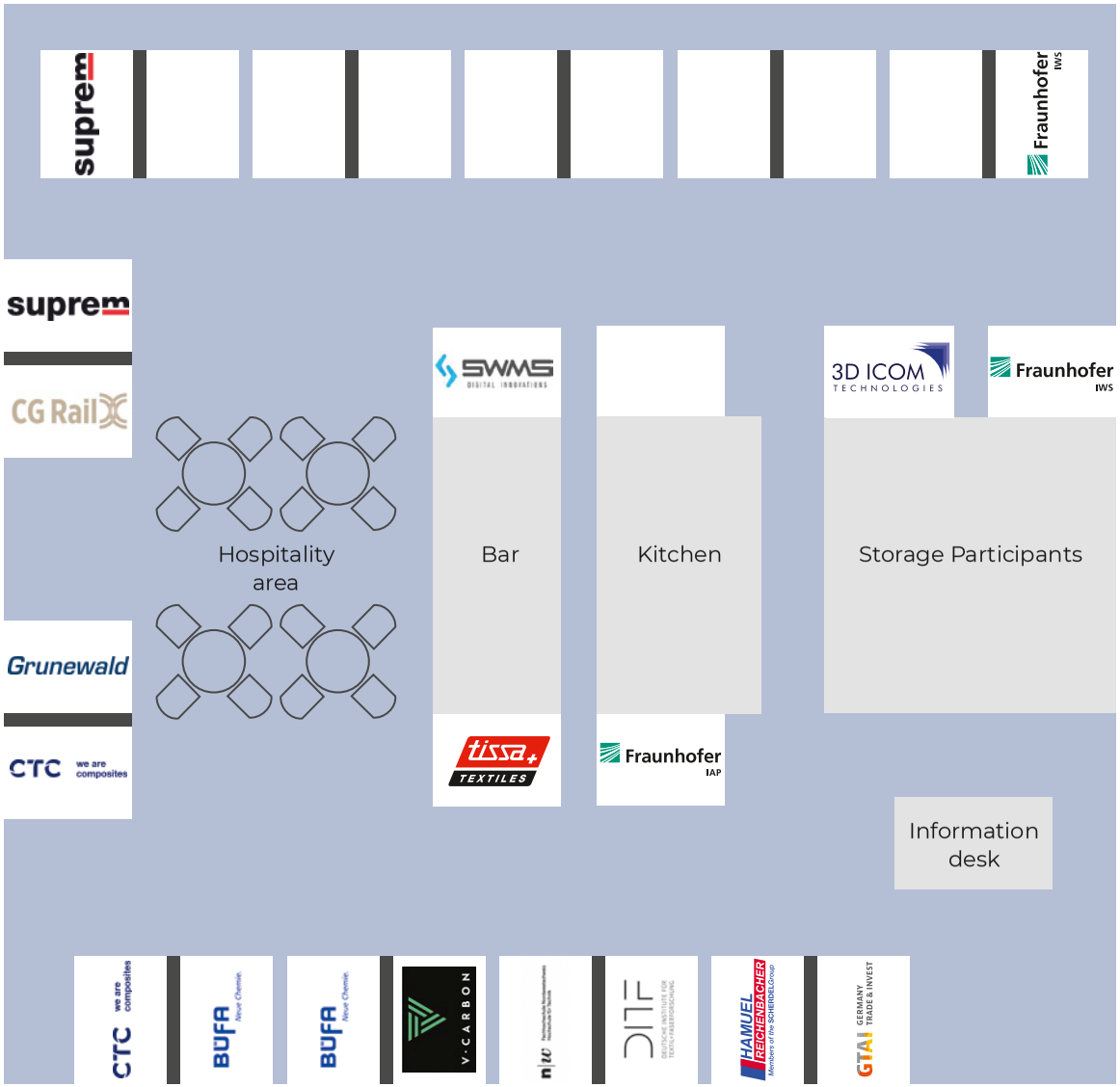

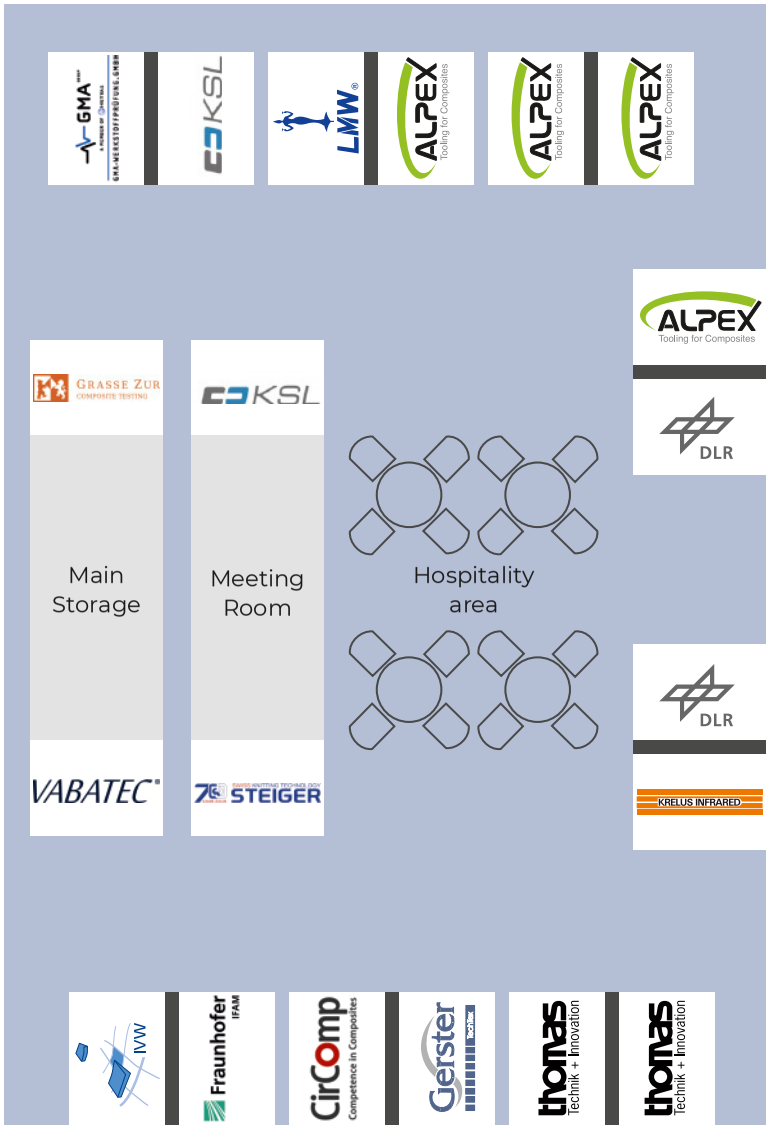


Expert Stage
Workshop rooms
Ask me Anything-Area
Networking Area

NETWORK

Know your costs

CU and 4cost agree on cooperation - advantages for CU members

Via a web portal, members of Composites United e.V. (CU) and other interested parties will soon be able to access a state-of-the-art cost analysis for fiber composite technology via a web tool. This is the result of a workshop of the CU working group „cost estimation“ and 4cost GmbH. The market knows the commercial tool of the Berlin based calculation experts. Fiber composites have always been calculated here – now it is easy to use even for untrained users. CU members will be able to use the tool at special conditions.

Fiber composite materials are impressively light and versatile. They are rather not inexpensive. So, when is their use worthwhile? This question has been on the agenda of the CU Cost Estimation Working Group since its foundation in 2012. The active members of the working group want to provide CU members with a tool with which they can make a reliable cost estimate even in situations where information is still missing. They have now found a competent partner in 4cost GmbH.

New service via web portal

With 4cost's tool every entrepreneur can estimate the expected effort of an application in advance. The result offers a reliable and exact basis for calculation with a deviation of 5–15 percent depending on the planning status.

The approach has been established for many years in industry and engineering and is now being adapted to CFRP. In a two-day workshop in December 2019, experts from CU, 4cost and external companies identified the key challenges using concrete examples. Dr. Arne Ostermann, head of the working group „cost estimation“, thanked all participants for this „great basis for the future service model“.

Joachim Schöffer, managing partner of 4cost, outlined it in concrete terms: „In a portal, an analysis is commissioned via simple entries, experts process and validate each request, the customer receives the validates in very short response times. This is a worldwide unique offer“.

Two strong partners

Ostermann is also convinced: „With the parametric approach of 4cost GmbH, valid results can be achieved very quickly. This applies in early project phases as well as for non-technical users“. Together with him, CU Managing Director Alexander Gundling is very pleased about the opportunity „as an association with around 400 members in all branches of the multi-material lightweight construction industry to help shape this calculation tool, which is new and important for our sector, from the very beginning“.

Now technical adjustments and the connection to the CU website will follow. CU members will then have their own access, which is linked to a bonus. In a first step, the use will be limited to the German market, in the future the internationalization of the offer is planned. ■

With a handshake the two managing directors Alexander Gundling (left) and Joachim Schöffer (right) sealed the future cooperation of their two companies Composites United and 4cost

Cycling made easy

First carbon thermoplastic e-bike Made in Germany - test ride for CU members

The vehicle fleet of the CU regional department CC East in Dresden now includes a Nuvelos. This is the name of the e-bike brand that the polymer specialist Rehau AG + Co launched on the market in July 2019 – with a highly resilient carbon fibre reinforced frame made of thermoplastic material.

It was created as part of the "TherMobility" research project sponsored by the Federal Ministry of Economics and Energy. In addition to Rehau, the Institute for Lightweight Construction and Plastics Technology (ILK) at TU Dresden and Storck Bicycles were also involved. The aim was to develop an integrative fibre composite construction for frame structures as the basis for future electric-based vehicles such as e-bikes, e-scooters, e-motorcycles or e-light vehicles.

The result, which has won several awards including the JEC Innovation Award, combines the outstanding mechanical properties of fiber composite materials with efficient high-volume production technologies such as injection moulding. This in turn allows great freedom of design. In the case of Nuvelos, for example, guide and fixing elements for the battery or motor can be moulded at no extra cost.

Automated production is synonymous with lower personnel expenses and reproducible component quality. As a result, frames for light vehicles could also be produced in large quantities outside Asia, where as of today the majority of all bicycle frames worldwide is manufactured.

With the market launch of Nuvelos in 2011, the project partners have now produced an e-bike body made of 100 percent recyclable composite material for the first time in Germany. CC Ost was able to purchase one of the bikes, initially limited to 200 pieces. After the first test ride, departmental director Dr. Thomas Heber is enthusiastic about the technical innovations: "The wide tyres, an ergonomic seating position and the powerful battery – that's a lot of fun." ■

→CU members can rent the e-bike for a test ride or a bike tour. Registration with:
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Guide to the treasure of knowledge

Digital knowledge management in small and medium-sized enterprises

Always at hand - booklets provide the most important facts in compact form

Knowledge alone does not help in everyday work; it must also be applied in the right place. Digital learning is a good way to convey knowledge, because every company can create its own instructional videos, knowledge maps or virtual scenarios. The CU joint project "Education 4.0 for SMEs – Competitive edge in lightweight construction through digital learning" provides the tools for this.

Many small and medium-sized enterprises (SMEs) would like to digitally systematize their company knowledge – but how? The joint project "Education 4.0 for SMEs – Competitive edge in lightweight construction through digital learning", funded by the German Federal Ministry of Education and Research (BMBF) and the European Social Fund, offers help. Project partners are Composites United e.V. (CU) together with the Anwenderzentrum für Material- und Umweltforschung (AMU) | User Centre for Materials and Environmental Research and the Institute for Software & Systems Engineering (ISSE) at the University of Augsburg, Medical School Hamburg, Eckert Schulen Augsburg and DIPF | Leibniz Institute for Educational Research and Educational Information, Frankfurt/Main.

»Knowledge carriers are all persons in a company, no matter where they work.«

What we know

The experienced colleague retires, superiors become ill surprisingly, the young father takes parental leave – often one's expertise only becomes apparent once it is missing. In such cases company knowledge management can help.

The first step is to identify relevant knowledge carriers. Their expertise can include concrete knowledge about plant parts, machine settings or processes, but also informal knowledge about internal company processes.

How we share

"Knowledge maps" can be a conveniant way of sharing knowledge. They contain relevant topics or tasks as well as links to the persons responsible for them. Such maps should be easily accessible. This basic information can be supplemented by additional content, e.g. with self-made instructional videos on more complex processes. If needed, a representative can watch this video, via smartphone, tablet or with special mixed reality glasses even directly on site.

Note: Knowledge increases by sharing but not by saving. For knowledge transfer to work, all employees must be taken along and their possible concerns must be taken seriously. Sharing knowledge ist time-consuming and is therefore often delayed for the sake of other, more urgent, matters. But at the end of the day, systematic knowledge management enables users to find the right information more quickly and effectively.

How an SME can derive as much benefit from the project as possible is best discussed for each individual case. The project team members are available for this purpose, whether for non-binding preliminary information or to arrange a practical day in the company. ■

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The future starts today

“Ready 4.0 future work“ enthuses ninth-graders for the working world of tomorrow

For two days Crowdworking, Design Thinking and Work 4.0 were on the curriculum of classes 9a and 9b of the Konradin-Realschule in Friedberg, Bavaria. 56 students participated in the first two project days of “Ready 4.0 Future Work”.

In a playful as well as practical way, the youngsters gained an insight into their future working world. They found it particularly “cool” to experience the production of drone components live with mixed reality (MR) glasses.

Their enthusiasm confirmed the two-part concept approach, combining theory and practice, of “Ready 4.0 Future Work”, which is a joint project of Leading Edge Cluster MAI Carbon and the Anwenderzentrum Material- und Umweltforschung (AMU) | Application Center of Augsburg University.

Teaching staff and project managers alike were very satisfied with the kick-off event. “The wow-effect was clearly noticeable”, CU project manager Phillip Scherer was pleased to say. His AMU colleague Irina Ehrlich emphasized that “new forms of work such as crowdworking enable learners to actively and collaboratively shape the course content”.

At schools in Bavaria, the two-day program can be booked free of charge for grades 8 to 11. ■

In the roles of different experts the students built their team workplaces of the future – for the tine being from Lego Serious Play®

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Awarded Theses

Study prizes awarded in 2019 – the baton passes from CCeV to CU

An CCeV Study Award 2019, each worth 1000 euros, received Amon Krichel and Michael Gnädinger respectively for their final theses on improved nonwoven orientation and the consolidation behavior of fiber steering preforms. 2020 is the first year in which the CU awards these prizes for the best bachelor and master theses relevant to lightweight construction.

Immediately following the first general meeting of the newly founded Composites United e.V. (CU), evolved from the merger of Carbon Composites e.V. (CCeV) and CFK Valley Stade, the CCeV study awards for outstanding bachelor and master theses in the field of composites were presented for the sixth and last time in September 2019 in the Filderhalle in Leinfelden-Echterdingen. Dr. Lars Herbeck from Voith Composites led through the awards ceremony.

Spoilt for choice

In 2019, 15 newly-qualified bachelor and master students had submitted their accepted theses on fibre composites or technologies. The theses' innovative content, the interplay of theory and practice, and their relevance to industry were assessed by a jury of five experts. This time, the jury consisted of Prof. Dr.-Ing. André Baeten (Hochschule Augsburg | Augsburg University of Applied Sciences), Günter Deinzer (Audi AG), Dr. Tilo Hauke (SGL Group), Dr. Christoph Irmler (LZS GmbH) and Gregor Peikert (Zürcher Hochschule für Angewandte Wissenschaften | Zurich University of Applied Sciences).

Recycling an old industrial process

The prize for the best bachelor thesis went to Amon Krichel. For his final assignment the 23-year-old industrial engineer from the University of Augsburg did research at the neighbouring Institut für Textiltechnik Augsburg (ITA) | Augsburg Institute of Textile Technology.

There he had used nonwovens made from recycled carbon fibres to investigate the extent to which needle-rod stretching can improve fibre orientation.

For this Krichel used a "very old process from wool production". He was particularly pleased that he was able to contribute to the topic of recycling, which is so important today, on a "machine from 1962".

Study Award 2019: Laudator Dr. Lars Herbeck, award winners Amon Krichel and Michael Gnädinger, organiser Katharina Lechler (from left to right)

For six months he tinkered with his approach for highly oriented nonwovens as an effective replacement for unidirectional tapes made of glass fibres. Highly oriented tapes make better use of the lightweight construction potential of the material and are thus a higher quality recycling product. An industrial partner has already taken up the idea for further development.

Improving an existing process

The CCeV Study Award 2019 for the best master's thesis went to Michael Gnädinger. The 27-year-old studied aerospace at the University of Stuttgart and his work was supervised by the Institut für Flugzeugbau (IFB) | Institute of Aircraft Design. At the Fraunhofer IGCV, he had examined the "Consolidation behaviour of Fiber Steering Preforms manufactured in the thermoplastic Automated Fiber Placement Process".

Gnädinger succeeded in identifying process-related laminate defects. Now that they are detected they can be avoided and thus the process can be optimized. Gnädingers advice on larger web radii and higher placement temperatures can reduce the occurrence of these so-called gaps by up to 50 percent.

After the price is before the price

In keeping with its legal predecessor CCeV and its proven tradition alike, the CU as well wants to promote young talents in the scientific and industrial composites sector in the future. Until 15 April 2020, relevant bachelor and master theses can still be submitted for this purpose.

For the presentation of the then first CU study prize 2020 to the successful applicants, the organisers already secured a place on the very big stage – at LightCon 2020 in Hanover in June (see p. 24), also taking place for the first time. ■

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Study and try out

Practice day for CU trainees at the IVW in Kaiserslautern

For the first time, the successful trainee program will take place in the current academic year 2019/20 under the banner of Composites United e.V. (CU). Organization and implementation, however, remain in good hands. Therefore, the first practical day of this year's trainees in Kaiserslautern went like clockwork.

Immediately after the welcome at the Institut für Verbundwerkstoffe (IVW) | Institute for Composite Materials at the Technical University of Kaiserslautern, the trainees started with "Test Engineering" and "Component Testing". After the lunch break, the trainees learned more about "Non-Destructive Testing Methods" and "Thermoplastic Composites".

The demanding program not only convinced the participants. Matthias Bendler, Managing Director of the hosting CU department CC West, was also very satisfied with the day and was delighted "that we were able to show the hopeful young talents our side of multi-material lightweight construction this year".

Kick-off event of the 14 successful CU Trainees 2019/20 with the CU managers Katharina Lechler (left) and Florian Helber (right)

This is very much in the spirit of the inventor. The student interest in the voluntary qualification program is great, and the users are also enthusiastic about it.

The advantage is also mutual: In two semesters, the trainees gain practical and up-to-date experience in the field of fiber composites and can make their first contacts in the industry. This also applies vice versa to the member companies, who greatly appreciate the early direct contact with committed young professionals.

For all who want to take part: Call for applications for the next trainee program 2020/21 is already underway. Application deadline for one of the 14 places is on 12 July 2020. ■

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With about 100 guests the CU Forum 2019 of the CC Austria at the Red Bull-Ring in the Austrian city of Spielberg was very well attended

Racy Meeting

CC Austria caters CU-Forum at the Red Bull-Ring in Spielberg

With around 100 participants the CU Forum at the Red Bull-Ring in Spielberg, Austria, was very well attended. There Carbon Composites Austria hosted the networking event at the end of 2019.

Overall the forum convinced with a varied lecture program and extensive poster expo as well as with fast-paced side events next to and on the slopes.

The guests from science and business followed the presentations of the top-class speakers with great interest. The topics ranged from automotive, mechanical engineering and medical technology to aerospace.

Exciting accompanying programme

Accompanying the event, an extensive poster exhibition showed innovative research projects and the latest findings of participants. Poster awards were presented for outstanding work for the first time. One each of the 500 euros-awards went to Andrea Anusic ("High performance composite with 100 % bio-based carbon content") and Matthias Drvoderic ("Simulation model for the fatigue behaviour of composite laminates"), both from the University of Leoben, as well as to Florian Silber ("Heating and laying down simulation of UD tapes with an AFP system") from the Upper Austrian University of Applied Sciences (FH OÖ).

The accompanying program at the race track included an exclusive guided tour through the Race Control Center and the pits, including a photo on the podium. A highlight was the opportunity to accompany experienced racing professionals as co-drivers while speeding the race track in a Porsche Cayman S. ■

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Valuable contacts

MAI Carbon receives Korean business delegation

A ten-member delegation of entrepreneurs from South Korea spent full four days of their one-week visit to Germany at the end of 2019 in Southern Germany.

Their host was MAI Carbon, the Bavaria based CU cluster that is also very active internationally. Being part of the international educational cooperation MAI iTeCK, MAI Carbon organized company tours and business talks at several of their loacal partners in Augsburg and the local area for their Korean guests.

The event kicked off at the Augsburg Technology Center (TZA) with an introduction to the MAI Carbon cluster structure and current national and international projects. The extensive program also included the Fraunhofer IGCV, Airbus Helicopters in Donauwörth, ITA Augsburg, Coriolis Composites, Hufschmied Zerspanungssysteme (chipping), Cevotec and Munich Composites, as well as the DLR in Augsburg.

Like the members of the delegation, Sven Blanck of MAI Carbon was very satisfied with the course of the visit: "Creating such opportunities for transnational cooperation is an important service for our domestic partners." he also said. ■

The Korean delegations schedule included a visit of the Fraunhofer IGCV in Augsburg

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The Swiss delegation together with the LIGHTer management at Volvo Trucks in Göteborg, Sweden

Swedish-Swiss solidarity

Successful first business trip from CC Switzerland to Sweden

For the first time CC Switzerland offered its members the opportunity to go on a Trade Mission to Sweden. Co-organiser of the trip from 18 to 22 November 2019 was LIGHTer, Sweden's strategic innovation programme for lightweight technologies. For the entrepreneurs and scientists, exchange and networking were the main focus, especially on lightweight materials and additive manufacturing. All participants rated the trip a success, and a follow-up meeting in Switzerland has already been arranged.

"The trip was a complete success," says a delighted Theo Sandu from CC Switzerland. "The Swiss particularly appreciated the direct exchange with representatives of the Swedish OEMs."

The five-day Trade Mission included visits to the two major Swedish vehicle manufacturers Volvo Trucks and Scania, the aircraft manufacturer SAAB and Ruag Space. The participants also attended the LIGHTer Conference at Chalmers University in Gothenburg. On site, the ten-member delegation from Zurich was accompanied and reinforced by other Swiss entrepreneurs and, on one occasion, by the Swiss ambassador to Sweden, Dr. Christian Schoenenberger.

> »At Volvo Trucks alone, 14 decision-makers were present while our delegation members presented themselves and their products.«
>
> **Theo Sandu, CC Switzerland**

"Very satisfied" with the results, all participants expressed their approval, whether Marcel Schubiger, managing director of Swiss CMT AG, or Dominik Stapf, lecturer at the Department of Fibre Composite Technology at Rapperswil University. Cecilia Ramberg, Managing Director of the LIGHTer Conference, also emphasized: "Combining the Trade Mission with our conference brought additional benefits to all participants". ■

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Transatlantic relations

US delegation visits Composites United and MAI Carbon

Always well protected was the US lightweight delegation during their return visit in Germany, here during the factory tour of Airbus Stade

In December 2019 eleven representatives of US science and industry were guests of Composites United Nord in Stade and of MAI Carbon in Augsburg and Munich. On the US side, well-known companies such as BASF, Johns Manville and DuPont as well as IACMI, MAI Carbon's US partner network, were involved. With their visit the lightweight construction experts from the States were responding to a visit by their German colleagues in October 2019, organized by the German American Chamber of Commerce in Chicago (GACC). ■

Big in Japan

Successful internationalization of Composites United continues

At the end of 2019, CU successfully completed the conception phase of the BMBF funded project "Internationalization of Leading-Edge Clusters, Future Projects and Similar Networks" (InterSpiN+). The implementation phase, in which a total of nine CU members will receive BMBF funding for two technical projects over a period of three years, will start on 1 April 2020.

During the two-year conception phase, Composites United (CU) was able to establish close cooperation with the Japanese partners from the Innovative Composite Center (ICC) in the Ishikawa Prefecture of partner country Japan. Consortia for two technical projects have been set up jointly and German-Japanese teams have been put together. The projects are only made possible by complementing the capabilities of the individual partners. The project topics CFRP recycling as well as thermoplastic profile production are highly relevant and the results will be of interest for the entire CU network.

The ICC is the largest fiber composite center in Japan. Its open and innovative approach makes it the ideal partner for Composites United in Japan. The next joint activities are already being planned: In September 2020 the JEC Forum Japan will be jointly organized for the first time together with the JEC (see p. 24).

"The Japanese market is very interesting for Composites United due to its high level of innovation and know-how, especially with regard to raw materials and manufacturing technologies. CU and its members will continue to benefit from the close cooperation with the ICC in the future after the end of the project," summarizes CU project manager Dr. Bastian Brenken. ■

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Reception of the German delegation around Composites United by Ishikawa Prefecture in Kanazawa in May 2019

Export hit lightweight construction

Composites United and Polish industrial region Katowice-Gliwice Śląskie want to cooperate

City Hall reception by Augsburg's Lord Mayor Dr. Kurt Gribl (ctr. right), on his right Marshal Jakub of Silesia Chełstowski

Jakub Chełstowski, Marshal of the industrially strong Polish Silesian Voivodeship, and Prof. Dr. Hubert Jäger, Chairman of the Board of Composites United (CU), declared their support for Europe as a strong lightweight construction location. In mid-January Chełstowski visited the Augsburg Technology Center (TZA) with a high-ranking delegation from science and industry.

