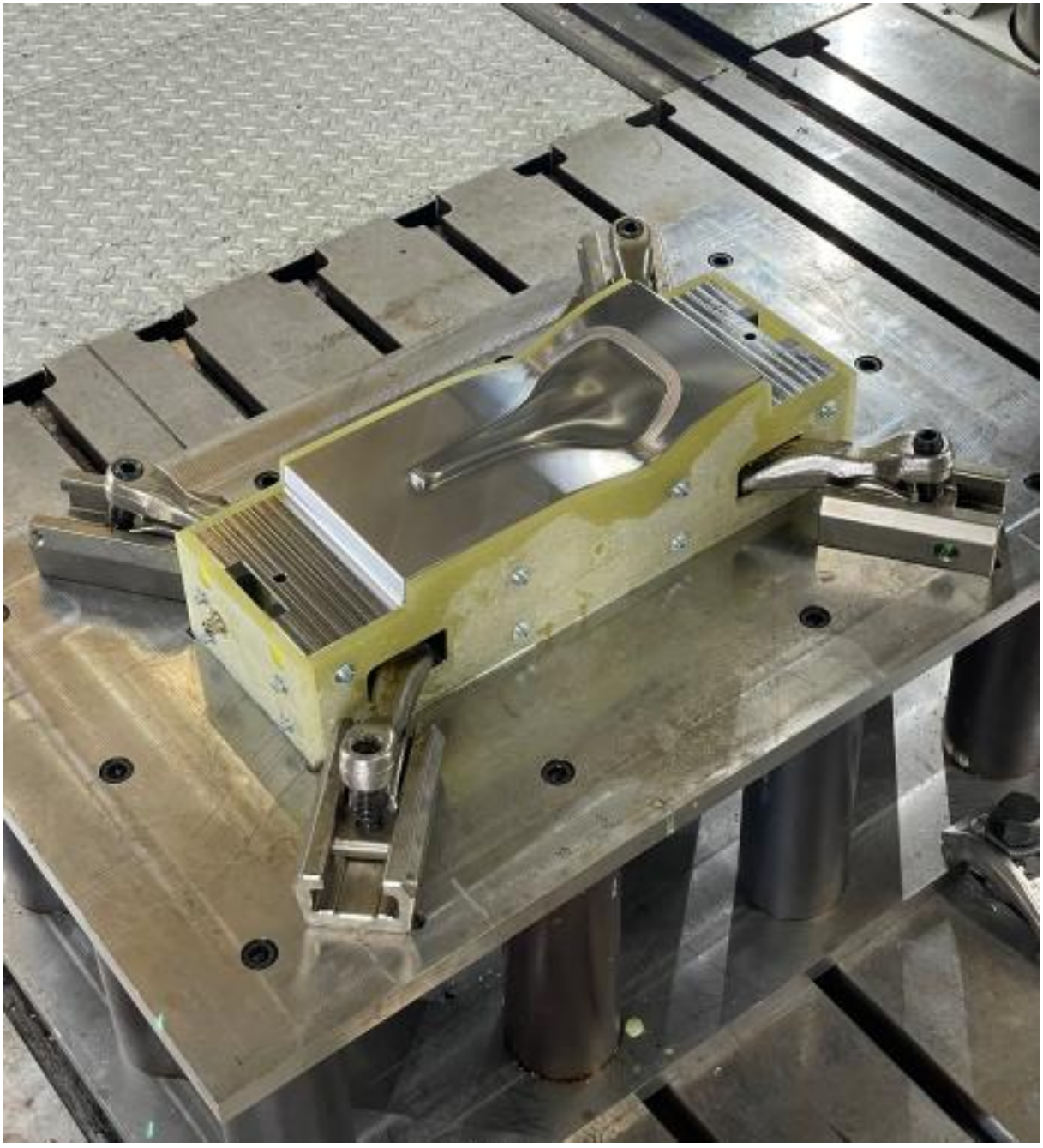
Bio-based composite components: Developing a vibration-supported, digital process chain

About this project



VIBRIO

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About this project

Markets:

Material: Others (Natural fibre reinforced plastic (NFK)), Carbon fibres, Natural fibres, Others (Fibre orientation, thermoplastic functionalisation), Thermoplastics, Laid webs, Natural fibre reinforced plastics (NFRP)

This project is funded by the Technology Transfer Programme Leichtbau (TTP LB) of the Federal Ministry of Economics and Energy.

