Overmolding

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Summary

With overmolding, a combination of processes is used to combine the advantages of (short fibre reinforced) injection molding with those of continuous fibre reinforced structural carriers. For this purpose, load-bearing fibre composite structural elements with thermoplastic matrix are functionalized by injection molding. The process is suitable for large-scale production and offers short process times with a high degree of automation. Scientific questions arise with regard to adapted construction methods, process design and quality assurance as well as process and part simulation and the characterization of part properties with special focus on the interface.

Selected projects

- EffDef - Effects of Defects: Impact of defects on the adhesive strength in Overmolding applications
- HyPaGear – Gearbox cover consisting of short-fibre reinforced thermoplastic with a material-hybrid, tailored reinforcement patch
- ThermoTwin / ConTwin - Development of an online-monitored consolidation process for hybrid thermoplastic preforms for the production of aerospace-specific components and investigation of joining processes to reduce emissions
- HyFrame - Functionalisation of a load-bearing window frame structure for the aviation sector based on CF/PAEK hybrid yarns using overmoulding
- HiQO - Online quality assurance of overmoulding processes by measuring insert and melt temperature as well as flow front speed inside the mould cavity
- MOTHEPLA - Rib base optimisation for rib structures and derivation of design guidelines
- Kombos - Creation of an FRP design for an agricultural machinery arm, considering the joining of FRP components by injection moulding
- Gecheckt – Development of an RFID transponder, which can be integrated into the overmoulded structural element to guarantee lifelong unique identification of the component

Equipment

- Injection moulding machine (Engel Victory 260) - Processing temperatures up to 450 °C
- Thermoforming cell (Rucks press, IR radiator field, Kuka robot)
- Aniform, Moldex 3D, Abaqus
- Oil temperature regulation systems (GWK, Lauda)
- Compounder

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PREVON – gecheckt
Development of a minimally invasive RFID transponder with sensory functionalities for integration into components by means of short carbon fiber overmolding for protection against counterfeiting, complete traceability and individual component monitoring

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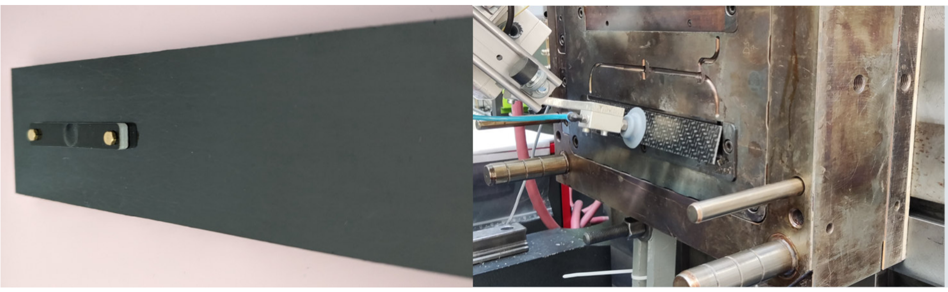
PROJECTS

Motivation and Goal

The objective of the PREVON cooperation project (PREVON: Production Evolution Network) "gecheckt" was the development of an RFID transponder (RFID: radio-frequency identification), which for the first time can be fully integrated into the component material as part of the short carbon fiber overmolding process and thus guarantees lifelong unique identification and plagiarism protection of the component. Furthermore, additional functionalities were realized via the RFID transponder, which can be implemented depending on the application. This can be realized on the one hand via the electrical design of the RFID transponder and on the other hand via additional integrable sensor technology. In this way, the field of application can be significantly expanded beyond the simple identification or the digital component file and can be used, for example, to measure the internal component temperature or mechanical strain as well as to provide evidence of manipulation ("tamper proof") of a possible misapplication (outside the permissible area of application) or to indicate a functional restriction (mechanical wear, destruction) of the component. The RFID tag was developed in such a way that it can be used within the overmolding process, in which a preformed semi-finished product (so-called insert) is overmolded with injection molding compound in a process and functionally reliable manner. The RFID tag is explicitly not used for process monitoring of the overmolding process, but is intended to provide its functionality over the entire service life of the component. Depending on the area of application and the desired functionality, both local (e.g. pure component tracking) and permanent monitoring of the RFID tag or the component (e.g. monitoring of the installed component) is possible with the help of the RFID communication system.

Approach

For the first time, the RFID tag should be usable in fiber composite materials, such as with the high-temperature and high-performance plastic polyetheretherketone (PEEK) together with short carbon fibers, which normally strongly attenuate or even completely shield radio signals due to their electrical shielding effect. For this purpose, specific construction designs and construction methods of the RFID tag were developed and tested so that the tags are suitable for the extreme process conditions prevailing during integration in PEEK overmolding with temperatures around 400 °C and pressures of several 100 bar and so that a radio-safe application and communication can be guaranteed in later use. For optimum structural-mechanical component integration, suitable integration strategies for minimally invasive tag designs were developed and tested so that the structural mechanics of the fiber composite component are not disturbed as far as possible.