In intensive group and individual discussions and during several plant tours, the Polish guests informed themselves about possibilities for future cooperation. With the CU and its Bavarian top cluster MAI Carbon as hosts, the focus was on multi-material lightweight construction.

On behalf of the Bavarian State Government and in particular the Minister of Economic Affairs Hubert Aiwanger, the Parliamentary Secretary Dr. Fabian Mehring, MdL (FW), personally welcomed the delegation to the TZA. Mehring stressed that "strengthening European cooperation" was "the right step in the right direction", especially today, in order to be able to assert oneself on the global markets of the future and to secure jobs in Europe.

As part of the delegation's visit, key representatives of industry and science from both countries signed declarations on intensive cooperation on the same day in Augsburg City Hall. The first joint projects between the Polish industrial region of Katowice-Gliwice Silesia and the large Central European lightweight construction network Composites United are to follow by the end of the year. ■

Pulling together on industrial policy: Marshal Jakub Chełstowski, Prof. Dr. Hubert Jäger, CU, and Janusz Michatek, President of the Katowice Special Economic Zone (from left to right)

© City of Augburg (above)

We congratulate

Construction expert celebrates „Rounds“

The fact that he celebrated his 80th birthday is really not visible to Prof. Dr. Ralf Cuntze (left). During the last round of management, CU Managing Director Alexander Gundling (right) congratulated the active celebrator. Gundling conveyed “very best wishes from the entire CU” and presented the dedicated construction expert with one of the limited carbon desk sets in recognition of his “tireless and valuable commitment to composites in the construction industry”. ■

Naming it right

Glossary for construction and mechanical engineering

Technical book for beginners and dimensioning engineers. The focus is on highly stressed components made of fiber composites, i.e. (carbon) fibers with polymer and concrete matrix. The comprehensive glossary in German and English contains terms and their definitions including abbreviations and indexing as well as a classification scheme for component-reinforcing fiber-reinforced composites. ■

Cuntze, Ralf: *Technical terms for composite parts. Springer Vieweg, Wiesbaden, 2019. XI, 171 p., e-book ISBN 978-3-658-25635-7, 39.99 €, Softcover (incl. e-book) ISBN 978-3-658-25634-0, 50,00 €.*

Set the course

Further development of the Ceramic Composites network

At the most recent strategy workshop in December 2019, the Board of Directors of the CU Ceramic Composites network discussed the strategic direction of the department in the coming years. In addition to the general further development of the network, it also dealt with technological issues as well as marketing and new markets.

Keywords on the agenda are, for example, maintenance of the BMWi lightweight construction atlas and participation in the DIN standardization committee for CMC. During the general meeting in Bayreuth on 14 May 2020, these points will be discussed with the members of the CU network Ceramic Composites.

A board meeting followed the strategic workshop mentioned at the beginning. It was chaired for the first time by the new network manager of Ceramic Composites, Denny Schüppel.

In his newfound role, Schüppel thanked his predecessor in office, Dr. Henri Cohrt, “on behalf of the Ceramic Composites Board of Directors, the former CCeV office, the long- standing colleagues, friends and companions […] for the great work and the wonderful years.”

Everyone attendant wished the long-serving departmental manager happy retirement. ■

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Head of department of Ceramic Composites with Dr. Henri Cohrt (4th from left), next to him the new head of department Denny Schüppel (4th from right)

Handover

„Network man of the first hour“ retires

Into well-deserved retirement went Johann Peter Scheitle, as did some of his peers at CU. The “network man of the first hour” and long-standing deputy managing director of CCeV handed over the management of CU-Working Committee “Manufacturing Processes and Automation” at the end of January, and thus his last honorary position in the association. The companions present endowed a unique candle arch made of CFRP, wood, slate and integrated electronics, handmade by CC East, as an official farewell with heartfelt thanks and all good wishes. In the picture from left to right: Dr. Hajo Wiemer (Symate GmbH), Dr. Thomas Heber (CC East), Dipl.-Ing. Johann Peter Scheitle as well as the two new WC-leaders Prof. Dr.-Ing. Steffen Ihlenfeldt (Fraunhofer IWU) and Dr. Gregor Graßl (FFT). ■

Who does what

Competence atlas for new approaches

The guide book of the Alliance of Fibre-Based Materials Baden-Württemberg e.V., presents 99 “Morgenmacher”, i.e. innovative companies and individuals, that are today working on the challenges of tomorrow. These can be mastered more easily if they are pondered across industries, interdisciplinary and network-wise. Here the guide book comes in, being designed as a platform for exchange, transfer, inspiration and enthusiasm. ■

AFBW: *Techtex Innovation Guide. Stuttgart, 2019. Free download at www.afbw-kompetenz.eu or at www.afbw.eu*

Farewell and Welcome

Changes in managment positions

Farewell to Dr. Henri Cohrt at the first general meeting of the just newly founded Composites United.

Dr. Henri Cohrt

Dr. Nicole Motsch

There was a change in management at two clusters of CU. That is **Dr. Henri Cohrt**, formerly Ceramic Composites, who retired, and **Dr. Nicoe Motsch**, formerly CC West, resigning the seals of CEO. **Johann Peter Scheitle**, who has been responsible for Carbon Composites (CCeV, founding member of CU) since the founding of the association, has also retired from the network structure.

CU would like to thank all of them for their commitment and the many years of good cooperation. For the future, CU wishes the three comendable experts all the best.

Denny Schüppel

As new CU network and cluster managing directors could be won **Denny Schüppel** for Ceramic Composites and **Matthias Bendler** for CC West, both experienced experts in their fields.

At this place a warm welcome to the two new directors, as well as good luck with the tasks ahead of them. ■

Matthias Bendler

Is something going extremely well in your company? Has an unusual approach proved successful, did someone or something turn out to be extraordinarily helpful?
Tell us all about it – about innovative sales channels, career changers, cooperations with out-of-the-box charm … We look forward to getting to know your best-practice-examples!

*In this first best practice interview, CEO of a medium-sized textile manufacturer, **Gottfried Betz**, reveals how as a partner of the Saxonian Textile Research Institute STFI he reinvents lightweight design.*

Physics meets textiles

futureTEX project auXteX develops new design principle for lightweight construction

The speciality of Strick Zella is high-tech knitting – modern fabrics and textiles combined with additional electrical and physical functions. The managing director is the physicist Dr. Gottfried Betz. Since July 2019 he and his company have been project partners of the Saxonian Textile Research Institute (STFI) in the futureTEX research project.

*Unusual, but **auxetic materials** expand under tensile load. This can lead to structural compaction when force is applied, helpful for example in bulletproof vests.*

What are you doing at futureTEX?

Gottfried Betz: I am the contact person for smart textiles and high-end knitwear. Among other things, I coordinate the auXteX project.

What is this about?

Betz: In auXteX we develop novel designs with improved mechanical property profiles. In view of the growing global mobility, the demand for raw materials and ecological requirements, lightweight construction plays a key role. These novel TechTex structures are then to be launched in the areas of Buildtech, i.e. in building construction, Indutech for industry and electrical engineering, and Sporttech for equipment and clothing.

© STFI/Wolfgang Schmidt (above), Dr. Gottfried Betz (left), STFI/Ines Escherich (right above), STFI/Heike Metschies (right)

Textile factory of the future – one research topic at futureTex

Research project futureTEX
futureTEX is a winner in the "Twenty20 – Partnership for Innovation" program of the German Federal Ministry of Education and Research. Until 2021, scientific institutions, companies and associations are developing a modular future model for traditional industries. The consortium currently comprises over 300 partners, 70 percent of which are from industry. The consortium leader is STFI.

What does your work look like?

Betz: We are exploring the potential of so-called auxetic metamaterials on a textile basis in the fields of construction (Buildtech), timber construction and protective clothing (Sporttech), right through to real demonstrators. Auxetic materials also expand horizontally when stretched vertically. This makes them ideal reinforcing materials in lightweight construction and a guarantee for safety and efficiency.

How so?

Betz: Resonant vibrations of buildings and processing machines can cause considerable damage and even lead to the failure of bridges or wind turbines, for example. By combining auxetic structures and shape memory alloys, intelligent textile composite components are designed to prevent such damage. Auxetic ropes and cords are also ideally suited as anchorages.

Is this research worthwhile for you?

Betz: At first, auxetics was a completely new field for us. However, in cooperation with institutes and industrial partners, we can generate innovations that we could not have tackled in-house. Moreover, product results are exchanged via an open source platform, from which a broad industrial target group can benefit. This in turn creates the basis for competitive advantages that can then be protected by patent. ■

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Lightweight pavillion "Smartie" – elegant symbiosis of textile reinforced concrete and efficient design

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Professional training seminars

→ Thermal engineering for fibre-plastic composites

Contents:

Basics of heat engineering

- Heat transfer (convection, heat conduction, heat radiation)
- Sample calculations and practical part, thermal processes for fibre reinforced plastics.
- Thermoplastics
- Thermosets
- Industrial and infrared ovens
- Furnace types
- Measurement technology and automation

Practical examples

The event will end with a tour of the company IBT.InfraBioTech GmbH.

→ **For:** Engineers, technicians, skilled workers from the plastic and fibre composite sector
→ **Freiberg:** 21 April 2020, 0,5 days, 10 am – 15 pm
→ **Price:** 150 Euro; free for CU members

→ Basic seminar thermoplastic fibre-plastic composites

Content:

- Basics of thermoplastics and thermoplastic semi-finished products (tapes, organic sheets, etc.)
- Comparison of the most important production technologies
- Joining for thermoplastic FKV
- Application examples (thermoforming, pressing, process combinations, induction welding, etc.)

→ **For:** Technically oriented employees from the metal and plastics sector.

→ **Kaiserslautern:** 28 April 2020, 1 day, 9 am – 4 pm
→ **Augsburg:** 29 October 2020, 1 day, 9 am – 4 pm
→ **Price:** 200 Euro; free for CU members

→ Error management in aviation – what administrative companies can learn from it

In error management in the aviation industry, the approach of "Crew Resource Management" (CRM) has been used for years to process errors. The concept of CRM can also be very valuable for commercial enterprises or for public institutions and authorities and can also be used there.

Content:

- Emergence of Crew Resource Management (CRM)
- Goals and methods of CRM
- Transfer of CRM content to various work areas
- Prerequisites and procedure for the transfer

→ **For:** Specialists and expert managers , mechanical engineers, engineers, scientists and technicians in quality assurance.
→ **Augsburg:** 07 May 2020, 0.5 day, 2 – 5 pm
→ **Price:** 200 Euro; 100 Euro for CU members

→ Basics of fibre composite production – quality production, damage prevention, occupational safety

Content:

- Introduction: materials, basics
- Handling of materials
- Procedure: laminating/preforming, autoclave, resin infusion/injection, adhesive bonding/painting
- Treatment of cured components; impact damage and its prevention

→ **For:** Technically oriented employees from the metal, plastics and wood sectors.

→ **Stade:** 14 May 2020, 0.5 days, 2 - 5 pm
→ **Augsburg:** 08 October 2020, 0.5 days, 2 – 5 pm
→ **Price:** 150 Euro; free for CU members

© thodonal/stock.adobe.com

→ Thermal analysis

Overview of thermal testing methods and their application in the field of fibre composites based on examples – from incoming goods to simulation data to quality control of the end products, including materials science background. Practical units at the well-equipped Fraunhofer IGCV laboratories.

Content:
- Differential calorimetry (DSC)
- Dynamic mechanical analysis (DMA)
- Rheology
- Thermogravimetry (TGA)
- Dielectric Analysis (DEA)
- Interlinking different measuring device

→ **For:** Technical staff from industry and research, materials testers, trainees.
→ Can be combined with "Mechanical testing" (see below)
→ **Augsburg:** 20 October 2020, 1 day each, 9 am – 5 pm
→ **Price:** 250 Euro; 150 Euro for CU members

→ Mechanical testing of fibre composite structures and plastics

Material-scientific and mechanical fundamentals (e.g. fracture mechanics), application cases with regard to existing standards and possible modifications including advantages and disadvantage, comparison of different test standards.

Content:
- Bending
- Tensile and compression test
- Shear test
- Compression (e.g. Compression after impact)

→ **For:** Technical staff, materials testers, trainees.
→ Seminar can be combined with "Thermoanalysis" (see above)
→ **Augsburg:** 21 October 2020, 1 day, 9 am – 5 pm
→ **Price:** 250 Euro; f150 Euro for CU members

→ Infiltration technology – theory and practice

General insight into the numerous infusion techniques, then concentration on the VAP® technique and its advantages. Familiarisation with the mode of operation and infiltration setup in theory and practice.

Content:
Theory
- Basic principle and areas of application of VAP® technology; materials used
- infiltration structure; behaviour of flow fronts; quality assurance

Practice
- Practical implementation of the assembly variants by means of flat panels. All participants can build and infiltrate an infiltration setup themselves under guidance.
- The participants can also visit the VAP® series production on site.

→ **For:** Technically oriented employees from the metal and plastics sector.
→ **Landsberg:** 24 November 2020, 1 day, 9 am – 4 pm
→ **Price:** 250 Euro; 100 Euro for CU members

→ Digital knowledge transfer – use of mixed reality and instructional videos in the company

Mixed Reality (MR) and instructional videos can be suitable formats to impart knowledge and demonstrate a new field of activity. The workshop gives an overview of the advantages and possible applications of digital knowledge transfer.

Participants will learn how to digitally prepare technical teaching/learning content without programming knowledge. After a theoretical introduction, a practical part under guidance will be used to independently design, implement and test digital content.

This workshop is an offer of the BMBF- and ESF-funded project "Education 4.0 for SMEs – Competitive edge in lightweight construction through digital learning". It is conducted by the University of Augsburg and Eckert Schulen.

Content:
Theory
- What is mixed reality (MR)?
- Current fields of application
- Software and technical equipment

Practice
- Independent creation of MR sample content with a HoloLens®
- Creation of own instructional video incl. filming and post-processing

→ **For:** Technically oriented employees, skilled workers, trainers, apprentices and trainees.
→ **Please bring along:** Smartphone incl. data cable
→ **Augsburg:** 25 November 2020, 1 day, 10 am – 4 pm
→ **Price:** 150 Euro; free for CU members

Dates 2020

... in between fairs

Fair
03. – 05.03.2020
JEC World Paris 2020

Symposium
06. – 07.03.2020
Rail Lightweight

CC Ceramic Composites
06.03.2020
CU-Theme Day "Reinforcement of ceramic material"

CC Bau/Construction
17.03.2020
Working Committee „Fiber-reinforced concrete"

Composites United
24.03.2020
WC „Application of rCF" and „Sustainability"

CC Schweiz/Switzerland
26.03.2020
General meeting

CC Ost/East
27.03.2020
Cluster meeting

CC Ost/East
31.03.2020
CU-Theme Day „Hands-on Carbon-Fibre-Variety"

Fair
20.04.2020
Hannover Fair

Professional Training
21.04.2020
Thermal technology for fiber-plastic composites

Professional Training
07.05.2020
Error management in aviation – and what administrations can learn from it

MAI Carbon
13.05.2020
Strategy workshop and General Meeting

Professional Training
14.05.2020
Basic knowledge of fibre composite production – quality manufacturing, damage avoidance, Industrial safety

Info
27.05.2020
Conference on Future Production of Hybrid Structures

Info
16.06.2020
Plastics Day 2020

CC Schweiz/Switzerland
23.06.2020
TradeMission Northern Germany 2020

Composites United (CU)
23.06.2020
LightCon 2020

Info
25.06.2020
24. Internat. Lightweight Symposium Dresden

CC Bau/Construction
23.07.2020
Theme Day „Automated Product. in Construction"

CC Bau + CC Ost/East
26.08.2020
Summer BBQ

CC Schweiz/Switzerland
03.09.2020
CU-Forum „Composites in Medtech"

Editorial Deadline
08.09.2020
for CU reports 02/2020

Info
16.09.2020
Institute for Composite Materials / 30th Anniversary International Colloquium

MAI Carbon
08.10.2020
MAI Carbon Projects Forum

Fair
10.11.2020
Composites Europe, Publ. CU reports 02/2020

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JEC Forum Japan

CU takes part in establishing a new conference in Japan in September 2020

Within the framework of the internationalization project InterSpiN+, Composites United was able to establish a very close relationship with the Innovative Composite Center (ICC) in Japan as well as other players from the Japanese Composite Highway Consortium (CHC). Now, together with the world's largest trade fair organizer in the field, the JEC Group, and the Japanese partners, a new annual conference format is to be established in Japan in the form of the JEC Forum Japan, in order to create a permanent exchange platform for CU members with the Japanese market.

The Japanese market is very interesting for Composites United due to its high innovative power and technical maturity. The JEC Group shares this interest and would therefore like to establish a new, permanent format in Japan together with the CU and the Japanese partners from the ICC and the CHC.

The focus of this upcoming event will be on technical presentations in a conference format, but networking and exchange between Japanese and international visitors will also be a priority. Main topics will be sports and medical technology, suitable for the Olympic and Paralympic Games in Tokyo in 2020.

The JEC Forum Japan 2020 will take place in September in Nagoya or Kanazawa. The exact planning is currently underway. As soon as the information has been determined, we will inform the network. ■

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FOCUS

ADDITIVE MANUFACTURING

JEC WORLD
Hall 5
Booth C80

3D-printed Light-weight Structures

Multi-material lightweight structures, efficiently produced by generative hybridization

Researchers at the Institute of Lightweight Structures and Plastics (ILK) at TU Dresden have developed an innovative generative hybridization process for the efficient production of lightweight structures. Together with partners from science and industry, they are investigating its application potential on a practical demonstrator structure.

When producing component, hybrid multi-material structures are the ideal way to achieve a high degree of lightweight construction by combining different materials. The implementation, however, is often made difficult by cost-intensive plant technology and, above all, by high mold tool costs.

In order to realize flexible manufacturing processes even with small quantities while at the same time achieving high resource efficiency, it makes sense to combine the advantages of classical process forms with a generative combination process.

Based on this consideration, at the ILK a robot-assisted hybridization process was developed. In this process, textile-reinforced thermoplastic components are functionalized generatively using fused layer modelling (FLM) without the need for additional molding tools.

With this new process, in addition to simple structures, functional elements as well as reinforcement geometries can be adapted exactly to the contour of the base substrate or component.

Adjustable joining properties

In order to fully exploit the lightweight construction potential with this novel hybridization process and to achieve maximum adhesive strength during composite generation, the interfaces between the individual components must be examined in detail. For this purpose, a process-adapted test strategy and a test specimen geometry were developed. Thus, achievable adhesive tensile strengths can be determined and evaluated during generative hybridization (Fig. 1).

The achievable adhesive tensile strengths can be specifically adjusted by varying the pre-treatment on the base substrate surface in combination with adapted process parameters. This is confirmed by the results of current investigations of generatively hybridized PA6-GF test specimens (Fig. 2).

The results showed that the adhesive tensile strength can be doubled by simply increasing base substrate temperature.

A corresponding plasma pre-treatment of the base substrate surface also has a significant effect on the bonding properties. For example, at the same base substrate temperature, the adhesive tensile strength was increased fourfold with an appropriate plasma configuration.

Generative hybridization in use

Based on the promising results, the ILK is working on the further development of generative hybridization processes for economic and flexible use in complex lightweight construction applications.

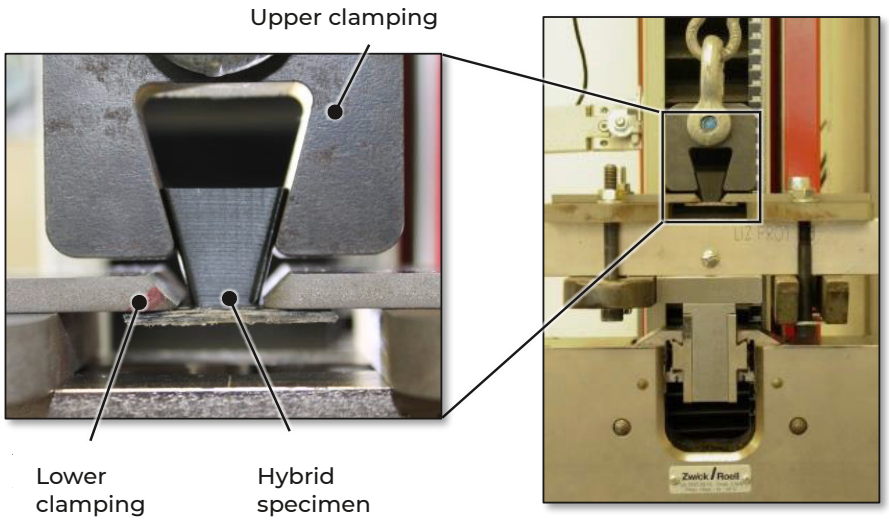

Fig. 1: Identification of adhesive tensile strength – test setup (l.) and close-up of clamping (r.)

Together with other partners from industry and research, the ILK is developing and testing an innovative process and tool technology combining additive and classical manufacturing methods in the current “MM3D” research project. For example, generative hybridization plays a major role in the efficient production of a multi-material structure in the form of a lightweight bicycle saddle. Its seat shell is hybridized with bionically inspired reinforcing elements generatively in the robot based FLM process to the exact contour. ■

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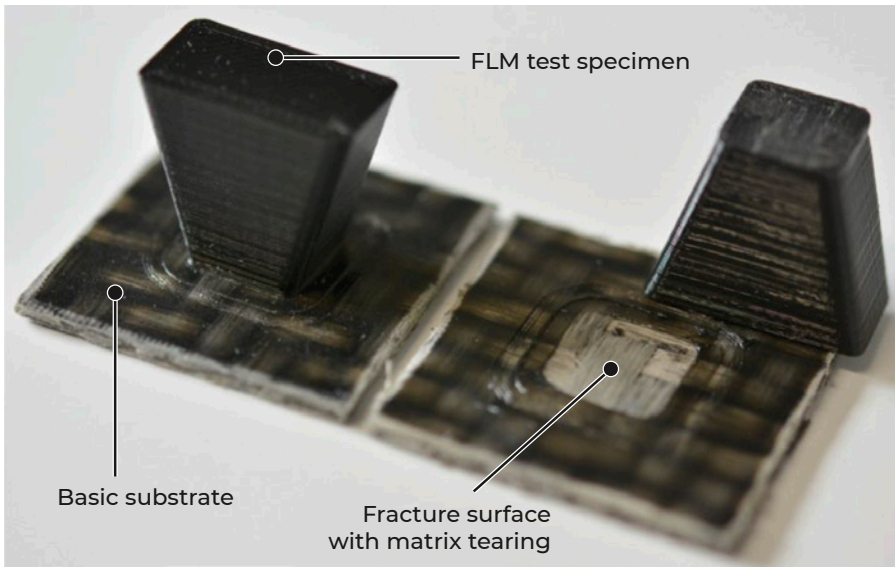

Fig. 2: Hybrid test specimen before (left) and after (right) testing

Complex goes additive

Topology optimization of an additive manufactured engine hood hinge

Fig. 1
Process-optimized developed additive manufacturable bonnet hinge

Efficient 3D printed components: Using the example of an additive-manufactured engine hood hinge, the development service provider EDAG Engineering GmbH presents the advantages of additive manufacturing and the challenge of creating a continuous process chain. All constraints are taken into account, from the definition of the installation space, through topology optimization, to the design process of the component.

A conventional hinge of an active engine hood weighs about 1,500 g and consists of about 20 individual parts, depending on the design. In an earlier collaboration with voestalpine and Simufact, EDAG had developed the additive-manufactured engine hood hinge LightHinge+ (Fig. 1). This has now been rethought. With the aid of topology optimization and process simulation, the result was a weight saving of 50 percent and a reduction in parts of 68 percent compared to the reference design.

Optimized additive process chain

The LightHinge+ improvement was very successful. Nevertheless, the interpretation of the topology results in the CAE environment and the data transfer to the CAD world remained time-consuming. In conventional topology optimization, labor-intensive processes are carried out using various tools to convert the CAE result into a production-ready result.

In order to fundamentally optimize this process, EDAG investigated several programs for topology optimization. First, local stiffnesses are analyzed on a simple support. Four tools are

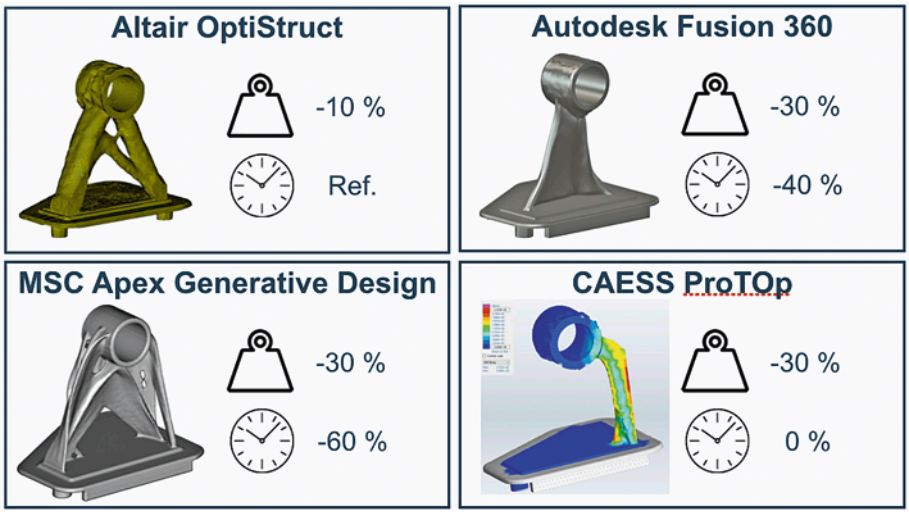

Fig. 2
Comparison of different applications for topology optimization

compared regarding the factors weight reduction and minimization of development time (Fig. 2). With regard to development time, the established optimization tool OptiStruct serves as a reference.