Technology Transfer Program Leichtbau

Context

Many lightweight components today consist of fibre-reinforced plastics with glass or carbon fibres and petroleum-based, thermoset matrix materials. These materials offer good mechanical properties, but cause comparatively high greenhouse gas emissions during production and processing and can only be recycled to a very limited extent. Natural fibre-reinforced composites with a thermoplastic matrix can be an alternative here. They have a low density, good damping properties and a significantly lower ecological footprint. They also offer a high degree of recyclability thanks to modern recycling processes.

For use in mechanically stressed components, however, these materials must be produced reliably and with consistent quality. In established continuous pressing processes, natural fibres can only be processed to a limited extent. This often results in uneven fibre distribution or insufficient penetration of the fibres with the plastic melt. This leads to quality deviations and usually limits the area of application to non-structural components.

In addition, many industrial heating processes work with high energy input. At the same time, the natural variability of the fibres makes stable process control difficult. Adapted, energy-efficient and digitally supported production processes are therefore required for industrial use.

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Purpose

In the VIBRIO project, the participants are developing a process chain for the production of highly functionalised, bio-based composite components. The aim is to produce natural fibre-reinforced semi-finished products suitable for series production with uniform penetration of the natural fibres and reproducibly high material properties.

A central approach is vibration-assisted processing during the impregnation process of the semi-finished products. The vibration improves the flow behaviour of the plastic melt and thus supports penetration into the fibre structure without exceeding the critical temperature limits of the natural fibres.

On this basis, the project partners are developing functionalised lightweight structures. With local reinforcements along the load path and integrated functional elements, the team is increasing structural performance while reducing the amount of material used. By manufacturing demonstrator components, they validate both the effectiveness of the manufacturing process and the feasibility of market-ready series components in industry. In addition, the researchers are developing a digital twin of the process chain that uses process data to stabilise process control and improve component quality.

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Procedure

To begin with, the researchers are analysing the requirements for materials, component geometry and process control for natural fibre-reinforced, bio-based plastics. Based on this, they are developing a vibration system for an energy-efficient, inductively heated double belt press and integrating it into the continuous production process.

In experimental studies, the project partners are optimising process parameters such as temperature, pressure and vibration excitation in order to achieve uniform penetration of the natural fibres, optimise mechanical material properties and stabilise the production of semi-finished products.

They then adapt established processes for further processing to the bio-based materials. These include tape reinforcement for load-path-compatible fibre orientation, thermoforming to produce the component geometry and back injection moulding to integrate additional functional elements.

At the same time, the researchers record process and quality data along the entire process chain. This data flows into a digital image of production and supports the analysis and optimisation of process control.

As a demonstration, the participants are manufacturing and testing a bicycle saddle shell made of natural fibre-reinforced thermoplastic biocomposite. The demonstrator component also shows the functionality of the process chain for series components and illustrates the transferability to other lightweight construction applications.

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About this project



Funding duration:

Funding sign:	03LB3102	**Funding amount:**	EUR 1.7 million

Final report

Further websites foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB3102A - VIBRIO in the federal funding catalogue

Bio-based composite components: Developing a vibration-supported, digital process chain

Project coordination

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English (EN){{ Projektpartner }}

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Lightweighting classification

	Realisation
Offer	
Products Parts and components, Semi-finished parts, Materials	✓
Services & consulting Consulting, Prototyping, Simulation, Technology transfer	✓
Field of technology	
Design & layout Lightweight material construction	✓
Functional integration Material functionalisation	✓
Measuring and testing technology Component and part analysis, Materials analysis	✓
Modelling and simulation Life-cycle analysis, Processes, Materials, Reliability validation	✓
Plant construction & automation	
Recycling technologies Recycling	✓

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Lightweighting classification

	Realisation
Manufacturing process	
Additive manufacturing Laminated object manufacturing (LOM)	✓
Coating (surface engineering) Others (Elastomer coating)	✓
Fibre composite technology Fibre spraying, Resin transfer moulding, Pre-preg processing, Others (Organosheet production, thermoplastic tape placement)	✓
Forming Thermal converting, Others (Vibration-supported double belt press)	✓
Joining Welding	✓
Material property alteration Thermomechanical treatment	✓
Primary forming Others (Thermoforming, back injection moulding)	✓
Processing and separating Others (Fluid release agents, melting)	✓
Textile technology Knitting, laid web production, Others (Organosheet production)	✓

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Lightweighting classification

	Realisation
Material	
Biogenic materials Others (Natural fibre reinforced plastic (NFK))	✓
Cellular materials (foam materials)	
Composites Natural fibre reinforced plastics (NFRP)	✓
Fibres Carbon fibres, Natural fibres	✓
Functional materials Others (Fibre orientation, thermoplastic functionalisation)	✓
Metals	
Plastics Thermoplastics	✓
Structural ceramics	
(Technical) textiles Laid webs	✓