Continuous carbon fiber insert with transponder (left)

Robot-assisted loading of the injection molding tool (right)

University of Bremen

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X-ray computed to-mography images of embedded tags

Possible Applications

Since the application of the developed system shows a wide range of possible uses and potentials, there is a broad target group across many industries. The use of the system in components and products manufactured using the overmolding process promises enormous application potential, especially when fiber-reinforced plastic materials (e.g. short carbon fibers with PEEK) are used. The focus here is on the entire logistics process and the lifelong traceability of products and components. The RFID tag integrated in the product or component can guarantee complete traceability with implemented component file as well as 100% protection against plagiarism, since the RFID tag can never be lost or removed without damaging the component. For the reasons mentioned above, the target group of the intended development includes in particular component and product manufacturers in the aerospace, automotive and agricultural sectors, which use the overmolding or injection molding process to manufacture their components and can use such RFID tags directly. However, the application is not limited to the components and products of the manufacturer alone, for example in enterprise resource planning, but should also provide additional benefits for the customer in the application and be able to play out the various advantages in logistics, quality and safety over the entire life cycle.

Supported by:

Federal Ministry for Economic Affairs and Climate Action

on the basis of a decision by the German Bundestag

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Funding

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ZIM Zentrales Innovationsprogramm Mittelstand

Project Partner

- tagItron GmbH, Salzkotten (joint research lead)

tagItron RFID-Komplettsysteme

Faserinstitut Bremen e. V.

The Faserinstitut Bremen e. V. is active in research and development tasks in areas of testing, development and processing of fibers, textile preforms and carbon fiber reinforced plastics. The Measurement Systems and Monitoring department is engaged in the development of measurement systems for assuring the product quality from fiber production via semi-finished fabrics to the final fiber reinforced product.

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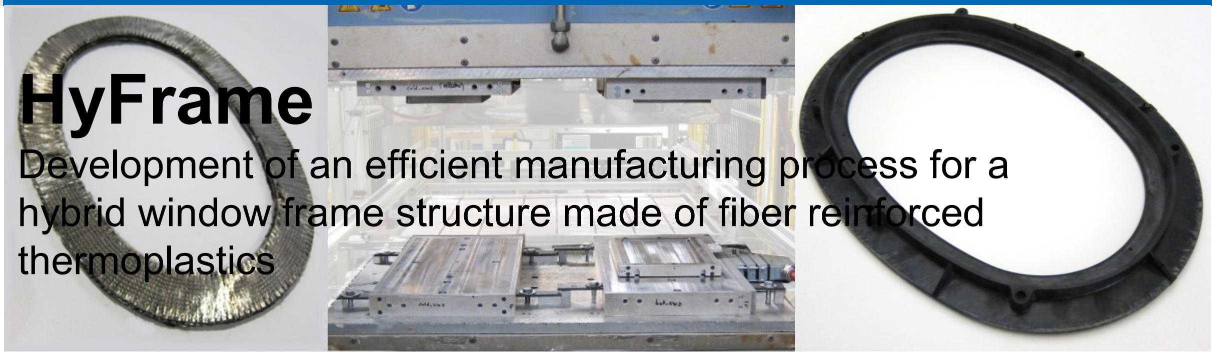


HyFrame

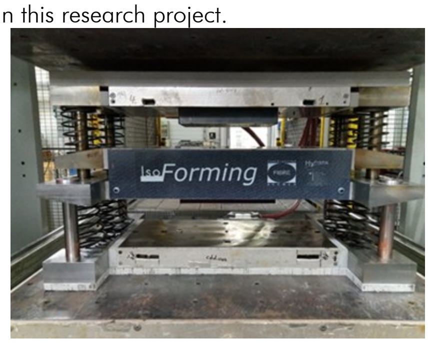
Development of an efficient manufacturing process for a hybrid window frame structure made of fiber reinforced thermoplastics

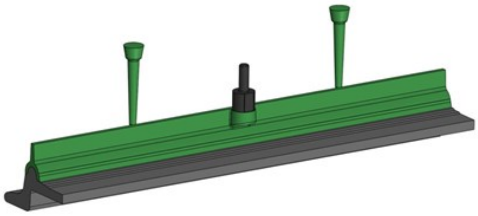
Motivation and goal

In HyFrame, a manufacturing process is being developed that will make it possible to produce load-bearing lightweight structural components more efficiently. The developed process chain should reduce the manufacturing time significantly (-50%), consume significantly less energy (-50%), and increase the geometric complexity at lower costs and the same mass. Design and manufacturing windows are narrowed down by innovative simulation methods for components and processes. Textile and preform development is supported by a consolidation model and drape studies. The innovative manufacturing processes for thermoforming, overmoulding and inductive welding are co-developed and optimized on the basis of test specimens and then raised to component level together with the partners. In summary, FIBRE is pursuing the goal of more efficient and effective aviation in the project.