The results for MSC Apex Generative Design and Fusion 360 show a better surface quality than the OptiStruct and ProTOp results. Therefore, no or only minimal CAD revision of the data for the following 3D printing process is necessary. Especially MSC Apex Generative Design has a high potential to save development time and is therefore used for a further optimization of the LightHinge+ hood hinge.

Transfer to a topology optimized design

In MSC Apex Generative Design the developer only needs to specify the boundary conditions and the design goal. The boundary conditions for topology optimization are assumed to be the frontal and lateral overpressing of the hood as well as the yield strength of the used stainless steel 316L.

Based on the possible installation space of the hinge, the software delivers the new, additive design within a few hours. The program suggests a weight-optimized design that saves 69 percent compared to the reference hinge and 19 percent compared to the LightHinge+. In addition, the stress is optimally distributed and the yield strength of 316L is not exceeded.

Last but not least, the design time of the additively manufactured hinge is 60 percent shorter, as the geometry does not have to be reworked by hand and the design effort is significantly reduced. Thus, MSC Apex Generative Design delivers a geometry of the component with minimized material usage, which is perfectly adapted to the loads due to its organic shape (Fig. 3). ■

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Fig. 3
Design comparison of the different hinge solutions

Integral structures

Additive Manufacturing, enabler for tailored helicopter architectures bases on fibre-reinforced composites

Additive manufacturing processes in combination with fibre composite technologies enable three-dimensional, load-dependant fibre alignment even in complex components. Due to a high degree of integration in component manufacture, they create the prerequisite for maximum utilization of the lightweight construction potential of fiber composites. The HYBSH project shows how additive manufacturing enables integral construction methods for helicopter structures.

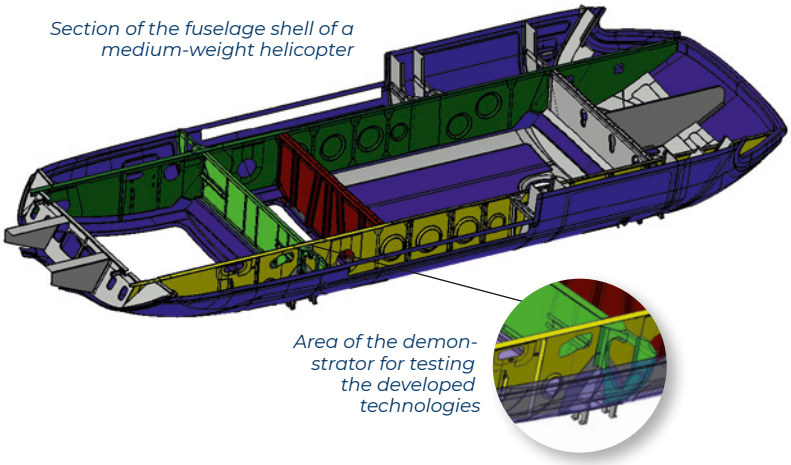
Conventional helicopter structures are usually manufactured and riveted in differential construction using established impregnation or prepreg techniques. Relevant cost factors are the assembly as well as the weight-related increased operating costs. The partners in the HYBSH aviation research project aim to produce competitive, lightweight and cost-efficient helicopter cells with fibre-reinforced plastic composites. This is why they are focusing on the further development of new types of helicopter architecture.

This will be achieved by means of optimized design and layout approaches and in conjunction with new material and process developments. Taking into account design aspects for use in helicopters, fibre composite technologies and additive processes are combined. This makes use of the advantages of both manufacturing strategies and enables additive manufactured functional and structural elements in a thermoset helicopter structure.

The underlying project is funded by the German Federal Ministry of Economic Affairs and Energy under the funding code 20W1715C.
The responsibility for the content of this publication remains to the author.

Design and optimization

At the Institute for Aircraft Construction (IFB), the design of load path optimized fiber composite components with additively manufactured elements is being advanced. In order to realize a structural use of additive polymer components, the optimization of additive structures is an important research focus in addition to the development of a suitable structural simulation. This is based on the results of the partners involved in the joining process development for fibre-reinforced thermoset-thermoplastic components.



Section of the fuselage shell of a medium-weight helicopter

Area of the demonstrator for testing the developed technologies

Forming and printing

Neue Materialien Bayreuth (NMB) GmbH evaluates different possibilities to provide additively manufactured elements with a fibre reinforcement. Strategies for forming flat, additive-manufactured structures are being developed.

In order to be able to implement flexurally rigid elements, the fibre-reinforced elements are also combined with topologically optimised cellular core structures. The direct printing of holding and connecting elements simultaneously achieves a high degree of integration during production.

Joining for thermoplastics and thermosets

A section of the fuselage shell of a medium-weight helicopter serves as a demonstrator for testing the technologies developed. Within the project, the project coordinator Airbus Helicopters is responsible for defining the boundary conditions and the design issues.

Furthermore, possible material combinations conforming to aviation standards are investigated and new joining technologies for thermoplastic-thermoset applications are developed. The focus is on the possibilities for 3D fibre reinforcement of additive components. ■

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A minimum of ten years

Fiber-reinforced 3D printing for the realization of durable automotive applications

New materials, processes and aftertreatment methods are being developed in the SYMPA project for the permanent use of stereo lithographically produced components in automotive applications. SYMPA is part of the BMBF funding program "From Material to Innovation".

The underlying project is funded by the German Federal Ministry of Education and Research under the funding code 03XP0164 (SYMPA) and takes place within the research campus ARENA2036.

The UV-based curing of plastics in the stereolithography process (SLA) offers the possibility to economically manufacture individual and complex components. Nevertheless, there has been a lack of long-term applications so far. The main reasons for this are the low mechanical properties of current materials, their low UV stability and insufficient knowledge about the mechanical, thermal and optical long-term resistance.

To overcome these circumstances, material specialists, machine manufacturers, research institutes and application partners are working along the entire value chain of SLA technology on new solutions within the German-Austrian SYMPA consortium.

Increased stiffness

At the Institute of Aircraft Design (IFB) at the University of Stuttgart, research is being conducted on the reinforcement of photopolymers with carbon and glass fibers. Already in first basic studies the modulus of elasticity could be doubled by adding milled short fibers. A particular challenge in the manufacturing process is the integration of the carbon fibers, which are impermeable to UV light so that the light penetrates only slightly into the depth.

In addition, in lightweight construction, the orientation in accordance with the load path is of particular importance when introducing the fibers. Besides other options, the magnetic orientation of nickel-coated carbon fibers is also being investigated. An open machine concept of Rapid Shape GmbH allows for quick modifications, so that new manufacturing strategies have already been successfully integrated. The technologies developed are applied and tested on topology-optimized lightweight structures at cirp GmbH.

Protective layer against environmental influences

Currently, the design of SLA components is difficult due to the varying mechanical properties during the service life. In preliminary studies, the IFB proved that pure UV exposure leads to further and further cross-linking and thus embrittlement of the plastics. In addition, hygric and thermal loads are the main reasons for early material failure.

Therefore, Henkel AG & Co. KGaA is now developing novel high-performance photopolymers with improved mechanical and thermal durability and is investigating their behavior in combination with reinforcing fibers. In addition, Joanneum Research Forschungsgesellschaft mbH and INOCON Technologie GmbH are conducting research into novel plasma jet processes for the application of metallic coatings for protection and functionalization. The aim of the project is to achieve constant material properties over a period of ten years. ■

Additive production of topology-optimized wheel carriers for the InVentus headwind vehicle at the Institute of Aircraft Design

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Additive manufacturing, efficient post-processing

Reducing process times with material-optimized cutting tools

Best possible matching of geometry, carbide and coating to steels up to 72 HRC

With the right finishing, the surface quality of additively manufactured workpieces can usually be improved quickly, cost-effectively and reliably. A prerequisite for excellent quality is that the cutting tools are optimally adapted to the material.

Whether it is the removal of support structures or the finishing of excessively rough surfaces, in additive manufacturing processes, the finishing of the workpieces is an almost unavoidable step. Often a considerable amount of time is required to obtain a sufficient surface quality of the workpieces. Hufschmied Zerspanungssysteme GmbH proves that there is another way: The machining expert from Bobingen near Augsburg knows exactly the potential that material- and machine-specific tools offer in the finishing of 3D printed structures.

The right tool for every material

Process times and costs can sometimes be considerably reduced by optimizing the machining post-processing. However, because every material used in additive manufacturing - from plastics and aluminum to titanium and hard steels – is to be machined differently, the tool must be chosen carefully. As a machining expert, Hufschmied has an extensive portfolio of tools for deburring and finishing. These options often serve merely as starting points for customer-specific solutions that allow even longer tool life and shorter process times.

At the K 2019 plastics trade fair, the machining expert impressively demonstrated how efficiently and at the same time gently workpieces can be reworked with tools from Hufschmied. Numerous interested visitors followed the live demonstrations at the Biesse and Krauss-Maffei stands, where tools from Hufschmied were used. A main attraction at the company's own stand was the prototype of an innovative fiberglass-based automotive leaf spring, which was machined with virtually no post-processing using milling tools from the HEXA CUT® Eco line. ■

JEC WORLD
Hall 6
Booth R52

With the HEXA CUT® Eco product line circular milled hole in the reworked glass fiber based automotive leaf spring

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Bringing experience on board

Quality assurance concept for additive manufacturing

Additive manufacturing represents currently a challenge for quality management. Influencing factors are numerous and manufacturers must always consider the complete process. They have to develop quality management concepts based on the special features of the processes, such as characterization of the raw materials, process control and component testing. Lack of quality control during the manufacturing process can otherwise quickly lead to high costs.

Tested to the smallest detail - elementary analysis at GMA

Many companies that used to manufacture conventionally have observed the new possibilities of additive manufacturing with interest. These companies recognise that the processes also open up undreamt possibilities for them in series production.

Especially for complex machining components, additive manufacturing promises less effort and thus reduced costs. However, it also requires new testing concepts for in-process quality assurance and for component testing. Thus, the promising revolutionary processes represent a challenge for all players involved.

For the conventional manufacturing process, the way to the approval of a component was clear. First, the stock material was procured, such as an AISI 304. An acceptance test certificate proved the basic material properties according to the respective material standard. Due to the operational purpose of the component, further certification, applying destructive or non-destructive test methods, were performed.

Know your limits – tensile strength testing at GMA

Supplementary QM chain necessary

For additive manufacturing, the primary manufacturing process is transferred from the "rolling mill to your own company". This challenges companies with the problem of setting the basic properties of the material themselves and establishing a supplementary quality management chain in-house.

In this process, established testing companies can provide support in identifying and integrating the numerous quality-relevant tests: from tensile tests to chemical analysis of undesirable impurities introduced by printing. In this way, aberrations can be avoided and the production process maintains what it promises: cheaper, faster, better.

Experienced testing specialists help

GMA-Werkstoffprüfung GmbH has already been active in the field of accompanying tests in the aviation industry for four years. The know-how gained in this field can be easily transferred to the automotive and industrial sectors. The testing portfolio consists, for example, of powder analyses, microstructure examinations and mechanical-technological tests. ■

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Data in the Cloud

Cross-process chain quality assurance with the AI system Detact

The additive manufacturing of components is a growth market with great potential. Systematic quality management can help to tap this potential by reducing expensive downstream testing. The quality process chains required for this are being researched in the BMBF research project "AGENT 3D_QualiPro".

For an economical additive production, all influencing variables on the component properties along the process chain must first be recorded during the transition from sample to series production. However, the possibilities for process monitoring, especially in the automotive, medical technology, aviation and turbomachinery sectors, do not yet meet the requirements. The existing methods for quality assurance do not cover the complete process chain and are often simply too expensive.

Systematic quality management can reduce these inspection costs by reducing the scope of testing with expensive measurement technology that is downstream of the production process. Thus, series production with additive technologies can offer economic advantages.

Virtual overview

The basis for consistent component characteristics is the automated acquisition and processing of production data during additive laser beam melting. To this end, Symate GmbH and the Fraunhofer Institute for Machine Tools and Forming Technology IWU, among others, are cooperating in that a central software system is responsible for recording all relevant data from the manufacturing process. This data is transferred to a special cloud and processed there fully automatically.

For this purpose, Symate has developed various software functions and algorithms for process modelling as well as interfaces for data acquisition and specific GUIs for data analysis and visualization. These are part of the extensive app-based AI system Detact®.

Data-driven quality assurance

Within the project "AGENT 3D_QualiPro" the researchers developed an approach that supports a successful certification of the additive manufacturing process chain. Primarily, the data is collected during laser beam melting and correlated with the achieved component quality. From these data, automated measures in the process chain are to be derived, which contribute to cost reduction of the additive serial production.

Dipl.-Ing. Martin Jaretzki, who leads the AGENT 3D_QualiPro project at Fraunhofer IWU, is convinced of the high potential of data-driven quality assurance: "In particular, the monitoring of the local melting baths during laser beam melting and the dynamic adaptation of the introduced energy can prevent expensive rejections. The current focus is on the detection of pores smaller than 50 µm in the process. The Detact software system makes an important contribution here, as it analyses the data extremely quickly and reliably. Management in the cloud enables manufacturers to react quickly to problems. With the increased reliability, the hurdle of using the technology for small series is lowered. This secures jobs in Germany and reduces CO_2 emissions." ■

Quality and data management with Detact supports economic series production with additive technologies

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Experience 3D practice

South German trade fair for industrial additive manufacturing

© Exhibition Augsburg/Marco Kleebauer

With the Experience Additive Manufacturing (EAM) trade fair, the Messe Augsburg will be presenting user-oriented trends in industrial 3D printing for the third time from 22 to 24 September 2020. The multi-location event has been developed for interested companies looking for an uncomplicated introduction to industrial additive manufacturing and networking with customers with real buying interest.

As a trade fair with an event character, EAM distinguishes itself by its pronounced user orientation. The event concept is unique because it presents the entire value chain of additive manufacturing in the form of a thematic course, divided into the three main areas of pre-, in-process and post-process.

Broad range

The interactive presentation covers all process steps, from the idea to 3D scanning, product development, materials and equipment, surface finishing and disposal. Outside the exhibition hall, interested parties have the opportunity to take part in company tours to take a look behind the scenes of production. 3D printing and fiber composite technologies have several points of contact. For the fiber composite industry, the market for industrial additive manufacturing offers good prospects. After all, new materials and substances remain a decisive driver for the future establishment of additive manufacturing.

Extras for CU members

To promote the exchange between stakeholders from both areas, Composites United e.V. (CU) supports the event as a specialist partner for the third year in succession. CU network members enjoy special participation conditions and a supervised program. ■

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Interdisciplinary Co-Working

New research building covers the entire process chain in additive manufacturing

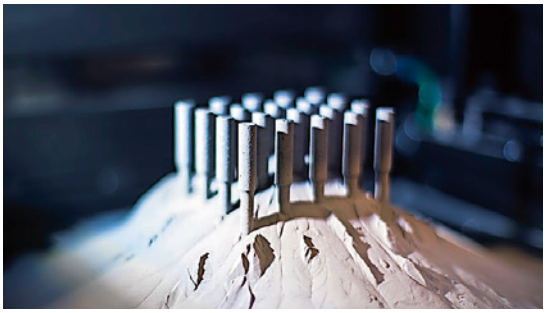
The University of Paderborn pursues an interdisciplinary research approach and at the same time bundles competences. In the new building "Y", adapted alloys, powder production, processing and the mechanical reworking of additively produced components can now be researched under one roof.

The University of Paderborn has further expanded the premises and plant engineering in the research area of additive manufacturing processes. In September 2019, the new building of the Institute for Lightweight Structures with Hybrid Systems (ILH) was officially opened with technical presentations and exhibitions.

The newly created floor space of 5,730 m² accommodates a technical centre, offices and labs, where research is conducted in the field of additive manufacturing processes, among other things. This also expands the expertise in this field that has been built up at the Paderborn Institute for Additive Manufacturing Processes, or PIAF for short, for more than ten years.

New building, double benefit

Both institutes require a wide range of expertise in the fields of materials, surfaces and production technologies for the research and development of additive manufacturing systems. The new research building now houses several chairs and departments such as materials science, production and joining technology, automotive lightweight design, chemistry and physics. This paves the way for further strengthening of interdisciplinary cooperation.



Cylindrical test specimens manufactured with L-PBF near net shape

At Paderborn University a total of about 50 scientists are working on the further development and research of additive manufacturing technologies. In the field of plastics processing, fused deposition modelling and selective laser sintering research is conducted on eight industrial systems by EOS, BigRep and Arburg, among others. With the new research building, the area of metal processing systems has been expanded from four systems to eight industrial machines. One of the cooperation partners in this area is the company DMG MORI. Technologies used are powder bed based laser melting (L-PBF) and direct laser deposition (DLD).

In addition to the development of process parameters for manufacturing technologies, the focus is on alloy development and powder production. The process chain up to the finished component is completed by machining on high-performance machining centres. The infrastructure created here enables rapid process development and efficient project handling. ■

Hands on in the machinery hall of the new Y-building

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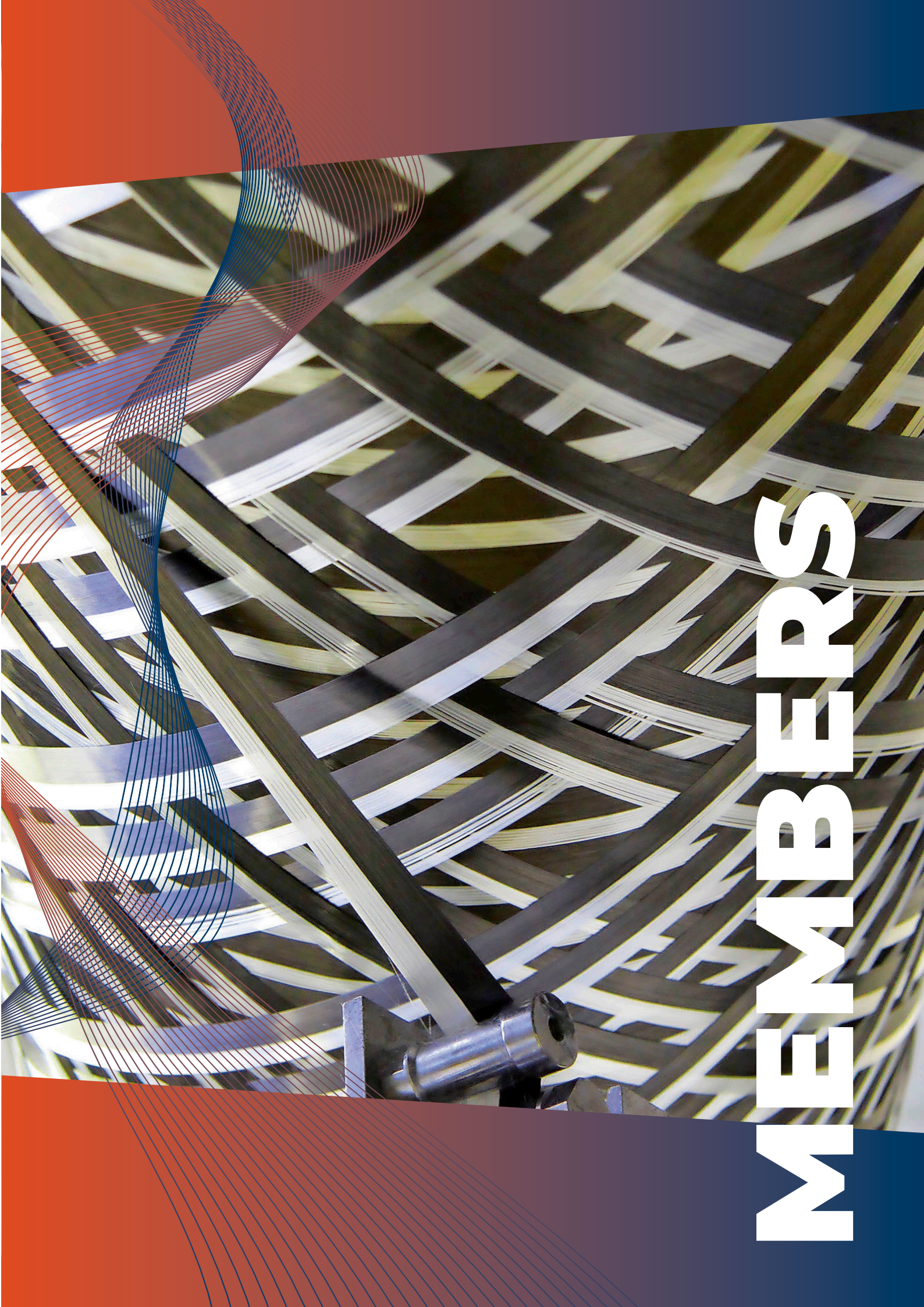

MEMBERS

Cool machining

Influence of the cooling lubricant system when milling Ceramic Matrix Composites

The COOLCMC research project at the Augsburg University of Applied Sciences investigates different cooling lubricant strategies for specific quality and process parameters in the machining of Ceramic Matrix Composites (CMCs). The results indicate that cooling lubricants have a positive influence on the machining process and the component quality.

High strength at high temperatures and simultaneous damage-tolerant fracture behaviour make CMCs attractive for many new applications, especially in aircraft gas turbines and high-performance brakes. Very high material costs require economical and efficient machining. Although many studies have been conducted on metallic materials, little is known about the influence of cooling lubricants (CL) on the mechanical processing of CMCs.

Cooling or lubricating

Ceramic materials are difficult to machine. Their anisotropic properties together with high hardness and comparatively low thermal conductivity lead to high tool temperatures, which results in premature tool wear.In principle, pure lubricants reduce the friction effects in the contact zone, while coolants dissipate the generated process heat. The coolant also removes chips and particles. Further there is a large number of multi-component mixtures, the so-called cooling lubricants (CL). They aim to combine cooling and lubricating effect in one system.

In the COOLCMC research project, two different cutting fluids were investigated: a water-miscible cooling lubricant emulsion (good cooling and flushing effect) and a non-water-miscible cutting oil (good lubricating effect). Water was used as the cooling component. The emulsion was supplied by means of a flood cooling system, the cutting oil by means of a minimum quantity lubrication system (MQL) (Fig. 1). Dry machining was chosen as the third case study.

Cooling makes the difference

A polycrystalline diamond milling cutter with geometrically defined cutting edges from the company Hufschmied Zerspanungssysteme, specially developed for CMCs, was used as the milling tool.

The results show that the use of cutting oil during the machining of the three tested materials (C/C-SiC, SiC/SiC, Al2O3/Al2O3) has no significant influence compared to dry machining. The use of cooling lubricants, on the other hand, is recommendable, as they can improve the cutting forces (Fig. 2) and the surface roughness by up to 20 percent.

How much coolant residue remains in the workpiece after machining depends on both the microstructure of the material (open porosity) and the type of cooling lubricant. This is shown by additional thermogravimetric analyses (TGA). CMCs with higher porosity have more cutting fluid residues. For oily cutting fluid, residues of 1 – 8 weight percent were measured. For aqueous coolant, on the other hand, residues generally remain below 1 weight percent (Fig. 3). In both media the coolant is completely evaporated from 300 °C.

The work was supported by the CU network Ceramic Composites within the scope of the preliminary research.

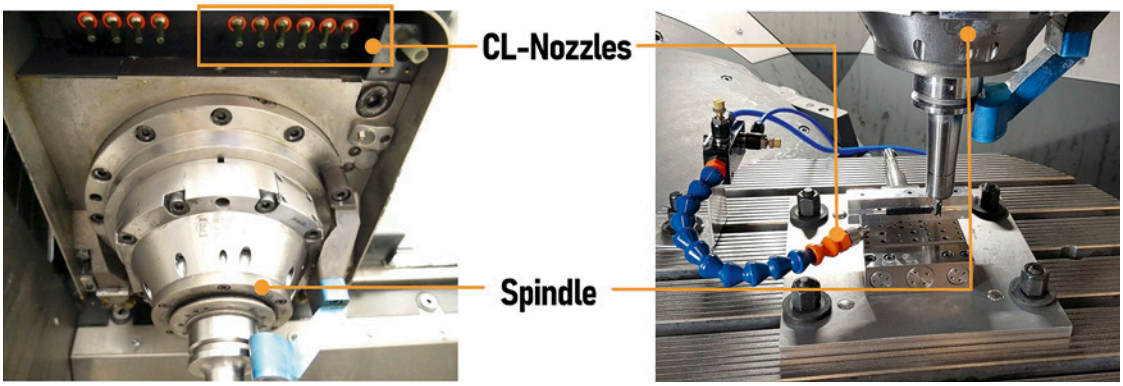

Fig. 1: Flood cooling system (left) and MQL (right) with experimental setup for measuring the cutting force during linear milling

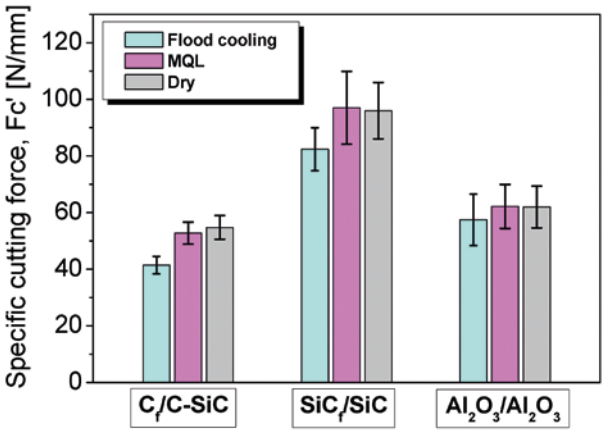

Fig. 2: Specific cutting force of different CMCs for aqueous CL, oily MQL and dry machining

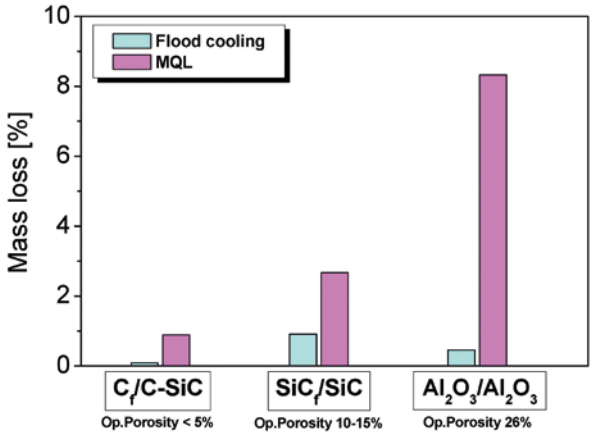

Fig. 3: Mass loss (coolant residue) of different CMCs for aqueous CL and oily MQL

Further steps

The results indicate that the use of cooling lubricant for machining CMCs with geometrically defined cutting edges has a significant positive influence on the machining process and the component quality. Their effect on other quality and process parameters, such as tool life and imperfections occurring on the component, should be experimentally investigated in future work. ■

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COMPOSITES UNITED

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Metamorphoses

C/C-SiC composite ceramics made of modified hybrid yarns with short fibres

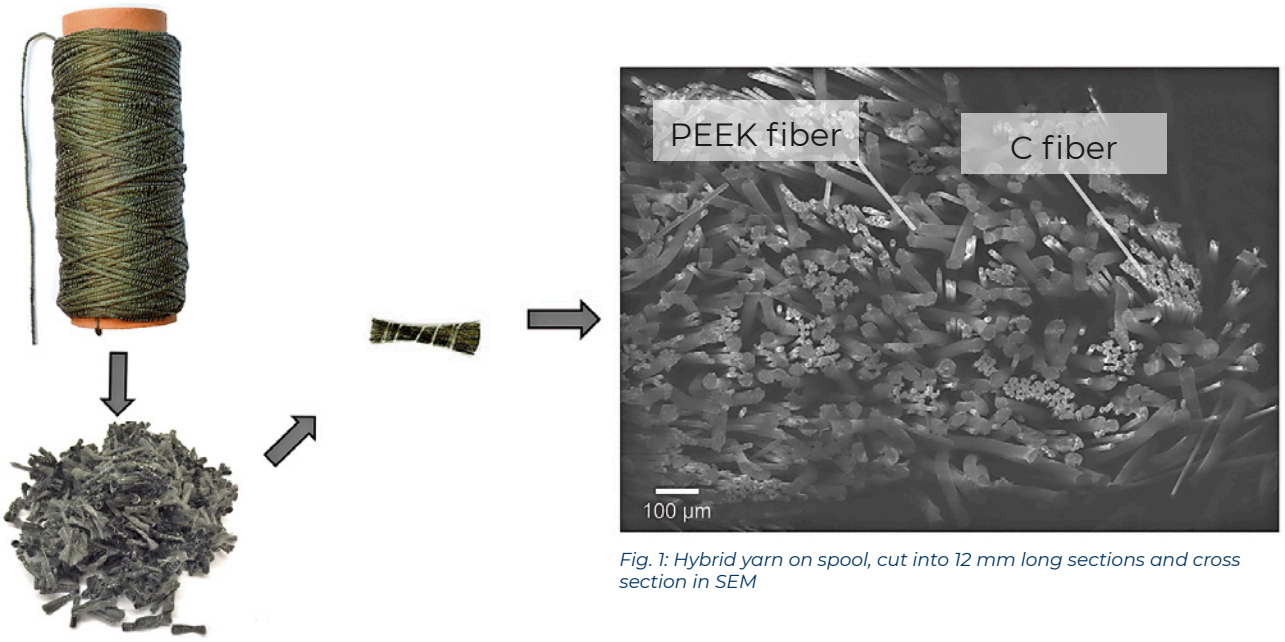

Fig. 1: Hybrid yarn on spool, cut into 12 mm long sections and cross section in SEM

A special hybrid yarn for the production of C/C-SiC composite ceramics opens the door to new applications of recycled C-fibers (rCF). The promising material was developed and tested in a joint research project at the Institute of Ceramic Materials at the University of Bayreuth and the German Institutes for Textile and Fiber Research (DITF) Denkendorf.

In C/C-SiC composite ceramics, fracture toughness and strain to failure are significantly increased by reinforcement with fibers. Applications such as ceramic brake discs would otherwise not be feasible.

The production of these composite ceramics begins with the manufacture of the CFRP. The thicker the utilized fibre bundles are, the more difficult it is to infiltrate them with a polymer matrix, as the infiltration paths become longer. This is especially true if non-prepregable short fiber bundles are available as the starting product. This applies, for example, to the rCf short fiber sections gained from the CFRP recycling process.

Placeholders and pioneers

To overcome this disadvantage, a special hybrid yarn was developed at the DITF Denkendorf using a carding and spinning process. In addition to C-fiber bundles (50 % by volume, approx. 80 millimeters long), the yarn contains PEEK staple fibers (approx. 60 millimeters long) as a polymer matrix (Fig.. 1).

After pyrolysis (> 900 °C, inert), the latter leave behind > 50 % by weight of amorphous carbon. Polymers such as PP or PA are unsuitable, as they decompose without residue during pyrolysis. But carbon is needed as reaction partner with silicon so that SiC can be formed in the later siliconization.

In order to test the general use of hybrid yarns for the production of C/C-SiC, the yarns were divided into 12-millimeter-long short fiber bundle sections in accordance with existing process routes.

At the University of Bayreuth scientist succeeded in manufacturing several showcase CFRP sheets (150x150x3 mm³) and a disc-shaped demonstrator (diameter = 130 mm, thickness = 2 mm) from this in a hot-pressing process (Fig. 2).

The research work was kindly co-financed by the CCeV/CU.

Successful practical test

In the subsequent pyrolysis, the bond between fibers and matrix was maintained, which is necessary to protect the C-fibers in the final liquid siliconization (> 1420 °C, vacuum). Infiltration with Si showed that the desired open

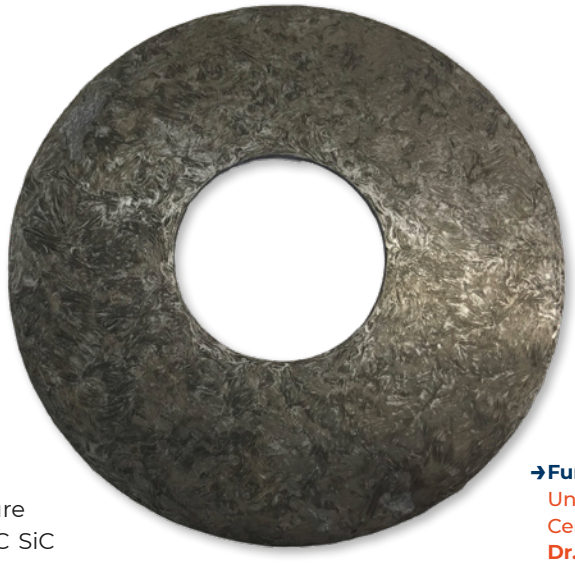

Fig. 2: DC/C-SiC-Demonstrator (Øa = 130 mm Øi = 50 mm in CFRP condition)

percolating pore network existed in the newly developed C/C material, as the entire sample volume could be infiltrated with liquid silicon. The measured values for density and porosity, flexural strength around 100 MPa and microstructure show the competitiveness to the C/C SiC reference material.

In this study it was possible for the first time to successfully use hybrid yarn as a starting raw material for C/C-SiC. This opens up a great potential to convert rCF in hybrid yarns into high-quality structural materials. ■

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Short fibers 12 mm C/C-SiC	Bulk density DIN 1389 in g/cm³	Open porosity DIN 1389 in %	3-Pt-bending strength DIN 658-3, n = 10 in MPa	Strain to failure DIN 658-3, n = 10 in %
C/C-SiC-Hybrid	1.96	4.1	97 ± 15	0.39
C/C-SiC Ref.*	1.84	4.6	111 ± 22	0.53

* DOI: 10.1002/ade,-201800835

Density, porosity and flexural strength of C/C-SiC, produced using the C/PEEK hybrid yarn

CU reports 02/2020

■ **The next CU reports**
will be published in due time for the Composites Europe in Stuttgart from 10th to 12th November 2020.

Editorial deadline: Tuesday, **8th September 2020.**
We will remind our members about this date in advance by e-mail and newsletter.

Furthermore,
we invite our CU members to send announcements and reports from their company or institution at any time. We will be happy to publish them on our CU website www.composites-united.com.

Tailor-made porosity

Fiber-reinforced oxide ceramics in the injection molding process

In the preliminary project "Development of an adapted feedstock for injection molding of CMC", research is being conducted, among other things, for the transfer of the injection molding process (CIM, Ceramic Injection Molding) – already established for the production of monolithic oxide ceramics – to fiber-reinforced oxide ceramics (OCMC).

Fibre-reinforced oxide ceramics (OCMC) have a very high potential as a lightweight material for future applications, especially in complex load collectives with high thermal, mechanical and corrosive loads, e.g. as turbine components, burner nozzles of furnace plants and in the aerospace industry. The increase of the fracture toughness as well as the damage and load tolerance in comparison to the non-fibre-reinforced material is of outstanding importance.

At present this material has been accessible only to products in the high-price segment (aerospace, etc.) through manual manufacture.

Injection molding of OCMC

By modifying and developing large-scale production technologies, a reproducible and cost-efficient production can be realised. In addition, this extends the application areas for OCMC.

This approach is also pursued in the ZIM-network OxiCer, which is coordinated by the endowed chair "Textile Plastic Composites and Hybrid Compounds" at Chemnitz University of Technology. More than 20 partners from industry and research institutions work together in this network.

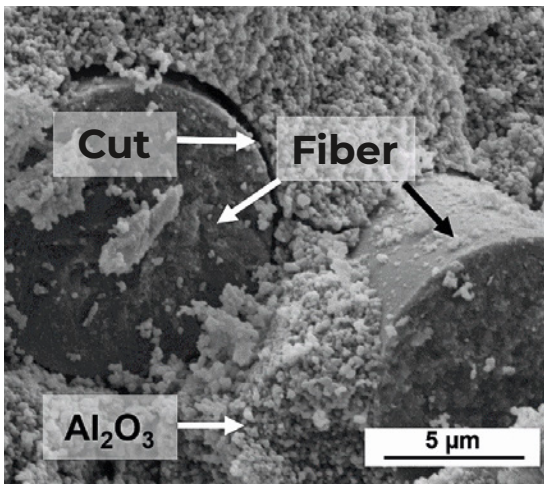
In order to be able to realise mass production, the injection moulding process (CIM-Ceramic Injection Moulding) established in the production of monolithic oxide ceramics should be transferred to the production of fibre-reinforced oxide ceramics. This process is characterised by its excellent automation and enables the production of components with complex geometries in large quantities.

Pore size alumina	Pore size alumina using CBA (Chemical Blowing Agents)	Pore size alumina using cellulose
1–2 µm	10–150 µm	10–30 µm

Pore size of alumina test specimens produced by the CIM process with and without the addition of pore formers

The high injection pressures usual for the CIM process and the resulting densification of the ceramic matrix represent a challenge. The components produced in this way are characterised by an almost pore-free structure and the resulting high strength. This positive property profile for monolithic ceramics has a negative effect on the desired performance of OCMC.

A damage-tolerant behaviour can be achieved by the specific adjustment of the matrix porosity in addition to the development of a weak fibre/matrix adhesion (see figure).



REM image (SE) of an OCMC fracture surface. Energy dissipating mechanismsat the fibre/matrix interface determine the damage-tolerant behaviour

Investigation

In a recent research project, funded by CU network Ceramic Composites, the influence of different pore formers on the matrix porosity was investigated. By adding cellulose with a suitable particle size, matrix porosities in the required pore size range could be achieved (see table above). The results of the proof-of-concept study were convincing for the continuation of the technology development. ■

The research work was kindly co-financed by the CCeV/CU.

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Understanding the sound

Simulation-supported sound resonance analysis of complex geometries

At the Department of Ceramic Materials Engineering at the University of Bayreuth it was investigated how elastic properties of complex shaped components made of monolithic ceramics and composite ceramics can be determined non-destructively.

In acoustic resonance analysis, the natural frequencies of a component are excited by striking it and recorded by a microphone. Because the natural frequency is dependent on geometry, density and elastic characteristics, the modulus of elasticity, for example, can be calculated analytically.

» For beam and disk geometries of monolithic materials, the method is already defined by ASTM E 1876.«

With the aid of the GrindoSonic® MK7 instrument it is possible to determine the Young's modulus of elasticity of monolithic ceramics in bar form directly and non-destructively. Based on this the next goal was to also characterize complex geometries such as pipe sections beyond the pure good/bad analysis (Fig. 1) in a project partly funded by Carbon Composites e.V. (Department Ceramic Composites). Furthermore, elastic properties of fiber-reinforced composites with direction-dependent elastic constants were to be determined by means of acoustic resonance analysis.

This calculation can only be achieved by finite element (FE) simulation. For the simulation of the natural frequencies, destructively determined elastic parameters or elastic parameters known from literature are used as initial values. After the simulated frequencies have been assigned to the non-destructively measured frequencies, the elastic parameters are adjusted to them in the FE simulation (Fig. 2).

With this technique it has been possible to determine the modulus of elasticity and Poisson's ratios of plates and pipe sections made of two-phase silicon infiltrated silicon carbide (SiSiC). The greatest challenge is the clear assignment of the simulated to real frequencies. However, this is made possible by specifically adapt-

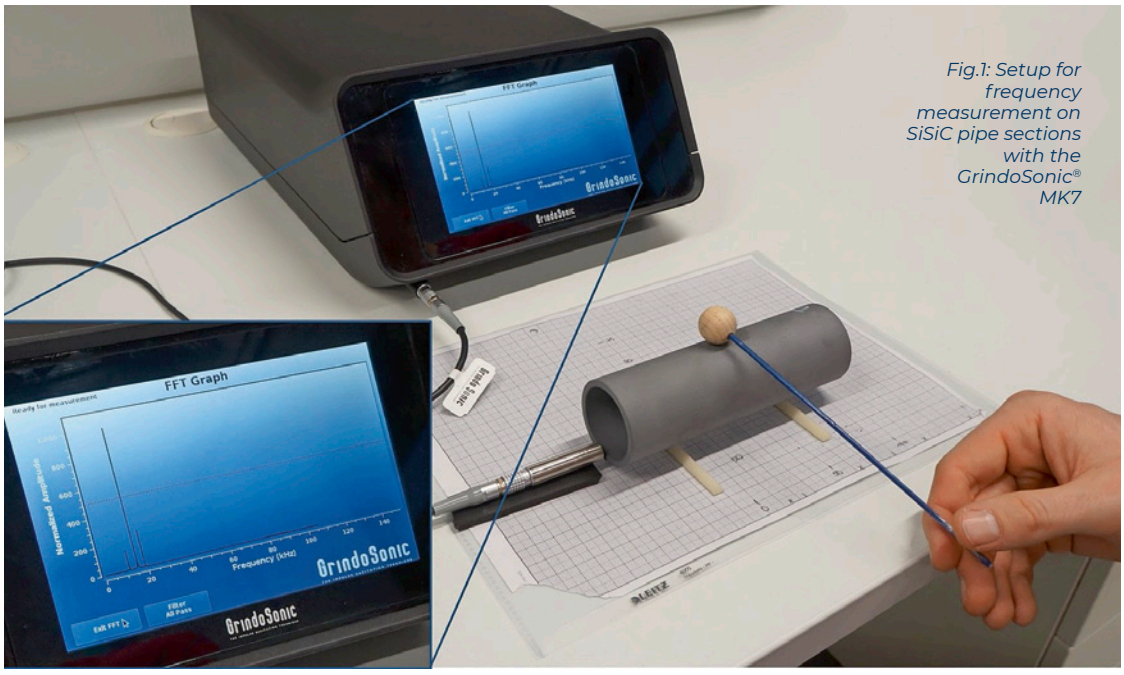

Fig.1: Setup for frequency measurement on SiSiC pipe sections with the GrindoSonic® MK7

The research work was kindly co-financed by the CCeV/CU.

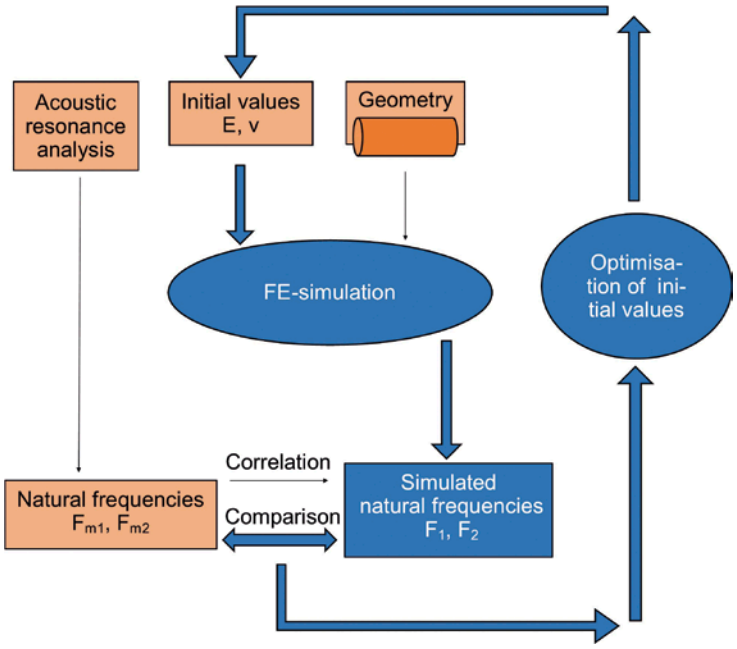

Fig. 2: Functional structure of the simulation-based sound resonance analysis

ing the anchor point, support and microphone position to the respective simulated frequencies (Fig. 3).

Fabric-reinforced C/C-SiC was also measured and simulated in the form of rods and tubes. With this orthotropic material, at least six frequencies are required to unambiguously determine the six direction-dependent elastic characteristic values. Increasing anisotropy therefore complicates and prolongs the calculation.

The number of phases in the material also influences the feasibility. For example, individual frequencies are more separated in C/C material than in multi-phase C/C SiC. In the future, an automated agitation device as well as adapted bearings and a directionally measuring piezo sensor will be used to clearly assign the frequencies. ■

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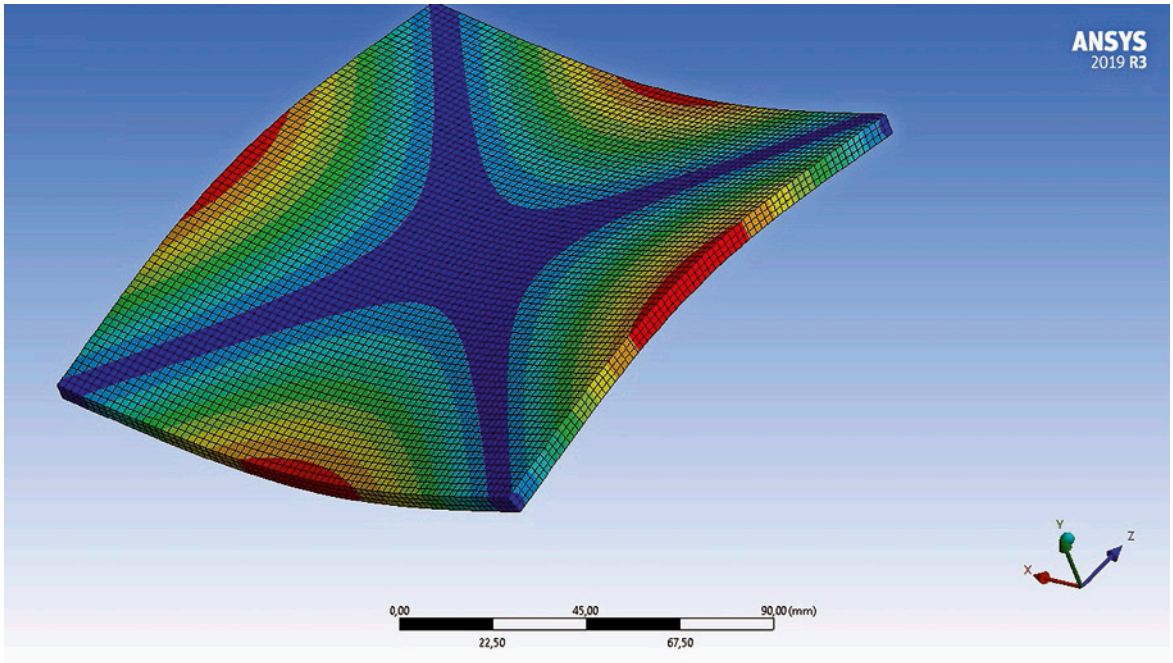

Fig. 3: Exemplary vibrational shape form of a plate-shaped geometry at a natural frequency of 2.517 kHz simulated in Ansys® 2019 R3

I spy with my virtual eye ...

Augmented Reality brings the test laboratory of the future to life

Automation, component testing, condition monitoring - these processes are prime examples of successful digitization in industry 4.0. Approaches such as Augmented Reality (AR) also offer possibilities to support, design more efficiently and further develop these and other industrial processes.

The sun shines through the large window front into the spacious production hall of the Augsburg Technology Center. Here, the "test laboratory of the future" extends over 250 m²: robots automatically test various mechanical components – controlled and monitored from a control centre. As a human being, you can move safely through a fully functioning test laboratory. Until it's time to take off your glasses – and everything comes to a standstill. How is that possible?

Virtual anticipation

Augmented Reality (AR) is a computer-assisted representation in which an image of the real world is expanded by virtual aspects. This is achieved with the help of special glasses and built-in cameras. Fade-ins and overlays then embed additional information or virtual objects.

AR opens up new opportunities, especially for industry. Because it allows digitally planned and constructed products to be compared in and with actual conditions and a real application to be simulated. This offers a perfect virtual insight into a planned test situation.

Testing and production

This technology is being put into practice in the innovation laboratory currently being built in Augsburg. Here, top-level applied research is being conducted in the areas of Industry 4.0, digi-

Thanks to Augmented Reality, guests can already take a look at the test laboratory of the future

Look through holo-glasses – and the test laboratory comes to life virtually

© Klaus Satzinger-Viel, University of Augsburg, Media Laboratory University of Augsburg

tal twin, condition monitoring and materials testing.

The use of robot-supported testing of fibre-reinforced components on this scale is unique worldwide: Two robot arms press with defined adjustable force vectors on a vehicle chassis to determine its load capacity under realistic conditions. A third robot performs optical measurement and inspection work on the components involved.

In this concept, engineering science and computer science must interlock in order to perform safe, efficient and diverse inspection tasks automatically. Results should be used immediately to quickly correct a possibly defective production process. The test laboratory becomes a learning system.

Feedback with reality

"We are inquiring with producing industrial companies in our region to what extent this vision could represent the industrial future in Swabia", explains Prof. Dr. Siegfried Horn from the Institute for Materials Resource Management (MRM), overall project manager of WiR – Knowledge Transfer Region Augsburg. In this BMBF-funded project, scientists are building up the innovation laboratory on an interdisciplinary basis, thus realizing the test laboratory of the future.

From mid-2020, the robots in the innovation laboratory are to start work and test the first components. Until then, interested parties can put on their AR glasses at any time on site and take a look into the future. ■

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Learning from and with each other – MAI ITECK partners impart German training know-how in South Korea

Korean from apprentice to master craftsman

Vocational training cooperation with South Korea: Export of the German dual training system

The BMBF-funded project MAI ITECK is now entering its final phase. The aim of the pilot project is to establish a dual vocational training system in South Korea based on the German model. A permanent educational cooperation between the Eckert schools involved as project partners and the East Asian country is aimed at.

MAI ITECK stands for „International Training of Educational Competences in Korea“. It is the name of a binational project in which for the German part Eckert schools, MAI Carbon and MINT_Bildung AMU of the University of Augsburg are involved. The aim is to build up and establish a network in South Korea that will enable dual training there along the lines of the German system.

The German Federal Ministry of Education and Research (BMBF) is funding the project until 30 July 2020.

First training course successfully launched in South Korea

The German dual training system was adapted to the given regional South Korean conditions. The approach was meant to help to secure skilled workers, especially in the field of carbon fibre composites.

Regionally, the focus is on the South Korean province of Jeonbuk. Its provincial capital Jeonju is considered a centre of the carbon industry.