Approach

The development of adapted hybrid yarns and the textile-technical processing to load-suitable designed preforms, the optimization of processes for the production of the structural continuous fiber reinforced inserts and the stiffening as well as functionalization of these in overmoulding, up to the connection by means of induction welding are the starting points, which are examined in this research project.





At Fibre, the development of the connection of inserts for the transfer of structural loads with injected mold elements and subsequent welding is being investigated. This should enable cost and weight savings. Central to this is the reduction of component distortion in the manufacturing process, which is conceptually taken into account in the design of the structure and the process. For insert production, both MAG and TFP preforms based on adapted hybrid yarns are used, thus achieving a high degree of automation and online quality assurance. The preforms are then isothermally pressed, which enables short cycle times and high laminate quality.
Overmolding is used to stiffen the overall structure and integrate functions (integration of load introduction elements and sensors). The basis for the necessary connection strength of the individual components is the use of special PEEK variants from Victrex.
Weight and costs are to be achieved in particular by welding the window frame to the fuselage structure, which is implemented in currently used window frames by Hi Lock connections.

Potential applications

Structural components for aerospace applications are the central focus, further applications in aerospace or medical technology are possible based on the development. By using more

favorable matrix materials, application scenarios in the automotive or agricultural machinery industry can also be created.

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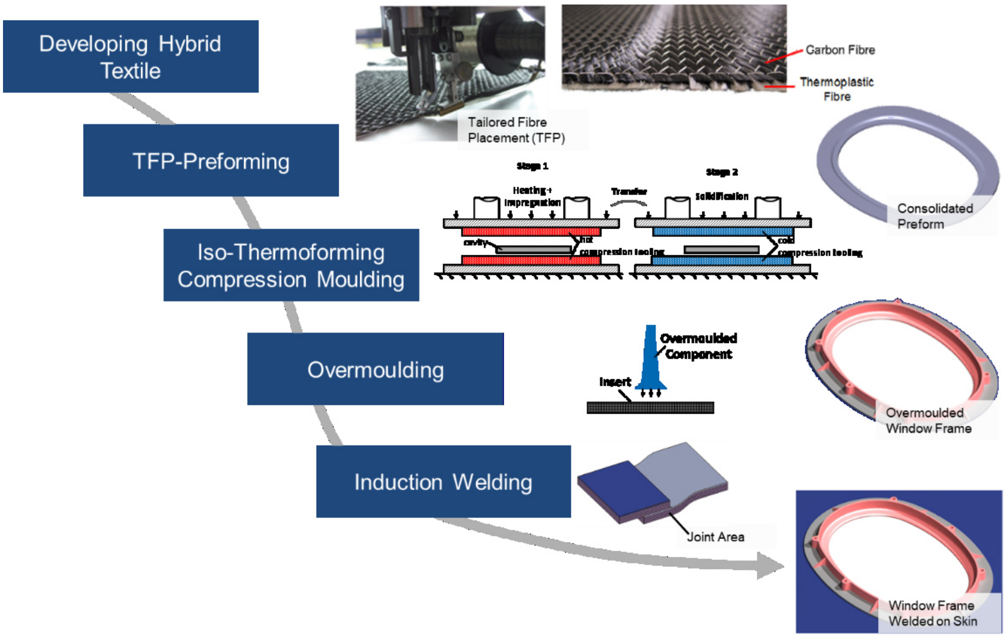
Funded by

The research project HyFrame was funded by the Federal Ministry of Economics and Energy as part of the LuFo program, for which we would like to thank the Federal Ministry of Economics and Energy.

Federal Ministry
for Economic Affairs
and Energy

Projeckt partner

- ACE Composites GmbH
- Hightex GmbH
- Megatherm Elektromaschinenbau GmbH
- MERKUTEC GmbH & Co.KG
- SAERTEX GmbH & Co. KG
- Faserinstitut Bremen e.V.



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KOMBOS

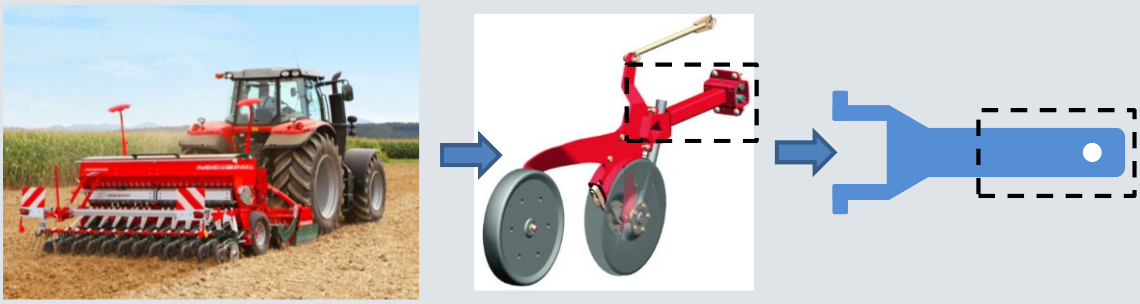
Development of an overmoulding process for complex polymer-coated thermoformed composite components for use in agricultural engineering (08/2018 – 07/2020)