In August 2019, the first course in cooperation with the South Korean research institute Korea Institute of Carbon Convergence Technology (KCTECH) was successfully launched here. In KCTECH, a local partner has been found with whom Eckert Schools will continue to work together after the end of the project.

School class visits the campus of the Eckert schools

Educational cooperation with South Korea also took place beyond MAI ITECK. In mid-September 2019, for example, Eckert schools welcomed ten pupils from Jeonbuk to a three-month stay at the Eckert Campus in Regenstauf. The program included CNC training, German courses and various visits to companies. A cultural program with a short trip to Prague was also included.

The participants were or are pupils of a Korean master school (equivalent to the German Realschule) in their final year. On the Korean side the program is financed by the Ministry of Education Jeonbuk. ■

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Guests from Down Under

New Zealand scientists visit project partners in Kaiserslautern

Scientists from the Centre for Advanced Composite Materials (CACM) at the University of Auckland responded promptly to the visit of their colleagues from the Institute for Composite Materials (IVW) in Kaiserslautern. The background is the joint project "Retention" within the framework of the mobility support programme funded by the German government.

It ties in with the cooperation between the two research institutions, which has existed since the early 1990s, in the fields of materials science, process engineering and process simulation.

The aim of the funded project is to evaluate the potential of a novel manufacturing concept for the production of fibre-plastic composites for the industries of both countries. In the new concept, which aims to achieve high process robustness, impregnated and dry fiber structures are stacked; a vacuum build-up is then used to initiate a resin transfer.

In a first exchange round in January 2019, three IVW scientists had visited their colleagues in New Zealand and were able to exchange ideas directly with New Zealand entrepreneurs on site. The return visit in autumn was made by Simon Bickerton (Head of CACM), Tom Allen (Senior Researcher) and Graeme Finch (Business Development Manager).

For their part, the three of them got to know the German composites industry better during company visits and an industry workshop. The results so far and the feedback from the industry are very promising, which is why IVW and CACM are currently preparing a follow-up project with industry participation. ■

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The IVW thanks the BMBF for funding the project "Retention" (funding code 01DR18005). The IVW also thanks the team of the CACM and the University of Auckland and the companies Rhein Composite GmbH, Math2Market GmbH, Saertex-GmbH & Co. KG, CirComp GmbH, Compactive GmbH and CompoSpoke for their hospitality.

Scientists from CACM and IVW with TUK President Prof. Dr. Helmut J. Schmidt (left above), with the presentation of current research (right above) and with IVW executives (below)

Fig. 1: H145 with new generation BMR

H135 Heritage pays off

A New Bearingless Main Rotor for the proven H145

The H135 helicopter with the first serial bearingless main rotor (BMR) represents a fleet of over 1.300 aircraft which has accumulated more than 5.3 million flight hours. Based on this technology, the H145 is now equipped with a new BMR, bringing this successful helicopter to new levels related to performance and operational cost.

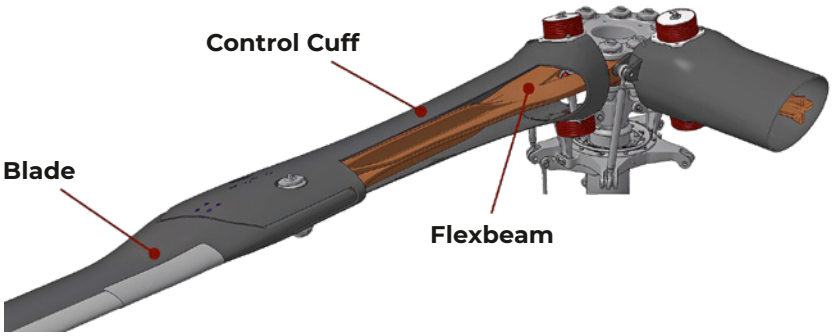

Fig. 2: Flexbeam, Control Cuff and Blade

This article summarizes the ongoing success story of the H135 helicopter, initially known as EC135, produced by Airbus Helicopters. A series of research projects between the years 2000 and 2017 have contributed to the current status of the next generation BMR which is now finally available for the H145 helicopter (Fig. 1).

Advancement

To make a good system better the engineers aimed at reducing noise, cost, weight and maintenance cost while at the same time improving comfort and performance. Several building blocks regarding design and manufacturing technologies are established to achieve the enhancement targets.

In terms of aeromechanic layout a new planform and new aerodynamic profiles are combined in an advanced, optimized aerodynamic blade layout to improve the efficiency and accomplish the best compromise between hover and forward flight performance.

Furthermore the flapping hinge offset (location of an equivalent virtual hinge for out-of-plane blade motion) is an important parameter

of so-called stiff rotor systems like the BMR. So the most suitable hinge offset for the best compromise of agility, comfort of ride and loads had to be analyzed.

Design

The challenge from the design point of view is to put the above mentioned definitions into hardware while at the same time drive down manufacturing cost, maintenance burden and weight.

The first key design feature of the new generation 5-bladed BMR is the modular design concept (Fig. 2) separating the blade and the flexbeam-control cuff unit in opposite to the fully integrated blade of the original EC135. Furthermore the shape of the flexbeam is optimized to reduce the flapping hinge offset without lifetime restrictions. Finally there is an innovative blade attachment design with only flat laminate layers instead of fiber loops which lowers aerodynamic drag and manufacturing effort.

On top of technical gains in terms of maintainability and full blade folding capabilities, the modularity and the flat blade attachment allowed to introduce infusion technology for the blade and the control cuff in order to save cost on material and manufacturing.

Implementation

The final BMR solution combining all new elements of design and manufacturing technology was flight tested on the EC135 demonstrator aircraft “Bluecopter” as early as 2015 and also on an H145 demonstrator aircraft in 2017. As all predictions and benefits were met, the decision was taken to implement this new generation BMR on the H145 with an expected market introduction in summer 2020.

This new version now benefits from 150 kg more loading capacity composed of an empty weight reduced by 50 kg and a maximum take-off weight increased by 100 kg, from a direct maintenance cost decrease and also from a significant enhancement in comfort of ride and vibration levels. ■

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Four VRAs integrated into a fully automated large-scale production line

Tailor-made stacks

JEC WORLD
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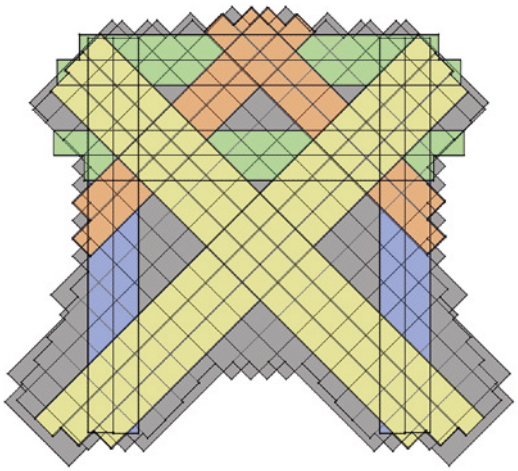
Components for individual customer requirements

The Voith technology group develops and produces customized fiber composite stacks for the automotive and aviation industries, among others. In production, innovative preform processes minimize lead times and reduce material waste – the end result is high-quality fiber composite solutions for every individual case.

Voith Composites is the Group's CFRC development and production center. Here, Voith supports its customers throughout the entire development process, from design and prototype production to the development and implementation of entire series production lines.

Many years of mechanical engineering know-how and experience in the fiber composite market make Voith a competent partner for composite products. The processes used have already proven themselves in the large-scale automotive production of approximately 65,000 components per year. Depending on requirements and customer wishes, dry and pre-impregnated stacks can be produced.



Left: Stack manufactured using a VRA

Right: Virtualized stack

The preform technologies developed by Voith achieve near-net-shape fiber placement. The two-dimensional stacks can then be formed with a die forming or in a double-diaphragm process. Finally, different systems are available for impregnation and curing.

Dry or pre-impregnated stacks

The Voith Roving Applicator (VRA) is a fully automatic direct fiber placement machine with high scalable lay-up rates. At the JEC World 2018, the production line for the carbon rear panel of the Audi A8 based on VRA technology won the JEC Innovation Award.

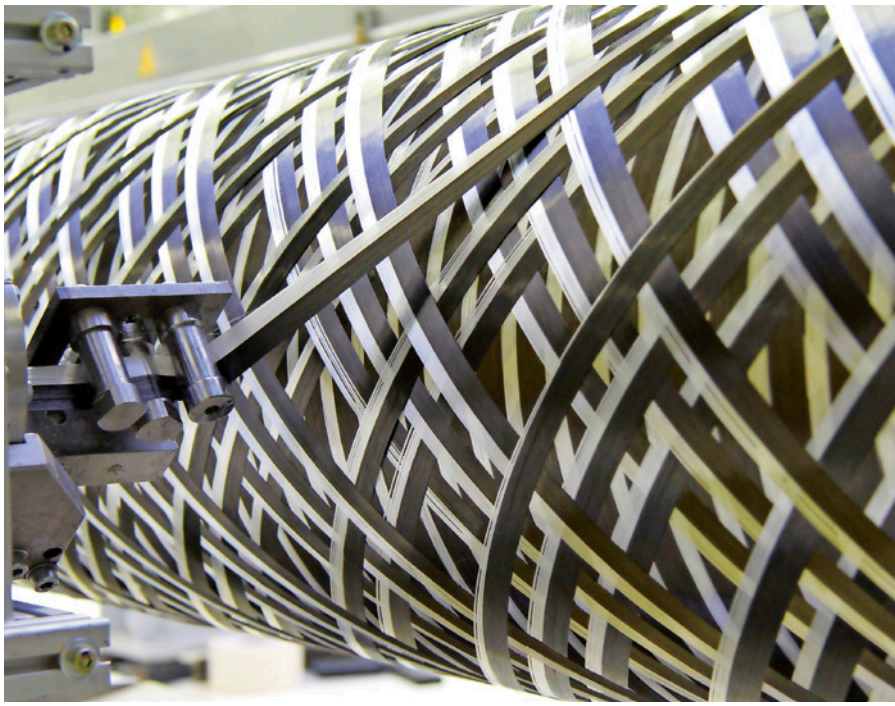
The VRA process, developed over five years, processes low-cost raw materials such as untreated rovings and binder powder. It thus produces near-net-shape dry stacks including individual fiber distribution and local reinforcements within a fully automated preform production process.

Second-generation VRAs can impregnate the resin directly into the fibers instead of applying a binder. This further streamlines the process chain and facilitates handling of the workpieces – especially if they are processed within the same production line.

Wound stacks

Voith Prepreg-Winding (VPW) is a winding technology for the mass production of composite preforms and components without cost-intensive resin injection. Stacks are produced in a particularly time-efficient manner.

VPW processes several rovings in parallel, impregnates them with resin and then produces two-dimensional preforms in a special winding process. These are preformed three-dimensionally and subsequently cured. Depending on the winding pattern, the winding process achieves a lay-up rate of up to 140 kg/hour. ■



VPW of hybrid material made from glass and carbon fibers

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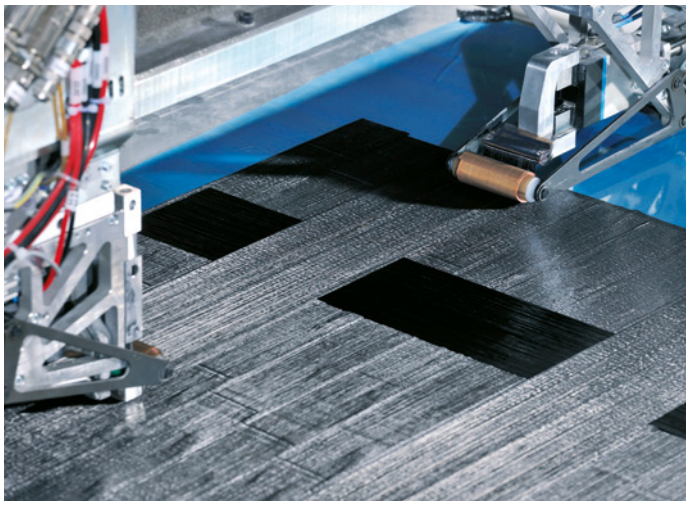

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Textile follows form

Component-adapted textiles for more efficient processing of fibre composites

Complex geometries are usually realized by cutting textile webs. Alternatives are textile preforms and highly drapable broad fabrics from Gerster TechTex. The business unit of Gustav Gerster GmbH & Co. KG with its textile innovations supports more comprehensive automation, reduces handling costs and cuts waste.

The more complex the shape of a component, the more limited is the drapability of "conventional" textiles. This is due to the intrinsic rigidity of their fibres as well as the fixation of the fibres to each other. In non-woven fabrics, these are the sewing threads, in woven fabrics it is the friction of the fibres in the woven structure.

Textile preforms

An example of textile preforms are woven spiral tapes in round components. Round spiral tapes are designed completely to fit the component and are used in mechanical engineering and ceramic brakes, among other things. The fibre structure can be varied according to the load, from purely unidirectional (in circumferential direction) and purely radial to different warp and weft densities.

Adaptable non-wovens

Drapfix and Draptex are the names of two highly drapable biaxial fabrics from Gerster TechTex. They allow the fibers to be shifted in the longitudinal direction, while the fiber spacing is virtually maintained.

The draping process itself is carried out by spreading out the textile. If the distance is longer, yarns are drawn in from the edge, if the distance is shorter, fibres are pushed beyond the edge of the cut. Draping processes can be easily automated, e.g. using movable rollers, flexible mats or adapted pressing tools.

Apart from improved draping properties and "suitable" fibre lengths, only small restoring forces result from the inherent rigidity of the fibres themselves. The forming geometry of the textile in the tool is thus much better preserved. In addition, different fibres, such as glass and aramid fibres, can be varied within the fabric.

Faster is cheaper

High draping properties, low restoring forces and the use of locally adapted fibre types are important components in the load-compatible production of complex geometries in a single step. An advantage especially for processes with low cycle times. ■

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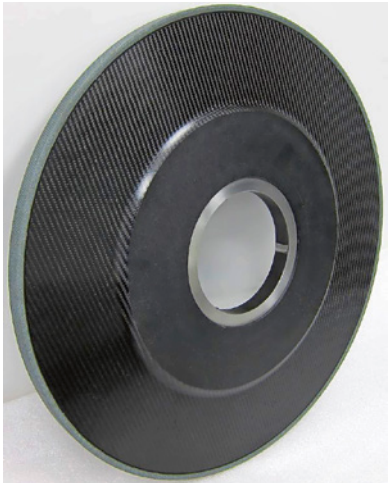

CBN grinding wheel with CFRP body, manufactured from Gerster spiral cloth

Robot-made laboratory centrifuge made of Gerster Drapfix and spiral mesh

Hold together firmly

Adhesion of CFRP to aluminum components in hybrid sandwich structures

The Bavarian Research Foundation is funding the project "MC-Sandwich" for the "Realization of function-integrated, highly complex metal-CFK sandwich structures" with a metallic core and CFRP facings. Project partners are the Fraunhofer IGCV, MT Aerospace, Schmelzmetall, EOS, Kuhn Coatings, Hyperganic, Software Factory and Gierl DCP.

At the Fraunhofer IGCV CFRP material competencies with many years of experience in the field of additive manufacturing are specifically bundled to realize highly complex, functionally integrated structures for special applications. A current research project is "MC-Sandwich" for the "Realization of function-integrated, highly complex metal-CFRP sandwich structures".

Today's demands on properties and complexity can only be met by a multi-material design. The difficulty, however, lies in ensuring an optimal connection between the components. In the first project phase of "MC-Sandwich", for instance, the wettability of the aluminum component by epoxy resin was investigated.

Procedure

First, flat test specimens were produced from aluminum using the laser beam melting (LBM) process. Then the polished metal surface of the test bars were treated mechanically (blasting with corundum and glass beads) and chemically (coating with silanes and DLC).

This prepared the surface for optimal adhesion. The extent to which the pre-treatment influences the wettability with epoxy resin was determined experimentally by measuring the contact angles and surface energies.

Results

The complete wetting of the surface with epoxy resin both after a DLC-2 and after a hydrosil-silane coating with a contact angle of 0° is shown in Fig. 1. In comparison, the epoxy resin on an uncoated polished surface has a contact angle of 12.1° and thus wets worse. The surface energy of the polished metal can be increased up to 64.4 mJ/m² and thus leads to better wetting.

For an untreated sample (intrinsic), only the roughness caused by the LBM process leads to complete wettability by the epoxy resin (Fig. 2). A roughness of ≥ 7.5 µm is required for a DLC-3 coating for the epoxy resin to completely wet the metal surface. Here, the roughening caused by blasting results improved wetting behavior.

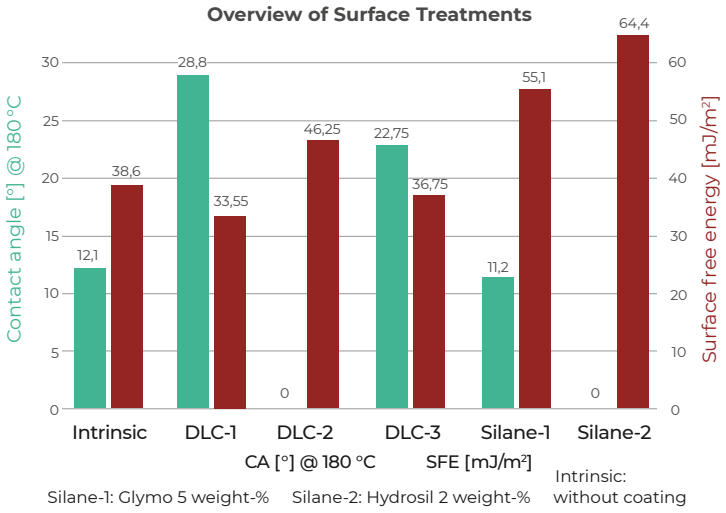

Fig. 1: Effect of different silane and DLC coatings on surface energy and contact angle when wetted with epoxy resin

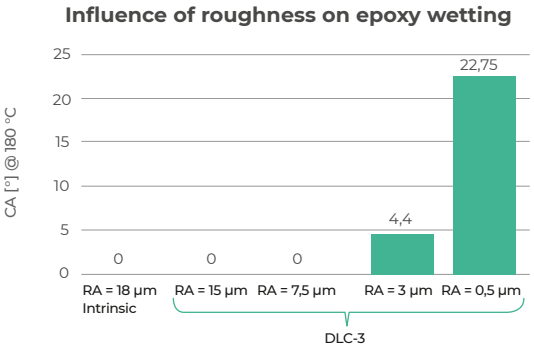

Fig. 2: Wetting behaviour of epoxy resin at different roughness levels and a DLC coating

Conclusion and outlook

With a process-related mean roughness value of 18 µm from the LBM process, the epoxy hard completely wets the metal surface. This is a basic requirement for an adequate metal-CFRP bond. It has also been shown that at lower roughness levels, coating with DLC-2 or hydrosilanes leads to better wetting. The extent to which complete wetting is also sufficient for adequate adhesion will be clarified in the further course of the project. ■

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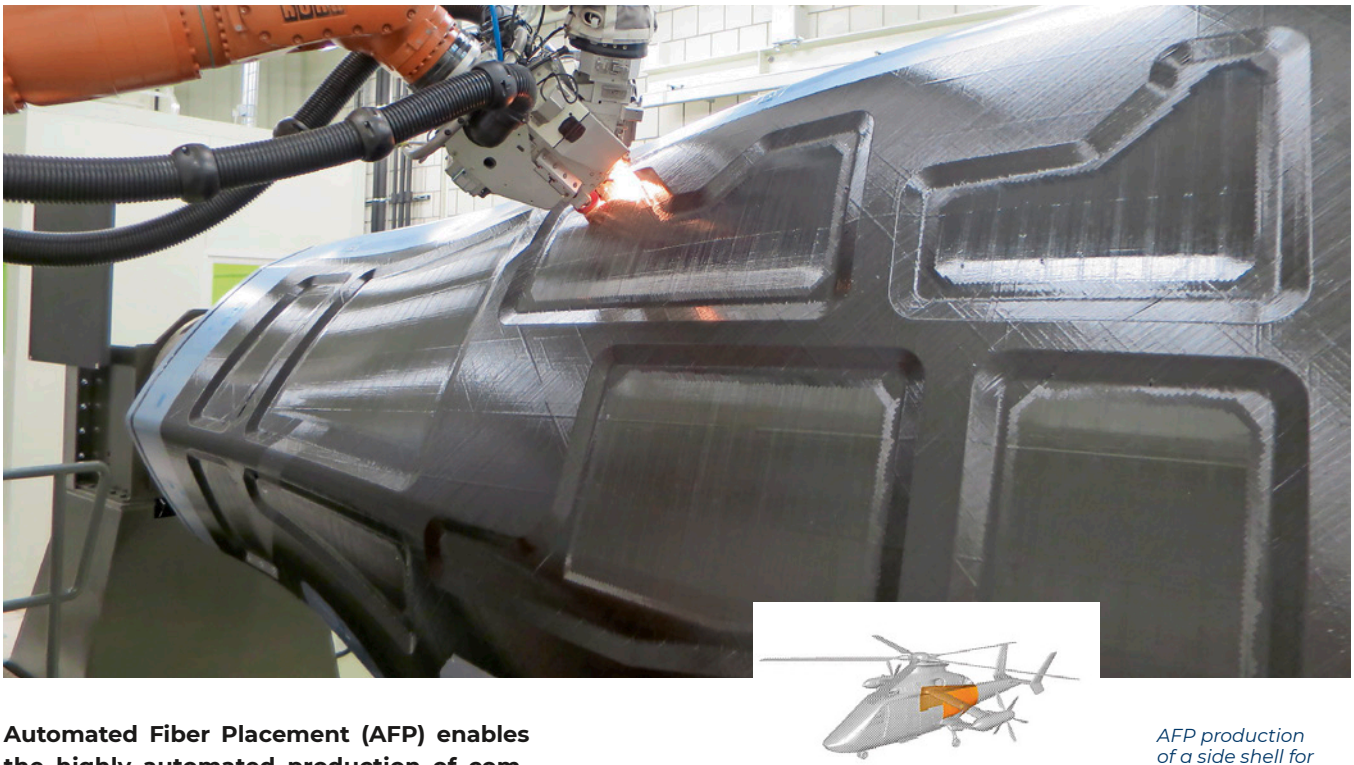
Side shells for helicopters

AFP process development for complex sandwich shell components



AFP production of a side shell for the RACER demonstrator helicopter

Automated Fiber Placement (AFP) enables the highly automated production of complex components made of continuous fiber reinforced plastics. Shell components in sandwich construction represent a new, potential application for AFP in the aerospace environment, but require specific further developments in terms of manufacturing engineering and production process.

Robot-based automated fiber placement is an established process for the production of monolithic components made of continuous fiber reinforced plastics. However, the process poses technical challenges in the manufacture of geometrically complex shell components with sandwich areas.

Manufacturing Engineering: Reference Curve Generation

Due to the discrete tow width, double-curved surfaces with ramp areas cannot be completely covered in the AFP lay-up method, given that boundary conditions such as fiber angle deviation or fiber steering must be fulfilled. In the reference curve design, which is one of the core elements of manufacturing engineering, it is possible to specifically influence the balance of coverage, fiber angle deviation and fiber steering.

This is made possible by a specially developed process in which knowledge-based templates allow independent, flexible curve generation. The reference curves are represented by a spline. The points that define the spline can be shifted parameter-controlled and thus the shape of the curve can be influenced locally. Accordingly, the fiber orientation can be controlled in geometrically complex areas such as sandwich ramps.

Process optimization

During AFP production of sandwich ramps, characteristic defects such as wrinkles, protruding tows or fiber bridging can occur. The opti-

mized system configuration defined in an experimental parameter study allows net-shape allocation of discrete sandwich areas in high quality.

Process chain development

In order to develop an AFP process chain adapted for sandwich components, the feasibility of several basic scenarios was tested in production engineering feasibility studies. In order for the laying surface to be fully accessible to the robot head, the laying tool must be configured male. The curing tool for outer skin components, on the other hand, must be in female configuration. Therefore, a transfer of the wet preform from the lay-up tool to the curing tool is required, for which a film-based approach was chosen.

The developed concept solutions were validated in an experimental feasibility study on a generic component. They form the basis for the production of two flight-capable side shells for the RACER demonstrator helicopter.