Motivation

Fibre reinforced composites have established themselves over the last few years in all sectors. Lightweight-driven aerospace is one of the technology drivers. However, government regulations and increased social environmental awareness are also leading to an increased demand for lightweight construction solutions in other industries.
A young representative of this is agricultural engineering, which is reaching the limits of legal requirements for road vehicles, especially due to ever larger machines and vehicle weights. Furthermore, increasing soil compaction is reducing customers' yields. In order to prevent this, solutions are being searched for to reduce the machine weight without compromising the service life and robustness. In order to be competitive with conventional metal construction, processes suitable for series production are to be combined and manual processing steps reduced. The aim is to create functionalised, structural products.
The KOMBOS research project is therefore developing a design method that combines the advantages of thermoforming with those of injection moulding. At the part of a handlebar of a sowing machine the process development is carried out with the aim of complex polymer joined fibre composite structural components.

Approach

Figure 1 shows an example of a sowing machine, the assembly and the demonstrator structure used for process development.



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https://www.poettinger.at/download/prospekte/16294/0/POETTINGER_POETTINGER-Magazin-2019_003.DE.0818.pdf

Figure 1: Sowing machine, assembly and demonstrator structure

First, the component was analysed with regard to its specific requirements and a list of requirements for the product-specific construction method was developed. In the concept phase possible construction methods were worked out and the preferred variant was elaborated in detail. This includes a number of different aspects:

- Mechanical preliminary design with FEM
- Construction of thermoforming and injection moulding tools
- Filling simulations to optimise the sprue concept

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Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

ZIM Zentrales Innovationsprogramm Mittelstand

Through iterative process adaptations, a process was developed which joins ribbed reinforced semi-shells to load-bearing components by injection moulding.

Figure 2: Assembled semi-shells and joined components

With the use of this construction method, load-bearing hollow structures could be developed while maintaining the construction space. In addition, the bearing eye could be integrated and the mass reduced by 50 %. In the tensile test the potential could be proven with maximum loads of more than 60 kN.

Possible Applications

Due to the design freedom of the construction a wide range of applications are possible. E. G.: Piston and coupling rods, tie rods and chassis, framework and truss structures.

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Funding

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Project Partners

- Merkutec GmbH & Co. KG
- Faserinstitut Bremen e.V., Bremen

Faserinstitut Bremen e.V.

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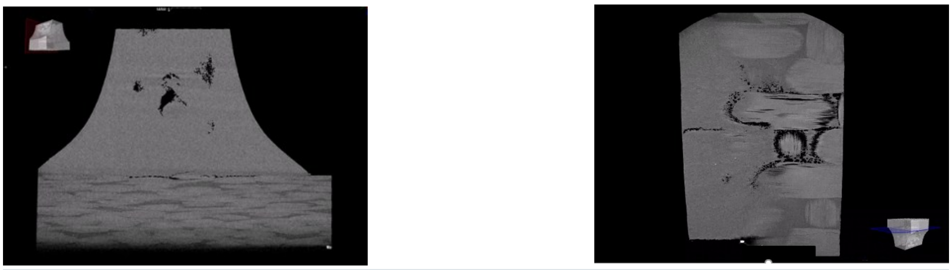
Effects of Defects: Impact of defects on the adhesive strength in Overmolding applications - EffDef

Motivation and Goals

Overmolding components are manufactured through the thermoforming of thermoplastic semi-finished products, which are subsequently overmolded with short fibre-reinforced material. In the event of fluctuations in the manufacturing process, defects such as pores and delamination may emerge at the transition zone or within the laminate. There is a paucity of knowledge concerning the impact of pore distribution, pore size, and pore patterns on the micromechanical behavior of the material and the failure of overmolding structures.

The objective of this project is to enhance the assessment of defects in overmolding components. The findings will be collated in a processing guideline that correlates process parameters with defect types and corresponding degradation factors. This processing guideline will take the form of a digital catalogue, which should serve as a preliminary step towards the introduction of a DIN-SPEC standard.



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Approach

The objective of the project is to gain a more profound comprehension of the material behavior of overmolding components when subjected to external loads. Furthermore, the collation of pertinent process data and an associated assessment of bonding quality are essential prerequisites for the successful qualification of the process. In order to micromechanically characterize the components of an overmolding structure, it is necessary to undertake high-resolution X-ray computed tomography (µ-CT) measurements. The analysis of the extensive data sets will be conducted using artificial intelligence (AI) and deep learning methodologies. The findings will be employed in the simulation of failure, which will be corroborated through in-situ tensile testing. The analysis methodology will comprise the following steps:

- Requirements and specifications
- Manufacturing of test coupons
- Application of X-ray methods
- Automated evaluation of measurement results
- Simulation, iteration, and validation
- Transfer and validation on a real component
- Defining the design of overmolding structures

Tensile-peel test specimens are geometrically suitable for in-situ characterisation at the coupon level. The requisite resolution for fibre identification and high contrast for distinguishing between fibres, matrix, and defects will be achieved through the utilisation of X-ray micro-CT (XRM). The necessary testing technology is currently available within the research facility. An appropriate neural network and training strategy will be required for automated evaluation. Subsequently, a methodology will be developed to integrate the defects into a 3D microstructure reconstructed from the CT measurements.