The premise of the helicopter is to achieve the best possible trade-off between speed, cost efficiency, sustainability and mission performance. The developed, efficient manufacturing process makes a significant contribution to achieving these goals. ■

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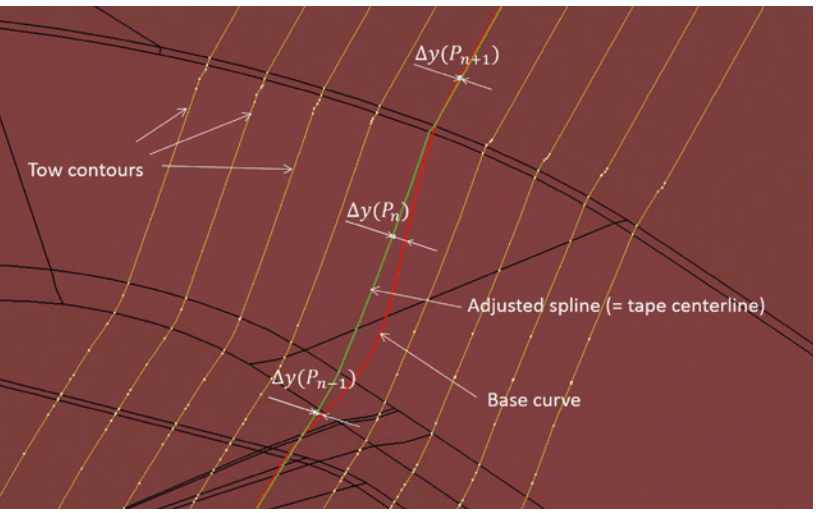
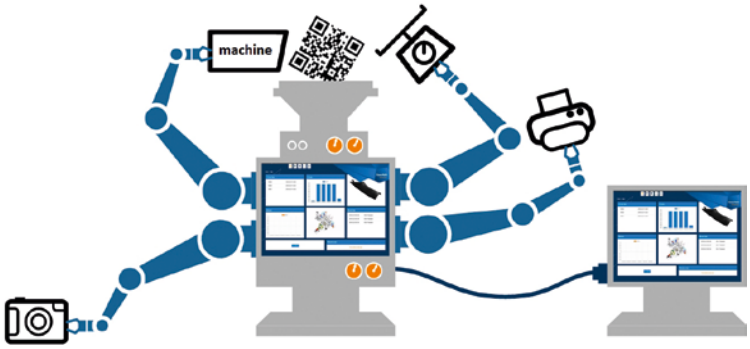


Spline reference points determine the shape of the curve and thus also the fiber orientation

Smart Interpretator

easyTrace collects all kind of production data



easyTrace is the name of a new modular system from KraussMaffei that collects all relevant production data in plastics processing and transfers it to specific customer systems for evaluation.

All modern machines communicate with their production environment. They record their production processes and provide the information for further processing in line with the time of the respective cycle – whether for the subsequent system in the process or for central evaluation. The different protocols, however, are not always 1 to 1 compatible with each other.

Pivotal Data Hub

KraussMaffei's new easyTrace data collection system is a kind of "interpreter" between machines of different generations, types, makes and instruments for production control. According to the developers, easyTrace acts "as a pivotal data hub between the individual stages of production, creating greater transparency across the entire value-adding chain and thus supporting quality assurance".

The data hub is seen as a kind of information highway with integrated interpreter. Information from material dryers, processing machines, complex automation, cameras, printers or scanners quickly flows into easyTrace. This supports almost all existing interfaces on the market, from E63, Profinet to E77. This means that machines from different manufacturers or older machines can also be integrated into the digital production.

Thus even with organically grown production facilities, it is possible to benefit from the advantages of Industry 4.0 quickly and easily and to digitalize the machinery step by step. ■

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JEC WORLD
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Injection moulding to go

New lightweight injection moulding machine is mobile for the first time

For their novel injection moulding machine, scientists at the Institute of Lightweight Structures and Plastics (ILK) at TU Dresden combined the weight advantages of fibre composites with an innovative design. Now the processing industry has a plant technology at hand, in which for the first time not the product is guided to the plant, but the machine to the product. This opens up new possibilities for designing manufacturing processes and producing complex hybrid structures.

In recent years, hybrid component structures have become more and more important, that are made of flat metal or fibre-plastic composite semi-finished products and are upgraded with additional plastic functional elements.

Usually such elements as structural stiffeners, joining or sealing elements are moulded onto the components using injection moulding technology. But especially with complex or large structures, this requires expensive moulds and injection moulding systems that are only economically viable for large series applications.

The current trend, however, is towards smaller quantities and an increasing number of variants. The familiar manufacturing processes, which focus on mass production of identical parts, are often unprofitable.

Less is more

The ILK lightweight design experts have developed a unique system technology to solve this problem: Their „Robotised Injection Moulding“ (ROBIN) allows significantly more variants to be produced with a surprisingly low investment in plant.

ROBIN consists of an automation system – such as articulated arm robots – and a mobile injection moulding system designed as a C-frame. The load-bearing component of the C-frame is manufactured in a fiber composite construction, which enables high structural rigidity with a sufficiently low total mass of approx. 150 kilograms (Fig. 1).

This makes injection molding mobile for the first time, the machine can be variably combined with conventional automation systems and directly integrated into continuous production or assembly lines.

The design of the C-frame and the compact mould dimensions make it possible to easily

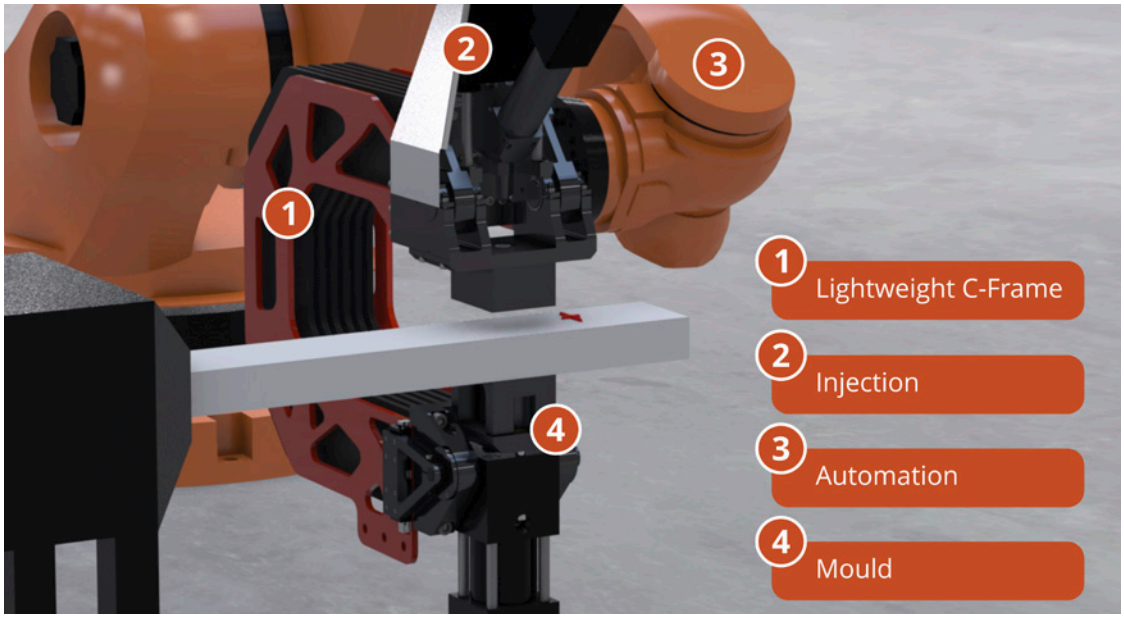

Fig. 1: Modular lightweight C-frame with injection unit for mobile functionalization

accommodate large components inside the frame. In this way, the functionalisation can be applied at almost any position on the component. These additions can be, for example, connecting elements, threads, structural stiffeners, spacers, edge protectors or similar.

... ready, go

With this choice at hand, customers will no longer need large, expensive injection moulding systems. Rather they can avoid investments of several million euros. With one or more coupled ROBIN systems, large-area injection moulding hybrid components can be produced and, in particular, small as well as medium-sized series can be implemented economically. The first such system (Fig. 2) was presented to a broad public for the first time at the K 2019 trade fair in Düsseldorf.

Now the developers of the ROBIN technology will implement pilot applications within the framework of an EXIST research transfer in order to bring the technology to the market in the next few years via a new start-up at the ILK. ■

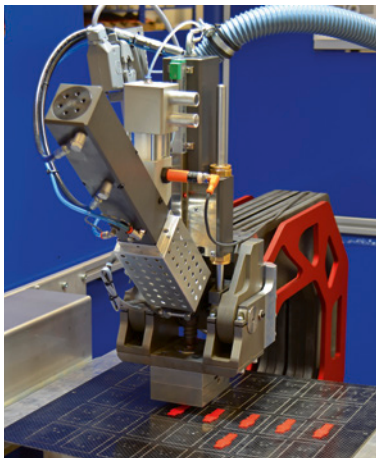

Fig. 2: ROBIN in the first application example for local injection molding functionalization of organic sheets

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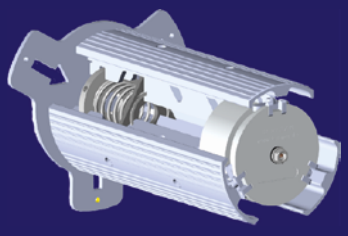
TEXMER

Fixture for the efficient unrolling of glass rovings without core

Glass fibers are intended to be processed in a great many fiber composites, which are normally intended for center-pull due to their production-related coil geometry. But as it is particularly Important in the production of many fiber composites that the fibers don't have any twists through the pull, there was a great need for alternative unwinding methods. At TEXMER, we are always interested in providing our customers with efficient and inexpensive solutions for their problems; we have thus invested a lot of energy and time in the development of a suitable product.



Since the introduction of our SKE mandrel just under five years ago, there have been more and More new processes, in which glass fibers can now be unwound efficiently and inexpensively. The SKE mandrel enables a good torque transmission due to its hexagon receiver. And it therefore also allows for high thread tensions. The dimensions of the holder geometry are adapted to our electronically controlled unwinding units (EGA2000) and our mechanical belt brakes, and thus enable an unwinding process with a constant thread tension from the full to the almost empty glass fiber roving.

JEC WORLD 2020 The Leading International Composites Show
March 3-4-5, 2020 | PARIS-NORD VILLEPINTE

Technical data:
Maximum Roving Weight: 20kg
Maximum unrolling speed: 180m/min
Tension range for inside roving diameter: 145-175mm
Maximum input pressure for pneumatic cylinder: 6bar

If we have sparked your interest and if you are looking for a simple affordable and efficient solution for unwinding glass fiber rovings, please feel free to contact us. We'd be happy to present you with an offer for our products.

Relief for home builders

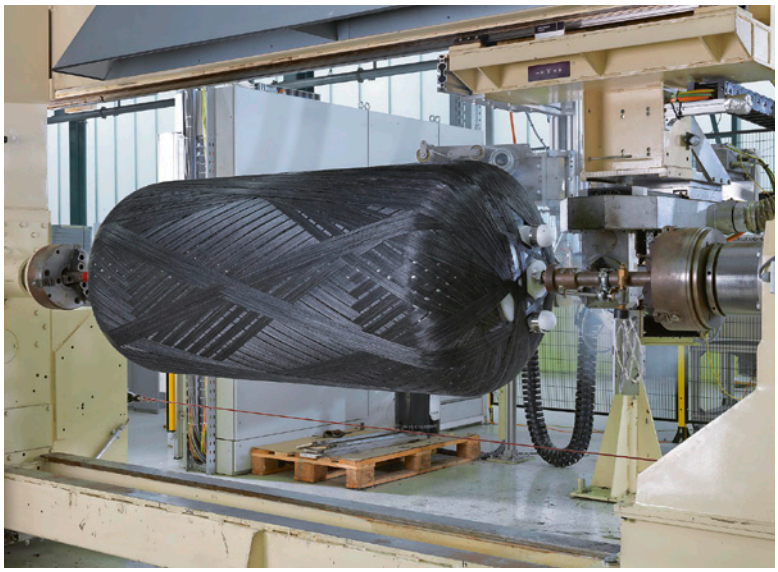
Lightweight construction in building technology saves weight, energy and resources

With favourable mechanical properties, the particularly lightweight fibre composites make a valuable contribution to resource conservation. Technologies such as filament winding and prepreg enable lightweight components for numerous branches of industry. Machine manufacturer Roth Composite Machinery helps to tap this potential. The Steffenberg-based company supplies filament winding machines for tailor-made manufacturing solutions – now also in building services engineering.

A major advantage of fiber composite components is their lightweight construction potential. Compared to conventional materialsup to 50 percent savings are possible for example in liquefied petroleuim gas vessels. This is an important aspect in terms of resource conservation and energy efficiency, as well as in aerospace technology and the automotive industry. In these sectors, lightweight construction has a direct impact on fuel consumption and emission values.

Lightweight construction in building technology

But Roth Composite Machinery supplies Filament Winding Machines for tailor-made manufacturing solutions into practically every industry. Also in the building technology products made of fibre composite plastics are most interesting due to their high tensile strength, force absorption capacity and corrosion resistance. Thus providing synergies overall the Roth group the company introduced its know-how in the development of the innovative heat storage tank Roth Thermotank Quadroline. can be used in many ways, for example with a permanent maximum system operating pressure of up to 3 bar directly in heating systems. It weighs only about one third of a comparable steel tank, which simplifies transport and installation. The energy balance is also convincing. The plastic composite material provides excellent insulation, while a stable outer cover made of high-performance EPS insulation efficiently minimizes heat loss. It is not for nothing that the Roth thermal tank in its version with the Thermocoat plus received the energy label A. ■



The Roth family business manufactures heat accumulators using the filament winding process at its site in Dautphetal, Hesse

» World innovation: first plastic composite heat storage tank as pressure vessel in composite technology«

A Roth Thermotank Quadroline weighs only one third of a conventional steel tank and is therefore easy to transport and install

JEC WORLD
Hall 5
Booth S30

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Small but powerful

New pultrusion machine sets standards in size and sustainability

The mechanical engineering company Thomas Technik & Innovation (TTI) announces its pullCUBE as "the worlds smallest pultrusion machine, which will enable pultrusion within many more industrial sectors and applications". pullCUBE is comparatively small in footprint and comes with "advantages such as safety features, sustainability, product quality and design as well as the capability to produce straight and curved profiles within one pultrusion system".

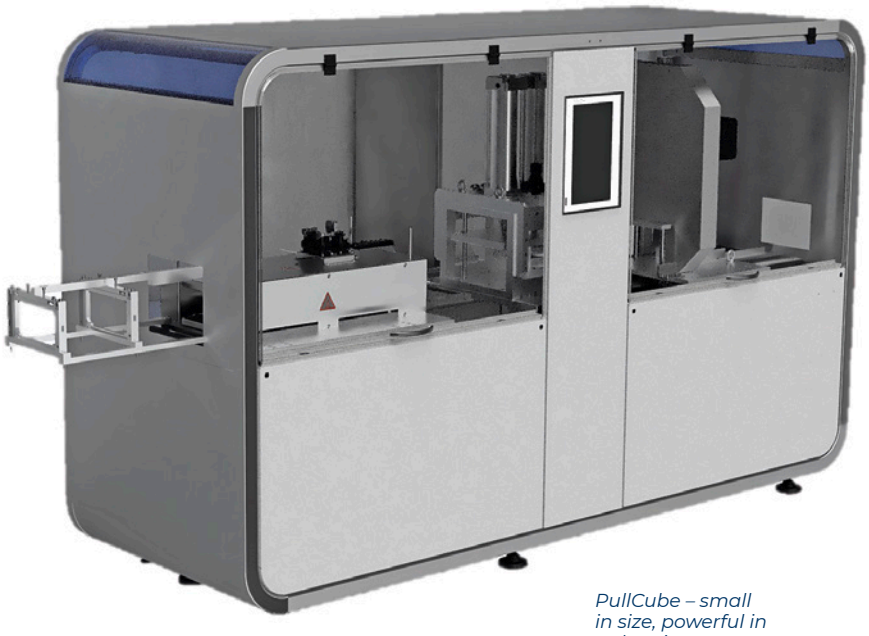
The pultrusion technology that pullCUBE is based on is named "moving mould technology" (patented) or Radius Pultrusion as its brand name. It is a pultrusion technology better described as continuous molding process, which had its breakthrough when the "Corvette Stingray 2020" was officially announced in July 2019.

This car carries the worlds first curved pultruded carbon fiber bumper beam produced by Shape Corp. from Grand Haven in Michigan, USA using TTI's unique Radius Pultrusion technology. The Corvette project verifies the technology and validates its serial production capabilities, which was part of Shape corp. within the joint cooperation. The veryfication and validation showed several major advantages, described in the pullCUBE key features below.

So TTI started to develop the worlds first pultrusion unit that is capable of producing straight and curved profiles within the same system with a fully equipped, overall length of 3.5 meters. This pullCUBE has its world premiere at JEC World 2020 in Paris.

pullCUBE key features

- 75 % shorter: pullCUBE comes with an overall length of 3.5 meters, including mould, gripper unit and flying cut-off saw – shortest machine size in pultrusion so far
- Easy transport & assembly: The small footprint means easy transport. Plus, based on a single chassy design, there is no need for time-consuming assemblies.
- In place production: pullCUBE creates new opportunities for construction areas worldwide. pullCUBE can produce in place and create any length required. E.g. a bridge may now have structural elements on site in full length as per requirement.



PullCube – small in size, powerful in pultrusion

- 75 % less waste for setup: Reduced waste of material for setting up production, due to small machinery dimensions.
- No purge, no waste: pullCUBE does not require a purge cycle. Assuming a price of 10 Euros per meter (e.g. automotive CFRP profile) and a line speed of one meter per minute a single purge would waste at least one meter of profile each 20 minutes. That sums up to 144.000 Euros of waste per 200 days of production – an amount that pullCUBE is set up saving.
- Unique design & safety: The fact that the pullCUBE system is completely closed makes its design unique as well as its production exemplary safe. That is, because operators cannot touch any hot moud surface, neither the gripper nor the saw. ■

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JEC WORLD
Hall 5
Booth P80

Attractive entry-level model

Flexible Crosslayer for automated fiber placement, dry fiber or prepreg

A flexible, low-cost entry-level machine to get started in automated fibre placement for composite part manufacturing is presented by the machine manufacturer M&A Dieterle. Users can choose between prepreg placement and dry fiber placement by simply changing the laying head.

JEC WORLD
Hall 6
Booth P28

Live demonstrations of the Crosslayer at the JEC 2020, M & A Dieterle GmbH together with Shima Seiki. Filacon systems from Tajima GmbH and the Institute of Aircraft Design (IFB) at the University of Stuttgart.

Bicycle frames, sports rackets, skis, skateboards, shoes and much more is individually configured and adapted today. Such flexible and individualised productions are possible thanks to fibre-reinforced plastics. In addition, they allow a low component weight, plus, less material is required due to design of components in line with the load path.

To speed up product production processes, automated instead of manual preforming is highly desired. The cost and ease of use of such equipment so far has been the bottleneck. This is changed with the Crosslayer machine. The Crosslayer offers to switch from manual laying processes to automated preforming. It is an entry machine for automation. User benefits are low investment to start preform automation, material scrap reduction, more efficient production as well as process stability.

Award-winning innovation

Not surprisingly, the Crosslayer, as a new system for simple, automated fiber placement, received the Innovation Award at the JEC-ASIA in November 2019.

"We continue innovating along this path", states Dietmar Dieterle, CEO of the Baden-Württembergian machine manufacturer M&A Dieterle. "It will already be at the JEC World 2020 that we present the Crosslayer with a second laying head." This is for prepreg placement. "You simply loosen four screws and you can switch from dry fiber placement to prepreg placement."

"The Crosslayer builds up preforms from UD dry spread & fixed Tows or prepregs," says Dr. Bettina Schrick, project manager at M&A Dieter-

JEC Asia Innovation Award 2019 for Crosslayer and novel dry fibre preforming process combinable with Tailored fibre placement

Crosslayer for flexible preforming

le GmbH in Ottenbach. The system automatically deposits the carbon fibre tapes with different lengths, angles, and build-up. “You can not only adjust the geometry of the preform and the orientation of the carbon fibre tape, but also determine the structure of the layers of the preform,” explains Schrick.

The crosslayer’s laying head unwinds the carbon fibre dry or prepreg tape, fixes it, cuts the tape and builds up the tapes layer into a so-called preform. This allows flexible production thanks to great design freedom. Besides, “compared to manual lay up, you can not only produce the preforms much faster, but also improve process reliability because there are always small deviations when cutting and laying the tapes by hand,” says Schrick.

Lowering costs is also an issue when operating the system. Thanks to automated laying, waste is reduced, material and resources are reduced and costs are saved. In order to familiarize yourself with the Crosslayer and its programming, no long learning phases are necessary. “After two to three days you are fit”, Stefan Carosella, development partner from the Institute of Aircraft Design, is convinced. ■

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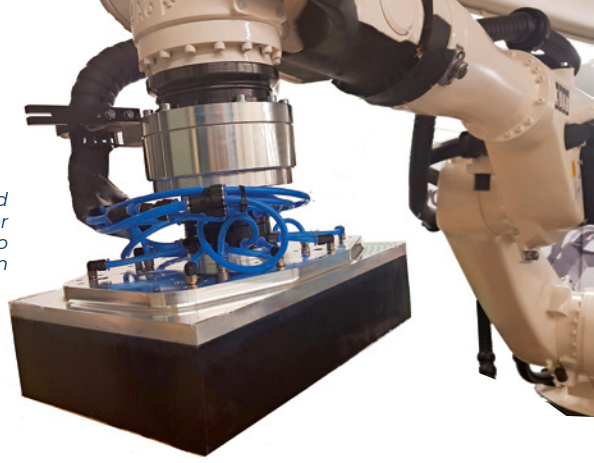


SAMBA Step L equipped with a patch gripper for large patches up to 300 mm x 200 mm

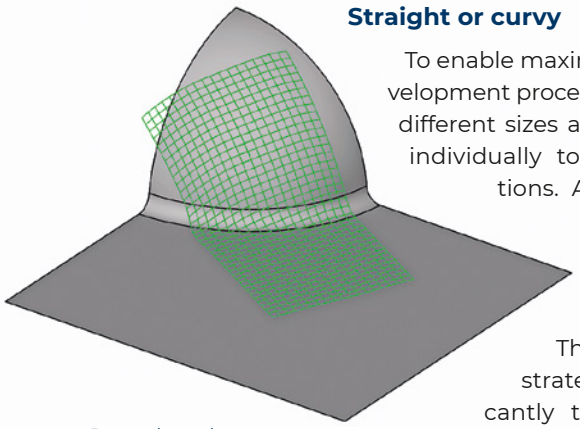
JEC WORLD
Hall 5
Booth Q80

Keep going

50 x increased patch size for Fiber Patch Placement technology

To meet aerospace industry's demands to produce complex and large aerostructures with Fiber Patch Placement, Cevotec has advanced the FPP technology. SAMBA Step L, the largest member of the SAMBA Series to date, can handle a maximum patch size of 200 mm x 300 mm as of today. Primary goal is to serve aerospace's application and process development requirements.

Already operational in the cevoLab, SAMBA Step L features a 6-axis pick-&-place robot mounted on a linear axis. This set-up allows to deal with typical part sizes of aircraft components. Adapted to the larger sizes, Cevotec also scaled the patch grippers to process patches up to DIN-A4 size (approx. 200 mm x 300 mm), which is a 50x larger patch area compared to the initial size of 20 x 60 mm as launched by Cevotec in 2017.



Draped patch modeled with 'Artist Studio'

Straight or curvy

To enable maximum flexibility in the development process, predefined patches of different sizes and materials can be fed individually to defined pick-up positions. A smooth deposition of large patches on curved surfaces is realized by a special roll-placement feature. This new patch deposition strategy contributes significantly to the quality of large patch laminates and potential air voids can be, depending on the application, effectively reduced or prevented.

The scaled patch sizes of SAMBA Step L are also supported by the FPP-specific software 'Artist Studio' through new features. To ensure a precise laminate design with larger patches on curved surfaces, the software now uses an integrated draping algorithm. This algorithm allows the accurate prediction of patch edges on curved surfaces and reduces experimental draping investigations.

Plural potential

SAMBA Step L is designed for developing automated lay-up processes for large aerostructures, such as spatially curved sandwich structures with sizes of up to 2 m x 3 m, e.g. for fairings, nacelles, panels or radomes. The system processes the demanding material mix of sandwich components like carbon, glass, aramid, adhesive, and others. In particular, the ability to precisely place auxiliary materials directly on the sandwich cores – with controlled pressure and temperature – offers the opportunity to remove debulking steps from the process and boost equipment productivity significantly.

As all Samba systems, also SAMBA Step L features a self-corrective, real-time process and placement control, which ensures high precision of the placement and the exact repeatability between one part and the next as well as high laminate quality. In addition, a force sensor has been implemented to precisely control compaction pressures during the placement process.

SAMBA Step L will be operational for customer projects from spring 2020 onwards. ■

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Correctly heated

With THT – Tailored Heating Technology to the perfect thermoplastic (lightweight) component

The newly developed Tailored Heating Technology (THT) permits homogeneous heating of tailored blanks before thermoforming. THT matches the heat input to the thickness of the material, i.e. thicker areas are heated more than thinner ones, for example in the case of a load path adapted fiber distribution. In this way, THT ensures that the forming temperature of each semi-finished product is uniform and adapted to requirements.

High-performance funace as stand-alone production unit

Tailored blanks made from organotapes typically have different sheet thicknesses and number of layers due to their load-compatible fiber orientation. Before thermoforming, the consolidated, flat Tailored Blank is heated to forming temperature. However, the varying wall thicknesses cause an inhomogeneous temperature distribution. At low wall thicknesses, so-called hot spots lead to degradation of the thermoplastic matrix and delamination of the fiber-reinforced plastic. Cold spots, on the other hand, lead to poor surface qualities, inadequate forming and poor dimensional stability of the product.