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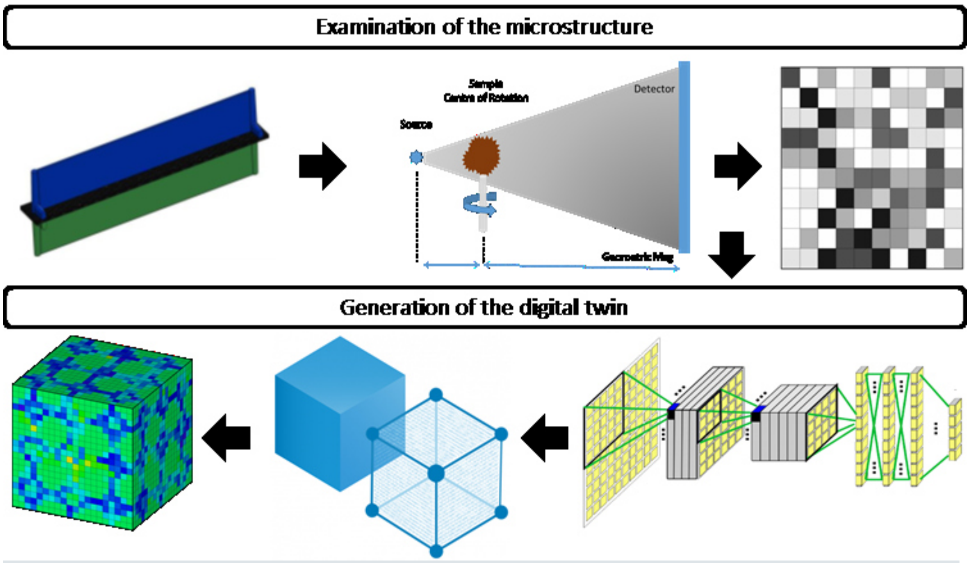

Proposed solution to generate the digital twin taking into account the missing parts

The determination of material characteristics and the influence of inhomogeneities should be established through the utilization of non-destructive experimental and numerical imaging techniques. This is employed to digitize the component. Following the successful characterization and modelling of the material behavior on the tensile peel test specimen, the results can be validated on a real component. Only then can appropriate measures be taken in production (selection of suitable process parameters) and service (prediction of material behavior under changed load), thus optimizing the manufacturing process.

Application

An illustrative example of an overmolded component in the automotive industry is the seat cross member, which is situated beneath the driver's and passenger's seats. The component is manufactured by overmolding a continuous fibre-reinforced thermoplastic, known as an organosheet. This approach allows the forming process of the organosheet, which is usually required, to be integrated into the injection moulding process. In addition to the excellent mass-specific strength of the organosheet, overmolding with ribbed structures also achieves high component stiffness.

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Funding

Supported by:

Federal Ministry for Economic Affairs and Climate Action

on the basis of a decision by the German Bundestag

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Expression of Interest in Collaboration

- LS Hybrid Solutions (Project partner)
- PART Engineering GmbH (LOI)
- Lehmann&Voss&Co. KG (LOI)

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PROJECTS

HiQO

High Quality Overmoulding

Motivation

In the overmoulding process, structure-bearing elements made of a fibre composite material are overmoulded with a thermoplastic in an injection-moulding tool. This combines the outstanding mechanical properties of the continuous fibre-reinforced insert with the geometric design freedom and short process times of injection moulding. As a result, the economic efficiency of lightweight structures is increased so that installation in aircraft becomes profitable and a higher degree of lightweight design can be implemented.

The integration of an automated online QA system into the overmoulding process enables a significantly more efficient production. In addition, it is an important building block for the certification of the process for primary structures in aviation, which makes an important contribution to the establishment of thermoplastic structural concepts with rivet-free joints. Furthermore, the application of the QA system and an accompanying increase in process reliability will reduce the number of rejects.

Approach

In the HiQO (High Quality Overmoulding) research project, a system for in-situ quality assurance for the production of overmoulding components is being developed. The acquisition of relevant process data in the injection moulding cavity and a derived evaluation of the bond quality form the basis for process qualification without a 100% inspection downstream of the manufacturing process.