Intelligent lightweight construction

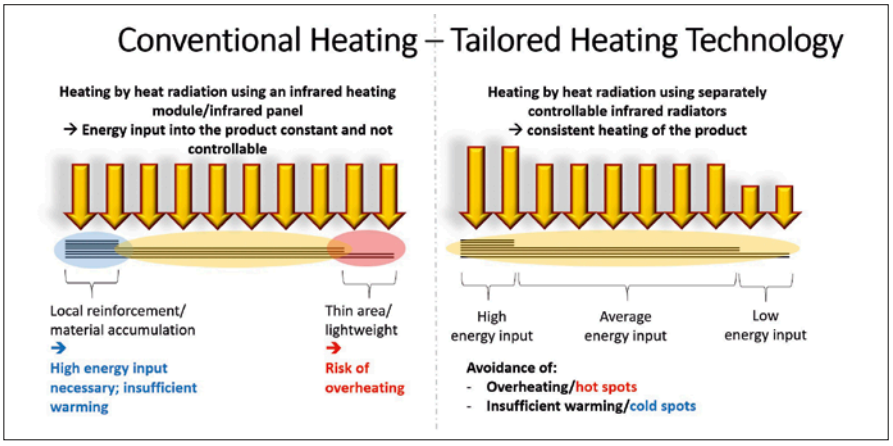
The IBT.InfraBioTech GmbH from Freiberg – established manufacturer of infrared equipment technology and specialist for infrared radiant heat – has a solution for the problem. In its bogie hearth furnace ThermoLine HEAT it uses the process engineering new development Tailored Heating Technology (THT) for the homogeneous heating of the Tailored Blanks. The heat input is locally varied or adapted according to the material thickness.

The following figure shows both the typical material accumulation in tailored blanks and the advantages of the new Tailored Heating Technology compared with existing heating techniques.

With THT, areas of thin sheet thicknesses are not unnecessarily overheated and areas of high material accumulation are only heated sufficiently to forming temperature. This is achieved by a two-dimensional pixel matrix of infrared spot emitters. THT thus results in higher process reliability, greater flexibility in product changes and lower reject rates by avoiding hot and cold spots.

It all depends on the emitter

In principle, IR heating systems can be very finely controlled and regulated, as IR emitters are much more responsive than comparable convective systems. However, the selection of the appropriate infrared radiator is decisive. The difference lies in the emission spectrum; there are short-wave, (fast) medium-wave and long-wave heat emitters. The suitable radiator can also be assigned to corresponding material classes and their absorption spectra via this property. In order to meet the different requirements, the experts at IBT use the entire spectrum of radiator types according to the needs. ■



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Fully flexible

High-performance AFP of complex 3D structural composite parts

Current developments in aircraft construction show a clear trend towards the utilization of composite materials. Increasingly, complex parts are being manufactured using CFRP materials. With the STAXX FLEX, Broetje-Automation offers an end-effector for difficult to manufacture 3D structural parts, specifically developed for series production in the aerospace industry.

The advantages of composite materials are enormous, as they combine weight savings with high rigidity of the manufactured parts. However, the industrial series production of CFRP components can be challenging. High quality requirements and complex component geometries must be combined with low unit costs and automated production lines.

This is where the Broetje-Automation Group comes into play with its composite systems: Extensive know-how in composite technology complemented by decades of experience in equipping production lines in the aerospace industry allow for tailor-made solutions. The company sets standards in the industrialisation of production technologies – not only for aviation but also for many other industries.

Made for fiber placement

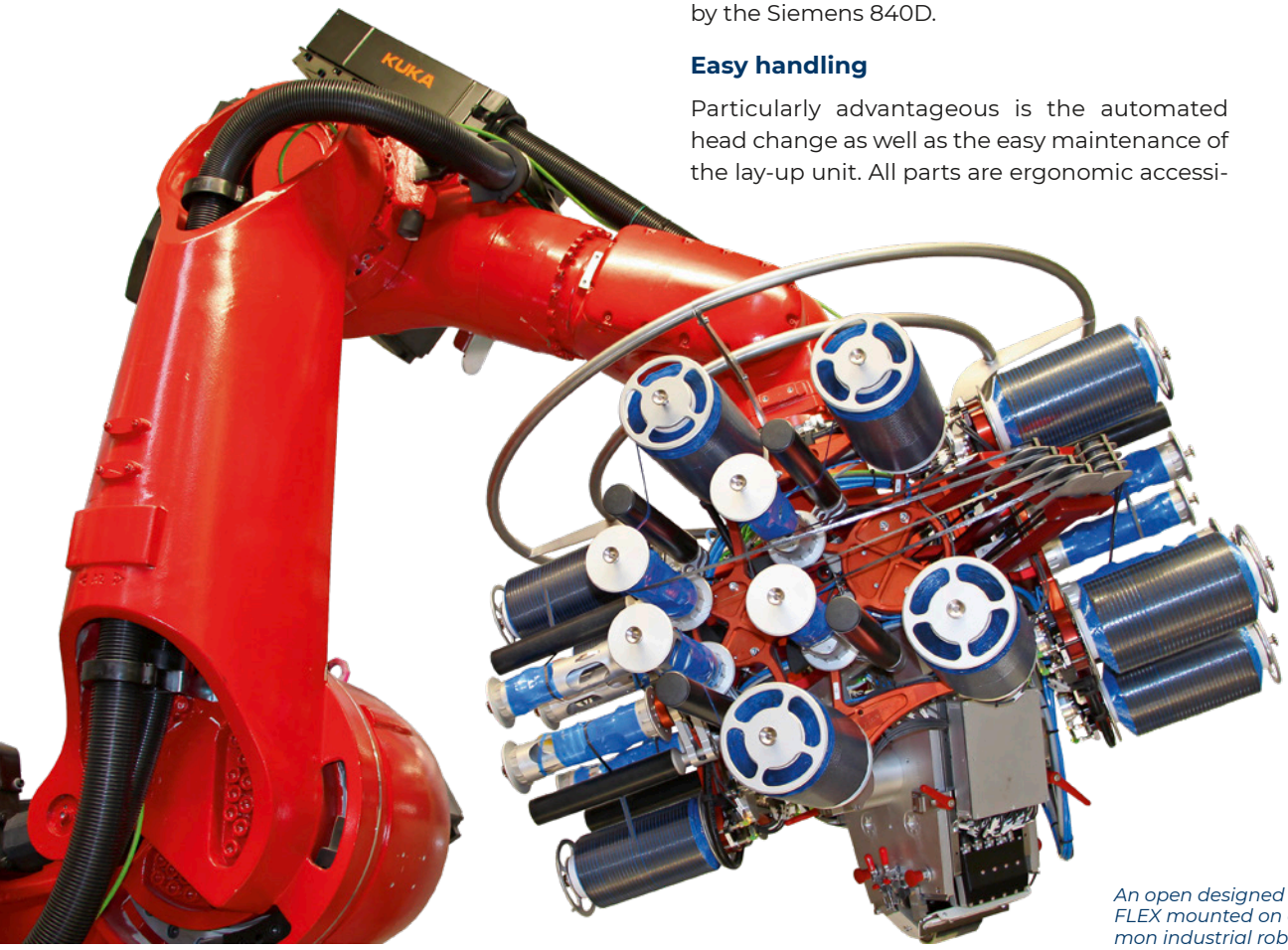
JEC WORLD
Hall 5
Booth N76

The STAXX FLEX has been entirely newly developed by Broetje-Automation. The end effector has a 16 tow AFP head with either ¼ or ½ inch width per tow. A lay-up speed of 60m/min, cutting at a speed of up to 45m/min, a particularly low intrinsic weight and, finally, low maintenance and operating costs make it one of the most efficient and cost-effective AFP solutions on the market.

In designing the STAXX FLEX, Broetje follows its product strategy of modularisation and scaling. Like almost all other machines made by the automation specialist, the system is controlled by the Siemens 840D.

Easy handling

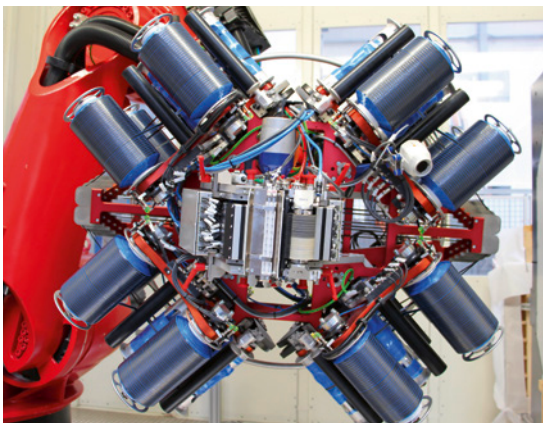
Particularly advantageous is the automated head change as well as the easy maintenance of the lay-up unit. All parts are ergonomic accessi-



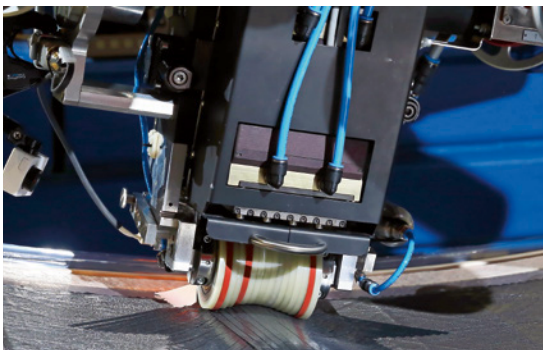
An open designed STAXX FLEX mounted on a common industrial robot

ble, and all components at the head can be exchanged in a very short time without additional tools. Thanks to a mass of only 440 kg including material, the end effector can also be mounted on a standard industrial robot, thus reducing the investment in the associated robot systems.

The STAXX FLEX is also digitally compatible with the majority of standard industrial robots. The CAM software, also offered by Broetje-Automation in cooperation with its partner SWMS, allows the simulation and optimisation of the laying process via Digital Twin, thus reducing material consumption and improving performance at the same time. ■



At 440 kg the STAXX FLEX is currently the lightest fibre placement head in its class



16 individually mounted rollers offer advantages especially for complex components

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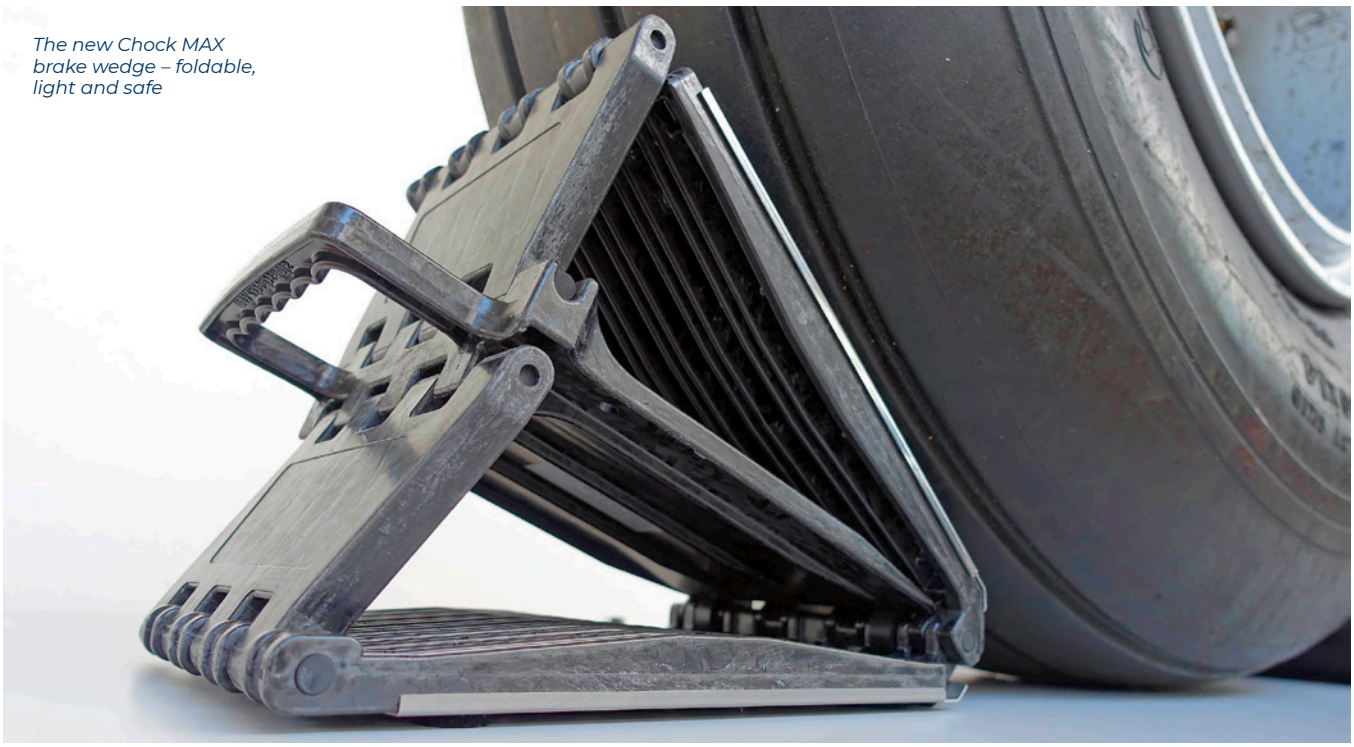
VMM WIRTSCHAFTSVERLAG



The new Chock MAX brake wedge – foldable, light and safe

Foldable Chock

3D fibre composite moulded parts – almost – without limits

Nägeli Swiss AG first showed its composite fibre chock for aircraft up to 350 tonnes at the Swiss Plastics Expo in Lucerne in January 2020. The Chock MAX from Alphachocks is light, absolutely robust and can be folded under the wheel before it can be removed with little effort.

"With the new automated composite compression process – aCC – we can automatically press fiber chips into complex 3D molded parts in a mold under pressure and temperature", reports Dominik Nägeli, youngest member of the Nägeli family. He knows his subject, since on the management board of Nägeli Swiss AG he is responsible for fiber composites.

At Swiss Plastics, the Swiss company showed the newly developed Chock MAX, a foldable chock made of polyamide fiber chips for aircraft. It is manufactured using the aCC process, which Nägeli Swiss AG developed together with partners.

Three essential advantages

The new Chock MAX made of polyamide 6 with carbon fibre reinforcement keeps aircraft up to 350 tonnes take-off weight and wheel diameter up to 1050 millimetres safely in parking position. Compared to conventional chocks made of metal or hard rubber, the Chock MAX has three major advantages.

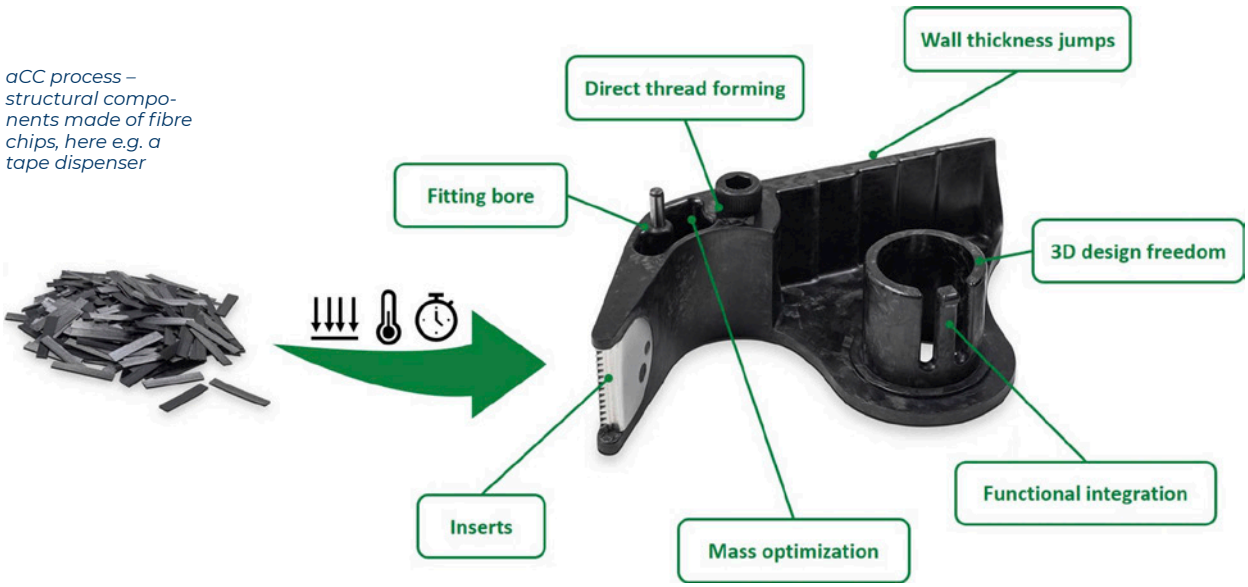
Firstly, at only 3.5 kg, it is much lighter than conventional wheel chocks. Secondly, it is almost indestructible thanks to 3D moulded carbon parts. And third, it is foldable. By folding the Chock MAX, it can be removed under the wheel at any time with little effort. Delays in air traffic caused by jammed chocks are thus avoided.

Automated construction of structural components

Nägeli Swiss AG manufactures the chocks for the Swiss Aerogenius AG, which holds the product patent. At least as revolutionary as the product is the innovative process that Nägeli, as a

Swiss Plastics Award 2020
At this year's plastics trade fair in Lucerne in January, a jury presented the Swiss Plastics Expo Award to pioneering products from the plastics industry. The award in the category Audience Award went to Nägeli Swiss AG for its newly developed Chock-MAX – a great success for the innovative product.

» aCC components are mainly suitable for areas in which injection molded parts, even with short fiber reinforcement, have too low mechanical values and aluminum components are too heavy.«



aCC process – structural components made of fibre chips, here e.g. a tape dispenser

technology leader, developed together with partners. The PA6/CF fibre chips are a combination of thermoplastic matrix and reinforcing fibres. They are pressed in a defined length in a forming tool under pressure and temperature to form complex 3D moulded parts.

With Carbon into the third dimension

The aCC process opens up new ways of thinking in the third dimension for carbon parts. That is because it allows almost any component geometry, however complex, to be implemented. For example, thread impressions, precisely fitting precision bores, integrated connecting elements or cracks in the wall thickness can also be produced. Until now, this was hardly possible with fibre composites.

Due to the automated, process-safe production with high repeat accuracy, series quantities of up to 100,000 components per year can be realized. This prospect makes the aCC process highly interesting as an alternative manufacturing method for many lightweight components, especially for moving parts. It is with satisfaction that Managing Director Christoph Nägeli reports that “designers and mechanical engineers follow our work very closely”. ■

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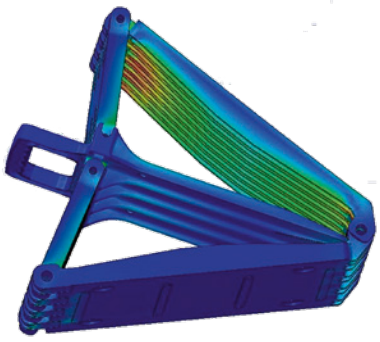
Chock MAX from PA6/CF fiber chips



FE-simulation as means in the development phase

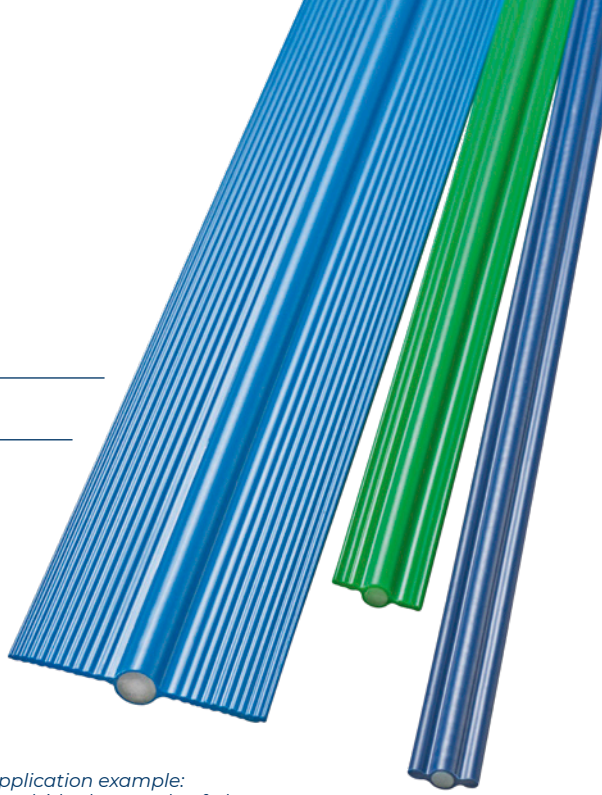
Public favourite – Swiss Plastics Expo Award 2020 for Nägeli Swiss AG

© Messe Luzern/Christoph Arnet (right)

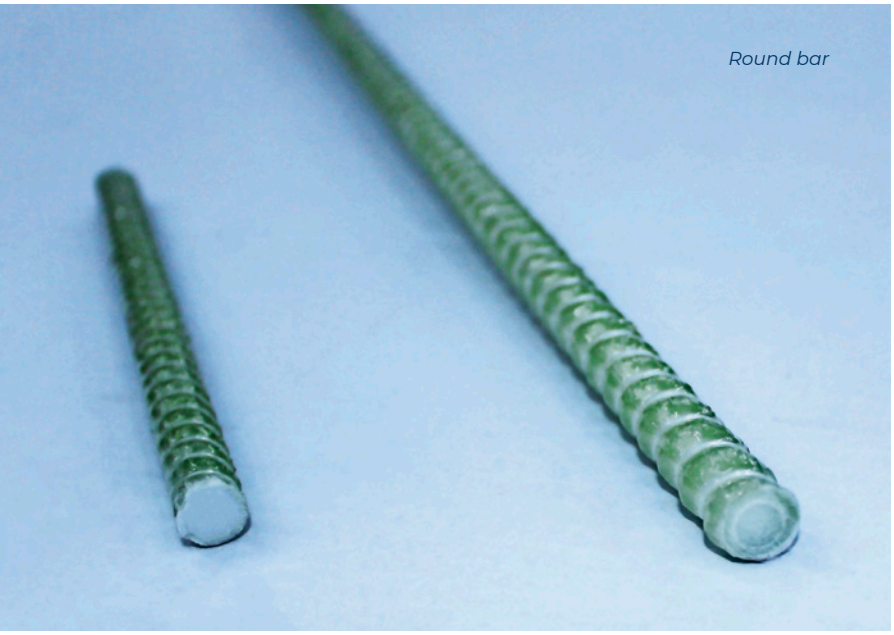
Patent granted

New pultrusion process with top speeds

OKE Group has developed a tool-free production process for unidirectional fiber-reinforced solid bars and sandwich bars. The new process allows for in-line coating of the bars with a thermoplastic material as well as for flexible and fast production, thus enabling the specialist for complex plastic components to produce rods according to customer requirements.



Application example: Goodside slats made of glass fibre reinforced plastic strips



Round bar

»We develop innovative solutions in partnership with our customers. And we all benefit from this good cooperation.«

Jens Schäfer, Project Manager Strategic Development at OKE

In conventional pultrusion processes, you use a heated tool for shaping and curingl. The length of the tool determines the process speed. Speed is limited, however, because the pull-off force increases with the length of the tool. Currently up to 3 m/min is prevailing.

Higher process speed

Unlike the conventional pultrusion process, with the OKE process shaping takes place without tools before curing. Rather, it is implemented in a continuous furnace with practically no contact.

The furnace part can be extended almost at will without noticeably increasing the pull-off forces. Process speed depends on the diameter of the bars. Currently, speeds of 5 m/min and more can be achieved. The rods can be produced in different sizes with a maximum diameter of currently 30 millimeters.

Many material combinations

In a follow-up extrution process the bars can be covered on the inside with a thermoplastic material. The covering serves, for example, as a protective layer or is used for injecting load application elements.

With the OKE pultrusion process all common fiber types such as glass and carbon fibers can be processed. Successfully tested matrix materials are polyester, vinyl ester and polyurethane resin systems, to name a few. Suitable for covering are all common extrudable thermoplastics such as PP, PE, PA, PVC, TPU.

Even grooved rods can be produced. A surface like this creates an additional form fit to the thermoplastic cover or to other surrounding materials such as concrete. This might be particularly welcome when the cover passes tensile and compressive forces on to the rod. ■

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Simplify Composites

Meeting place JEC – "Automation Hub" at the joint booth of TUM

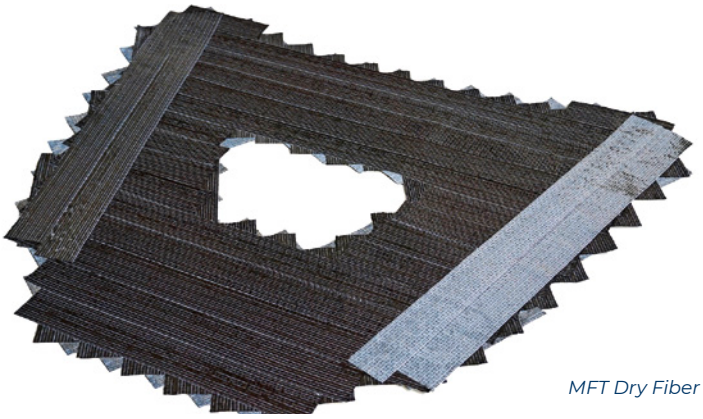
At the JEC Paris 2020 xC Consultants and the Chair of Carbon Composites (LCC) of the TU Munich and its partners will present the latest technologies and innovative solutions for the automation of composite manufacturing. The motto "Simplify Composites" stands for holistic solutions as well as innovative cooperation models.

With its competences in "Composites", "Communication" and "Consulting" xC Consultants organizes again this year the joint booth of the Technical University Munich (TUM) at the JEC in Paris. Main partner of xC Consultants is the Fiber Placement Center in the Bavarian MAI region. Established by SGL and the Fraunhofer IGCV, Broetje Automation, Cevotec, Compositence and Coriolis in Meitingen and Augsburg are now also working together on the cost-effective production of composite structures. To this end, they are combining their know-how from carbon fibers and semi-finished products to process and plant technology.