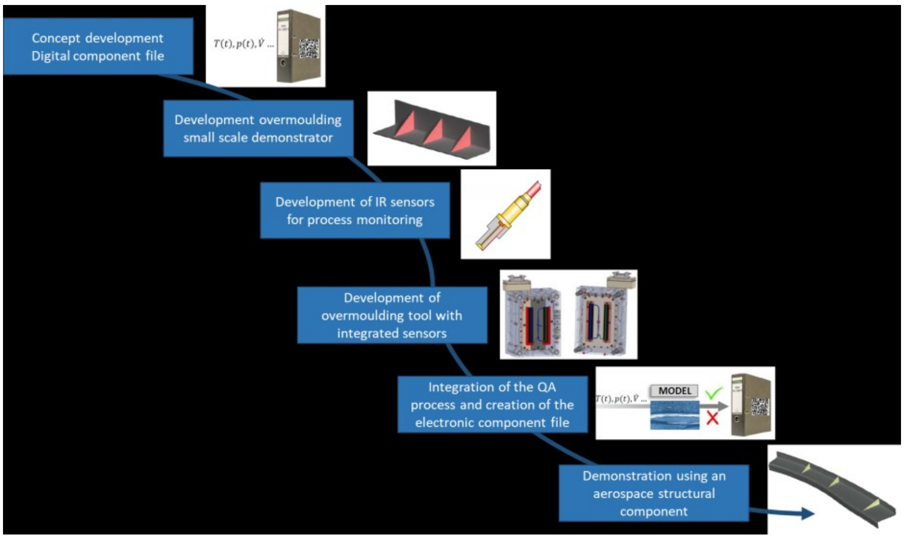

Figure 1: Work contents for the development of an online QA system for the overmoulding process.

In the project, the process window is narrowed down by an existing simulation methodology, which serves as the basis for predicting the bond quality. For data acquisition, an IR sensor system for determining local melt temperatures, flow velocities and insert temperatures is developed and integrated into a mould. The process variables measured online are compared with the modelled process window, evaluated and documented component-specifically in an electronic component file. By controlling the clamping force of the injection moulding machine, the cavity is sealed through the insert component and not through the tool. The range of applications is extended to large, locally stiffened components, which is demonstrated with a primary structural component from the aerospace sector.

In summary, the following objectives are being pursued in the QuaSimOdo project:

- Development of an overmoulding coupon demonstrator with integrated IR sensor technology for online process monitoring.
- Integration of the QA process into the production and storage of the recorded data and the quality assessment in an electronic component file.
- Demonstration using a primary structural component from the aerospace sector.

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Funding

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on the basis of a decision by the German Bundestag

The research project HiQO was funded through the federal ministry for economic affairs and energy (BMWi) as part of the „Luftfahrtforschungsprogramm“ research program (LuFo VI-1) to whom we would like to express our sincere thanks.

Funding period: 05/2021 – 04/2024

Project Partners

- FOS Messtechnik GmbH
- Kurz Kunststoffe GmbH
- Faserinstitut Bremen e.V.

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HyPaGear

Gearbox cover consisting of short fibre reinforced thermoplastics with integrated hybrid material patches based on endless fibres

Motivation

Today, one of the main challenges of lightweight design with fibre reinforced composites is to manufacture components with the required mechanical performance in series-production with short cycle times and low costs. Possible approaches are to align the cost-intensive reinforcing fibres locally along the load paths (tailored reinforcing inserts) and integrate it in large-scale production such as injection molding process (short fiber reinforced thermoplastics). The combination of continuous fibre reinforcements in areas of maximum loads and cheaper materials such as long fibre reinforced thermoplastic offers an efficient material application. Thereby, a required ratio of mechanical properties and attractive cost profile can be achieved.

Approach

The aim of the project "HyPaGear" is the development of a gearbox cover made of short fibre reinforced thermoplastics combined with a hybrid material patch based on endless fibres. The hybrid material patch represents the reinforcing frame of the component and consists of endless fibre. Therefore the fully automated Tailored Fibre Placement (TFP) technology is used, which allows to place fibres aligned with pre-determined directions of load forces. In addition, metallic inserts are integrated in the hybrid material patch. In that way bearings can be integrated.

Since the gearbox cover is a high-volume product, the process development is also part of the project. For this purpose, an automated process chain will be develop.

Figure 1: Process chain for manufacturing the gearbox cover consisting of short fibre reinforced thermoplastic and integrated hybrid material patch based on endless fibres on a test specimen level

To substitute the die-cast aluminium construction method in a new hybrid composite construction method successfully, following problems need to be investigated:

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- Material analysis regarding the component requirements
- Mechanical analysis of the gearbox cover and adaptation to the new hybrid composite construction
- Development of the bearing seat compatible to composites
- Process development of an automated process chain for the production of gearbox covers in high batch sizes

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Funding

The research project HyPaGear was funded through budgetary resources from the federal ministry for economic affairs and energy (BMWi) as part of Zentrales Innovationsprogramm Mittelstand research program (ZIM) to whom we would like to express our sincere thanks.

Funding period: 01/2017 – 12/2020

ZIM Zentrales Innovationsprogramm Mittelstand

Gefördert durch:

Bundesministerium für Wirtschaft und Energie

aufgrund eines Beschlusses des Deutschen Bundestages

Project Partners

- Weberit Werke Dräbing GmbH, Oberlahr
- Reiner Seefried GmbH – Schweiß- und Montagetechnik, Bremen
- Leipniz-Institut für Werkstofforientierte Technologien, Bremen

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PROJECTS

MOTHEPLA

Modelling of overmoulded thermoplastic Composites

Motivation

Overmoulding thermoplastic composites with a short fibre-reinforced injection moulding compound is one of the most attractive technologies for the future medium to large series production of structural components for passenger aircraft. The technology allows for placing the right material at the right place and is highly automatable.

The stronger use of advanced numerical simulation tools during the component development can help to save time and costs for design changes and tooling iteration loops. It also can reduce risks associated with the components mechanical performance and allow accurate predictions of strength and process-induced deformations.

Approach

The research project MOTHEPLA aims at the validation of existing and development of new simulation methods for overmoulded composite structures in order to provide a comprehensive virtual twin for composite overmoulding in the future. The virtual twin essentially comprises advanced manufacturing process simulations, structural simulations accounting for process-induced material and components properties as well as coupling methods for transferring relevant data between process and structural simulation steps.

In the project, we focus on a material system consisting of a common short carbon fibre filled PEEK-based injection moulding compound and a new continuous carbon fibre reinforced composite material based on a PAEK polymer with a lower melting point. The material system is characterised thermos-mechanically to provide all the relevant data for simulation model development and calibration.

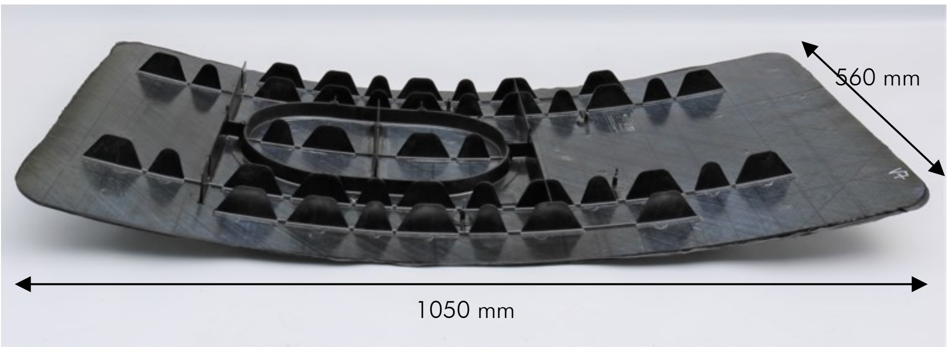

Figure 1: Overmoulded outer skin of the aircraft emergency exit door demonstrator made from PEEK carbon fibre composites in a single-step overmoulding process

Particularly, the formation and relaxation of residual stresses and the interface strength between moulding compound and composite inserts are investigated in depth. Therefore, dedicated test methods and overmoulding coupons are also developed.

The developed simulation methods are applied to a large demonstrator component featuring overmoulded rib structures. A comprehensive parameter study is conducted on the shape of the overmoulded rib foot. It can already be shown that residual stresses do have a significant effect on the optimal rib foot shape.

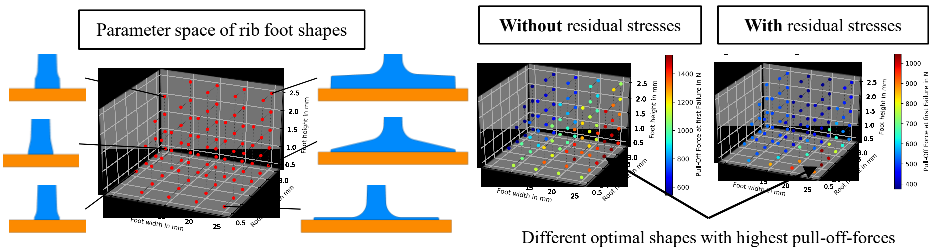

Figure 2: Simulation-based parameter study on overmoulded rib foot shapes using numerical finite elements models to account for interface strength and residual stresses

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Investing in Bremen's Future

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Project Partners

- Airbus Operations GmbH, Hamburg
- Airbus Helicopters Deutschland GmbH, Donauwörth
- Fraunhofer-Institut für Werkzeugmaschinen und Umformtechnik IWU, Chemnitz
- Neue Materialien Bayreuth GmbH, Bayreuth

Faserinstitut Bremen e.V.

Founded in 1969, the Faserinstitut Bremen e.V. (FIBRE) is a non-profit scientific institute specializing in fibre-polymer compounds and synthetic and natural fibres for technical textiles. The aim of the research is to support the industrial use of these material classes and to contribute to the sustainability of products by exploiting their outstanding property potential. To this end, a fundamental understanding of materials is used for the development of new materials, process technologies, (lightweight) designs as well as testing, measuring and monitoring methods. The basis for this is an interdisciplinary team of over 60 international employees who combine diverse specialist knowledge in the engineering sciences with expertise in chemistry, physics and computer science. Research is carried out in publicly funded basic and application-oriented research projects. FIBRE cooperates with its network of outstanding regional, national and international partners from industry and science. The Fiber Institute also offers industry partners direct support for materials science studies and individual development services.