At the joint booth, guests can learn more about the latest technological developments and about the experiences with this unique partnership model.

Additive manufacturing

Besides preforming, characterization, winding as well as process and structure simulation, one of the main research areas of the Chair of Carbon Composites is additive manufacturing. Current research results will be presented at the Hub and plans for a novel, robot-based system will be shown. It combines material science basics, control technology and process technology of additive manufacturing and fiber placement. The LCC will also present its expertise in these areas.



MFT Dry Fiber Stack

Proven companions

The partner Compositence GmbH stands for automation in composite manufacturing. The experienced team has already designed and installed several unique preforming technologies with associated design software.

The French IT engineering company Edixia Automation, specialized in industrial image processing, is one of the world's leading companies in the field of inspection solutions. At the JEC, the experts will be exhibiting two simulations: one is a sensor for AF inspection in a compact design, the other is a simulation of an inline scan of carbon textile surfaces.

New partners

Forward Engineering stands for lightweight construction competence in fiber composites and is a partner in product development for international industrial customers. A particular focus is on complete vehicle competence in automotive series development with a value chain from concept to series production.

BLC – Bavarian Lightweight Components – will also be represented at the joint stand for the first time. The company from Weyarn develops and manufactures composite structures especially for automotive engineering and demonstrates its competence by exhibiting several components such as leaf springs and carbon visible parts. ■

News from the production technology at the TUM joint stand at the JEC Paris

©Compositence (right up)

JEC WORLD
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Booth D85

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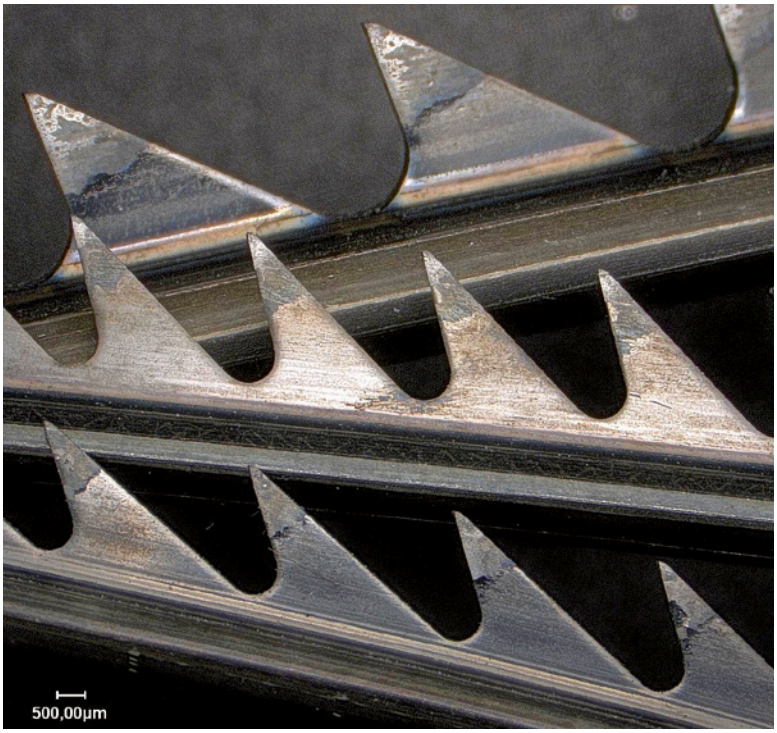
A closer look is worthwhile

Online monitoring of optimized card clothing for high-performance fibers



Microscope image of different card clothing

We would like to thank the German Federal Ministry of Education and Research for funding the project "HPF Card Clothing" under the funding code 03ZZ0635B.

"HPF-Garnitur" is the name of the latest implementation project of the FutureTex project, which is funded by the federal government and started in November 2019. The technical background is High Performance Fibres (HPF), in concrete terms it is about the effect and wear of adapted clothings during their processing. The project partners are also developing a maintenance-optimised process control system in line with Industry 4.0.

The processing of high-performance fibres such as glass, aramid and carbon fibres into nonwovens puts a great deal of strain on the metallic working elements in particular. The card clothing, for example, shows increased abrasion. This results in reduced maintenance intervals and increased process costs as well as a lower quality of the nonwoven fabric.

Project goals

In order to improve the situation, the experts of the Saxon Textile Research Institute (STFI) and their project partners are optimising such card clothing with regard to material surface, geometry and spacing of the teeth. They are also developing a digital monitoring system that can measure the degree of wear of the roller coverings. This image analysis method is intended to record areas of wear, defects and the need for cleaning and thus serve as a basis for maintenance and production planning in line with Industry 4.0.

Project partners

The project consortium consists of two research institutes and four industrial partners. This guarantees both development and investigation on a laboratory scale as well as applicability in the industrial sector.

»Optimized card clothings process the fibers more gently and thus increase the quality of the nonwovens produced.«

The Faserinstitut Bremen e.V. develops the online wear measurement, the STFI is dedicated to the process integration of the image analysis system. The clothing manufacturer Graf Kratzen GmbH in Gersthofen, Swabia, is responsible for the optimized clothing development for the different fibre types. And the Hilbersdorf-based Asglawo Technofibre GmbH, Tenowo GmbH, Hof, and Norafin Industries GmbH, Mildenau, guarantee adaptation, validation and verification of the wear analysis as well as the use of optimized card clothing on industrial plants. ■

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JEC WORLD
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Booth C80

Valuable raw material

Sustainable nonwovens based on recycled carbon fibers

Carbon fiber recycling has been a challenging topic for years and is more important today than ever before. Tenowo GmbH from the Bavarian city of Hof processes, among other things, recycled carbon fibers into a nonwoven fabric. The fibers come with original sizing from edge cut-offs of the woven or non crimp fabric production or from "end of life"-components without sizing or afterwards newly coated with sizing.

Tenowo GmbH has been active in textile processing since 1928 and in nonwoven production since 1973. In 2010, Tenowos R & D department began processing recycled carbon fibers (rCF) into a nonwoven fabric, initially in cooperation with the Saxonian Textile Research Institute, the Sächsisches Textilforschungsinstitut STFI.

Today Tenowo is able to provide nonwovens suitable for specific applications or to develop new products together with partners. Nonwovens are low priced alternatives to established textiles. New properties can be realized in fiber-reinforced structures. Advantages include good drapability, high surface quality, low volume weight and low costs.

From fiber ...

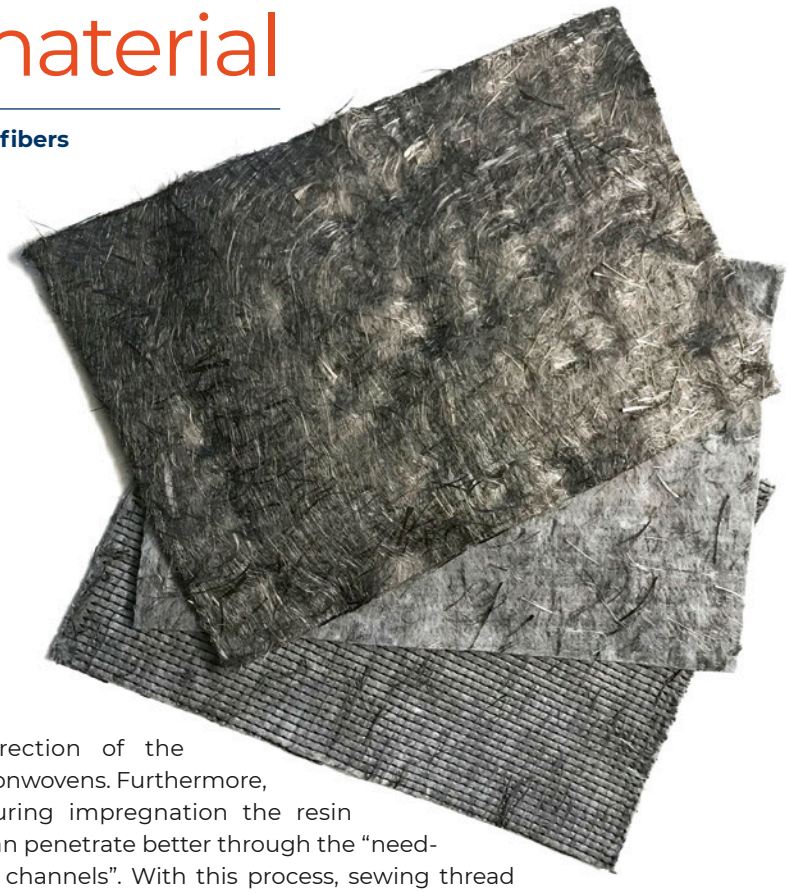
The fibers as the starting material for rCF nonwovens are provided by the carbon fiber processing industries. These can be edge cut-offs from woven or non crimp fabric production or fibres from "end of life"-components. In addition to pure carbon fibers, blends with other fiber types, such as thermoplastic fibers, can be processed as required by customers.

... to nonwoven

For bonding of carbon fiber nonwovens Tenowo uses two processes, which can be selected according to individual needs: One is needle punching, the other is Maliwatt stitch-bonding.

For mechanical needle punching, several needles punch through the fiber layers with notches to "intertwine" them. Needle punched nonwovens can be draped very well. Fabric widths up to 2000 mm and grammages from 100 gsm to 600 gsm can be produced.

The stitch-bonding process is already known from (multiaxial) fabrics in the field of technical textiles. Stitch-bonding improves handling and increases the maximum tensile forces in yarn direction of the nonwovens. Furthermore, during impregnation the resin can penetrate better through the "needle channels". With this process, sewing thread type, stitch length and pattern can be varied and other textiles can be applied to the top and/or bottom side of the fabric. Possible fabric widths here range up to 1500 mm with grammages from 100 gsm to 350 gsm.



Examples of different rCF-nonwovens by Tenowo

Chances and challenges

Potential applications for rCF nonwovens include fiber reinforcements in components, for example in the automotive, construction, transportation, sports or aerospace industries, as well as heat and electromagnetic shielding. Nonwovens with thermoplastic fiber content can be processed into components in thermal processes without any further intermediate steps.

According to the textile experts at Tenowo, the carbon fiber processing industry now is obliged to push the reuse of residual carbon fibers. The advantages are obvious: after all, it saves resources and reduces waste when carbon fiber residues are reintroduced into production as rCF-nonwovens. ■

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JEC WORLD
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Rail Recycling

World's first carbon fibre rail bogie unveiled at British University

The world's first carbon fibre bogie (CAFIBO), developed by British company ELG Carbon Fibre in collaboration with the University of Huddersfield's Institute for Railway Research, was unveiled in Coseley, UK, in December 2019. The bogie, which is made entirely out of surplus and recycled carbon fibre materials, was presented in Great Britain to over 100 industry delegates at the Railway Industry Association's (RIA) Unlocking Innovation event at the University of Huddersfield.

The new CaFiBo bogie is lighter than conventional bogies and optimises vertical and transverse stiffness. This bogie will:

- reduce track wear and infrastructure maintenance costs by reducing vertical and transverse loads on the rails.
- improve reliability and operational availability through an embedded health monitoring system.
- reduce energy consumption and hence global warming footprint.

The bogie is being developed as part of a two-year programme delivered by a consortium of companies comprising of CU-member ELG Carbon Fibre, Magma Structures, the University of Birmingham and the University of Huddersfield with additional support from Alstom. Over the next few months, the bogie will be tested on the University of Huddersfield's state-of-the-art test rolling rig named the Huddersfield Adhesion & Rolling contact Laboratory Dynamics rig, or 'HAROLD'.

First responses

Frazer Barnes, Managing Director of ELG Carbon Fibre commented, "Replacing steel with recycled carbon fibre to produce a rail bogie is a world first so it is a hugely exciting and rewarding project to be part of. We hope to make recycled carbon not only an attractive option for the rail industry in terms of weight reduction but also to eliminate waste and drive down cost."

Simon Iwnicki, Director of the Institute of Railway Research at the University of Huddersfield, said, "There are significant potential benefits from adopting novel materials and construction methods in railway vehicle bogies. The reduction in mass results in energy savings but can also reduce track forces and improve dynamic performance. I hope that the tests on the CaFiBo bogie being carried out here at Huddersfield will help to encourage the railway industry to accept these new techniques." ■

Rail bogie rig at RIA event at the University of Huddersfield

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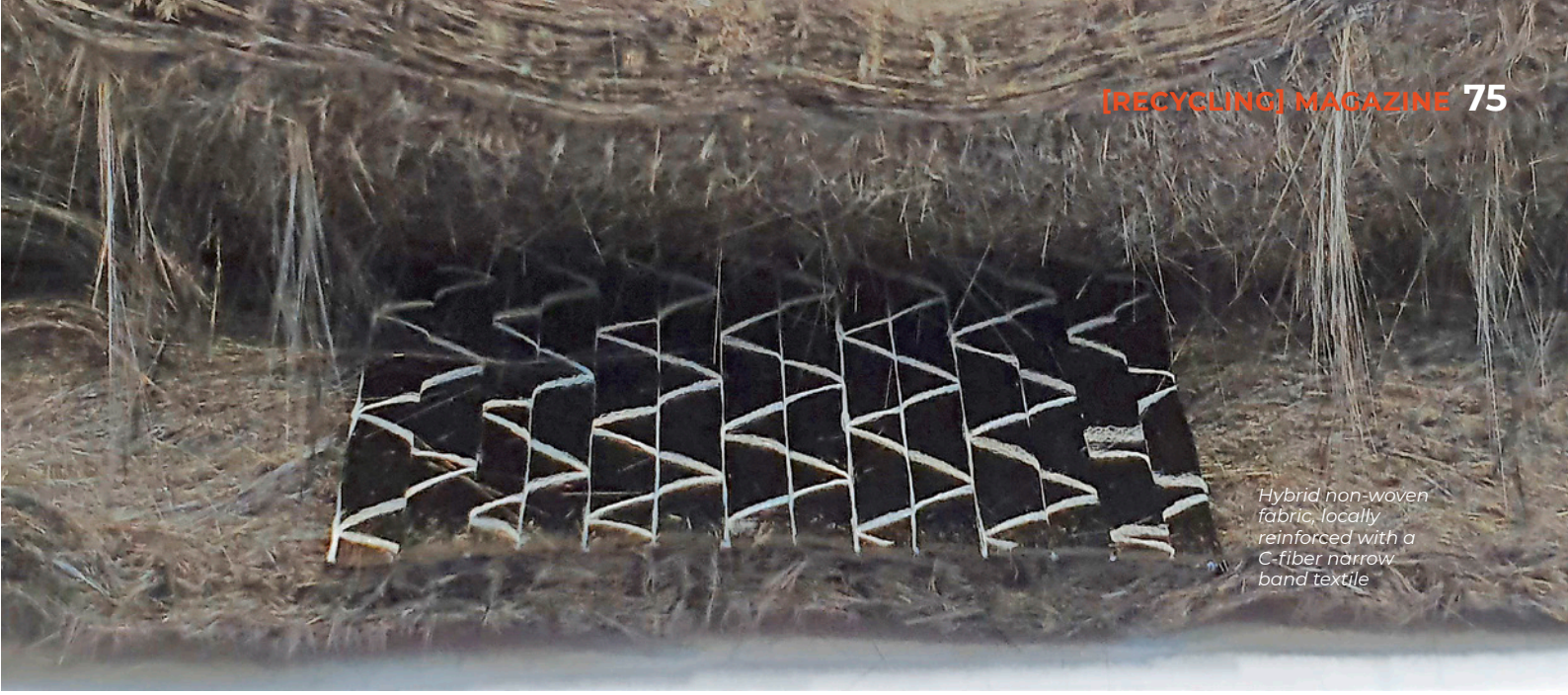

Hybrid non-woven fabric, locally reinforced with a C-fiber narrow band textile

Nonwoven in series

CosiMo research project "Composites for sustainable Mobility" in the Carbon 4.0 Campus

The aim of the R&D project CosiMo is the transfer of thermoplastic composites into mass production in the automotive and aerospace industry. In this regard, KraussMaffei Automation and ITA Augsburg are developing new joining methods for preform production.

In terms of design freedom, functional integration, joining technology and cost-efficiency, the property profile of thermoplastic composites is the logical response to current economic challenges, especially in the automotive and aerospace industries.

The R&D project CosiMo, which is funded by the Free State of Bavaria, aims to implement the use of composite materials on an industrial scale by reducing costs, scaling up to higher quantities and realizing larger components. Efficient production and applications in lightweight construction also take future requirements into account in terms of a positive life cycle assessment..

Technology for Tailored Nonwoven

KraussMaffei Automation (KMA) is working in cooperation with the Institute for Textile Technology Augsburg (ITA Augsburg). Together, they are developing production-ready plant technology for manufacturing preforms from hybrid nonwovens with local reinforcements. These so-called tailored nonwovens offer the possibility of combining recycled carbon fibers with natural fibers and reinforcing them with narrow-band textiles made of carbon fibers for adaptation to the load path (see illustration). In addition, functionalization is possible through the subsequent RTM process and the use of inserts. Thus, a product can be generated that meets the requirements of tomorrow's multi-material mix.

New joining for new mix

Established processes usually require auxiliary materials such as sewing threads or binding agents which interfere with the subsequent infiltration process. Within the framework of CosiMo, new joining processes are being developed that make use of the characteristics of the hybrid nonwovens used.

This means that the dry textiles can be joined with frictional and/or positive locking without the need for further process auxiliaries. In this way, they exploit the cost potential and form a robust process.

Ready for mass production

The ITA Augsburg has proven the process capability in experimental test series. On the one hand, sufficient joining forces were demonstrated with industrial robot-based, image recognition-supported handling studies and, on the other hand, the gentle joining of the fibers was proven by mechanical material tests.

On this basis, KraussMaffei Automation is developing systems ready for large-scale production. KraussMaffei Automation has many years of expertise in automation solutions, and the ITA Augsburg delivers specialist know-how in textile technology. The cooperation between the two project members makes ideal use of synergy effects. ■

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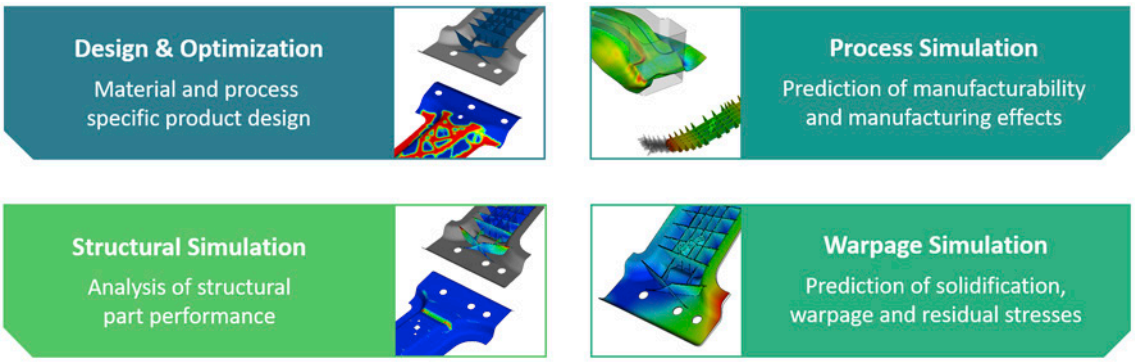
Faster than life

Holistic and robust virtual design accelerates product development cycles for fiber-reinforced composites



Composite materials reveal a particularly high lightweight potential, due to their excellent weight-specific material properties and their capability to be tailored to specific applications. Nonetheless, manufacturing of composites materials involves different challenges. A digital twin of the production process by means of process simulation is suitable for optimization of manufacturing processes, being key for the efficient product development with composites in the context of a virtual process chain.

Lightweight design is a development strategy, which aims to realize functions under specified technical, economical, environmental and social constraints by a system of minimum mass, while its reliability is ensured. Hence, lightweight design can be regarded as a holistic development strategy and the enhancement of a system's efficiency rather than just reducing the mass.

According to circumstances

Composite materials reveal a particularly high lightweight potential, due to their excellent weight-specific material properties and their capability to be tailored to specific applications. While the aerospace industry is using high-performance composite materials such as carbon fiber-reinforced materials since decades, the automotive industry still mostly uses materials such as steel and short glass fiber-reinforced composites, which are well-established since many years.

This is attributable to automotive mass production, where the material dominates the overall costs, due to the high throughput. Hence, automotive industry requires highly automated and robust production technologies, which may induce a high investment, but are affordable as long as material costs are sufficiently low.

Climate protection as a catalyst

Nonetheless, the increasing demand for reduction of CO_2 emissions can be an enabler for composite materials in the automotive industry. However, too high production costs and a limited understanding of automotive-specific processes still hinder high-performance composites to enter the automotive mass-production market. Moreover, manufacturing of composite materials involves different challenges. Firstly, raw materials are mostly expensive, which requires an optimal usage of the material. Thus, material consumption and waste needs to be optimized. Secondly, complexly shaped parts and their manufacturing substantially influences the fiber structure. Thirdly, manufacturing might be accompanied with defects, leading to an insufficient part quality.

Solutions by means of Industry 4.0

These challenges can be competed within the developments of Industry 4.0 by means of a continuous and functional virtual process chain, which includes a digital twin of the production process by means of process simulation. A digital twin is suitable for optimization of manufac-

On Track with Carbon Fiber

Innovative Tunnel Thruster with carbon fiber more cost-effective than in metal design

The development of a composite bow thruster propeller was in demand. With the presentation of a demonstrator, the first phase of a European joint project dedicated to this task has been successfully completed. The project partners are the Norwegian client Kongsberg Maritime, supplier of maritime systems, LZS GmbH and Airborne UK.

The bow of most modern ships is equipped with thrusters. They generate side forces to enhance manoeuvring capability of the ship, for example in ports or for additional station keeping power when dynamic positioning. Up to now, these thrusters are usually permanent magnet tunnel thrusters cast from a nickel-aluminum-bronze alloy.

Customized adapted

Kongsberg Maritime supplies bow thruster systems that are specifically tailored to individual vessel applications. However, the production of conventional bow thrusters is quite expensive, mainly due to the complexity of the part as well as to a significant effort for postprocessing the propeller by hand.

In order to reduce these production costs, Kongsberg Maritime, together with LZS and Airborne UK, set up a development project. LZS took over the simulation part, Airborne was responsible for all manufacturing design. The project partners opted for a disruptive approach and developed a novel tunnel thruster in a hybrid design consisting of CFRP blades and a stainless steel hub.

Prototype of the tunnel thruster in hybrid design

© Kongsberg

After six months of engineering and another six months of prototyping, the final prototype achieved the ambitious cost target. The demonstrator is currently undergoing a real test programme at Kongsberg Maritime. ■

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turing processes. Moreover, the integration of process simulation into a holistic virtual process chain enables to accurately predict the part's behavior in terms of dimensional stability and structural performance (cf. figure above). Based on this, relevant information on the part is virtually predicted, retained and passed on successively to subsequent simulation steps.

Holistic, virtual, and comprehensive

Simutence, a spin-off company of the Karlsruhe Institute of Technology (KIT), is specialized in the virtual design of composites and hybrids. The approach for the efficient development of innovative lightweight solutions from the initial concept to the final product is based on a holistic virtual process chain. This includes structural optimizations, as well as process, warpage and structural simulations for the virtual validation of manufacturability and load requirements. Simutence offers independent engineering services, tailored simulation approaches based on add-ons for established simulation software as well as consulting and training for the virtual product development. ■

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KVB KONSTRUKTION UND VERBUNDBAUWEISEN
LPAC Laboratory for Processing of Advanced Composites
LaFT LABORATORIUM FERTIGUNGSTECHNIK
LAP
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TEER Technologie der Energierohstoffe RWTH AACHEN
LCC Lehrstuhl für Carbon Composites
ipf Leibniz-Institut für Polymerforschung Dresden
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LEICHTBAU BW
KORROPOL LEICHTBAU-SYSTEMTECHNOLOGIEN
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CU reports 02/2020

Focus topic: Additive manufacturing

- Networking news
- Market innovations
- Strategies – regional, national, global

Editorial deadline: 8th September 2020.

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COMPOSITES UNITED

VMM WIRTSCHAFTSVERLAG

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IMPRINT

ISSN 2699-4569

Published by:
Composites United e.V.
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www.composites-united.com

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Ottenbecker Damm 12 | 21684 Stade
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Responsible for publication:
Composites United e.V.
Local Court Berlin | Register of Associations No. 37676
Tax No. 103 / 107 / 41111

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Making and marketing:
vmm wirtschaftsverlag gmbH & co. kg
Kleine Grottenau 1 | 86150 Augsburg
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tel +49 821 44 05-432
b.vogt@vmm-digital.de
www.vmm-wirtschaftsverlag.de

Printing:
Mayer & Söhne Druck- und Mediengruppe GmbH & Co. KG
Oberbernbacher Weg 7 |
86551 Aichach
www.druckerei-mayer-soehne.de

Picture credits:
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Cover:
Composition: vmm |
CityAirbus © Airbus helicopters |
hpv Cieo dev. ETH Zurich © CU

Frequency of publication:
Two times a year, published in German and in English. (2020)

Distribution:
CU reports is the members' magazine of Composites United e.V. Its acquisition is included in the membership fee of Composites United e.V.

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Total circulation:
2.000 copies

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IBAN: DE71 500 400 500 400 500 400
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