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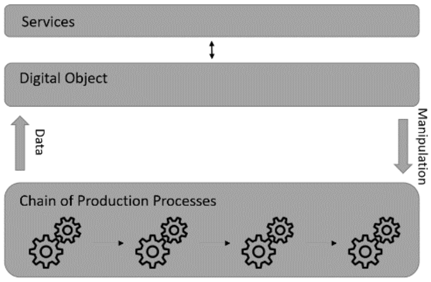
ThermoTwin / ConTwin

Development of an online-monitored consolidation process for hybrid thermoplastic preforms for the production of aerospace-specific components and investigation of joining processes to reduce emissions.

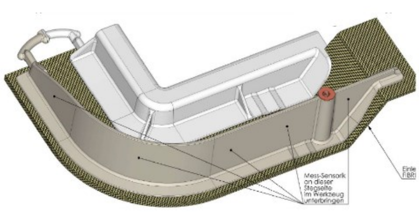
Motivation and Goal



In the global competition, the aviation industry is facing steadily increasing demands regarding the cost-effectiveness and resource efficiency of its products. One response to these demands is the use of fiber-reinforced composites for structural applications in aircraft. The significantly higher lightweight potential compared to metallic materials, combined with the suitability for functional integration, makes fiber-reinforced composites an attractive material for aviation and justifies their growing use. However, the economic potential of operating lighter aircraft is counterbalanced by the complex and expensive production processes for manufacturing composite components. In recent years, a widespread application of thermoplastic-based fiber-reinforced composites has been observed to make the production of composite components more economical. These offer clear advantages in terms of shorter production times and improved impact properties, but still need to make progress in terms of geometric variability, semi-finished product costs, and quality assurance in the respective sub-processes along the production chain. The development of a digitally connected process chain and a digital twin for the components to be produced serves quality assurance as well as scrap reduction, and can utilize the material's inherent advantages through adaptive process control for each individual component. The development of hybrid components is a key element that ideally fits into Airbus' strategy for a significant increase in load-bearing elements made from thermoplastic fiber-reinforced composites. This ensures interest in such solutions within the aviation industry and provides good prospects for the utilization of partial solutions by all partners.

Solution Approach

As part of this research project, the textile processing of hybrid yarns into load-optimized preforms, the optimization of processes for the production of structural continuous fiber-reinforced inserts, the functionalization of these inserts via overmolding, and the bonding through welding are being investigated.



ACE Composites GmbH is involved as a Tier 1 supplier in the creation of the demonstrator structure. OFFIS e. V. will map the entire process chain in a digital twin, capturing and modeling system data from the individual process steps. This will enable component-specific process control. The preforming of hybrid yarns will be carried out by Hightex Verstärkungsstrukturen GmbH, forming the starting point for the process chain under consideration. FIBRE focuses on the development of a consolidation process for hybrid-yarn-based preforms, utilizing mass-reduced molds to lower energy consumption. In addition, the welding of the manufactured structures for aerospace applications will be investigated using different techniques in collaboration with CTC GmbH. Construction methods tailored to the requirements of welding processes and the corresponding equipment will be developed.

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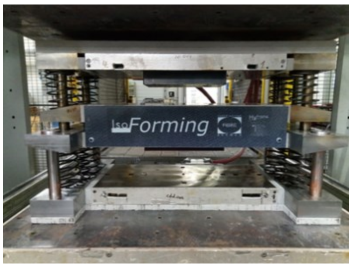
The recording of process parameters and the control of the processes will be investigated for both consolidation and welding. The networking of processes via the digital twin is intended to create an interaction capability that allows access to quality characteristics of the preceding process. By individually adapting the manufacturing process for each component, scrap production will be reduced, thus lowering resource consumption.



The overmolding of the structural inserts will be carried out by MERKUTEC GmbH & Co. KG, with a focus on local overmolding, optimization of temperature control, and monitoring of the manufacturing process. The entire process chain will be ecologically assessed in parallel by e-hoch-3 eco impact experts GmbH & Co. KG and compared with the state-of-the-art methods for manufacturing the respective components.
Weight and cost reduction of the components under consideration are to be achieved primarily through the welding connection, which is currently predominantly implemented in aircraft construction using Hi-Lock fasteners.

Possible Applications

Structural components for aerospace applications are the central focus, with additional applications in space or medical technology being possible based on the development. By using more cost-effective matrix materials, application scenarios in the automotive or agricultural machinery industries may also arise.

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Supported by:
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Project Partners

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- Hightex Verstärkungsstrukturen GmbH
- Faserinstitut Bremen e.V
- MERKUTEC GmbH & Co.KG
- OFFIS - Institut für Informatik
- e-hoch-3 eco impact experts GmbH & Co. KG

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