Hybrid lightweight structures made of FRP and metals: enabling automated production

About this project

Hybrid-Switch

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Markets:

Material: Glass fibres, Carbon fibres, Metal fibres, Thermoset plastics, Thermoplastics, Aluminium, Steel, Yarns, rovings, Laid webs, Crocheted fabrics, Woven fabrics, Glass-fiber reinforced plastics (GFRP), Carbon-fiber reinforced plastics (CFRP), Metal-fibre-polymer composite

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Technology Transfer Program Leichtbau

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Context

Companies are increasingly focussing on hybrid lightweight construction in order to make technical systems more efficient and resource-saving. They are specifically combining different materials - such as metals and fibre-reinforced plastic composites (FRP) - in one component. This combination unites the strengths of both materials: high strength, low weight and design flexibility. This results in components that are specifically adapted to local loads.

In practice, however, the widespread use of such hybrid components often fails due to a lack of joining methods and automated production processes. The technologies available to date can usually only be implemented on a laboratory scale or with a great deal of manual effort. The transitions between FRP and metal are challenging in terms of design and difficult to integrate into existing production chains. At the same time, insufficient recycling options and a lack of life cycle analyses make sustainable application difficult.

Purpose

This is precisely where the Hybrid-Switch project team comes in. The partners are developing automated, production-ready manufacturing processes for hybrid lightweight structures made of FRP and metals. To this end, the researchers are developing automated manufacturing processes that can be integrated into existing production environments and can also be used in small and medium-sized companies.

The focus is on transferring new hybrid joining technologies to established series production processes: Pultrusion, resin injection processes and injection moulding. The researchers design components with integrated functions and deliberately dispense with additional connecting elements. This reduces the number of individual parts, simplifies assembly and increases resource efficiency. At the same time, they are extending the range of applications of classic joining processes such as welding and riveting to hybrid material systems.

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Procedure

The project team is pursuing three technical approaches - each focussing on different component types and manufacturing processes. One focus is on the production of hybrid-reinforced profiles. The partners are combining textile metal structures with fibre composite systems and integrating them into the pultrusion process - a continuous manufacturing process for producing profile-shaped components. The researchers are testing this technology on a demonstrator from the commercial vehicle sector, specifically a hybrid profile connector.

In a second approach, the researchers are developing hybrid pipe connections. Here, they are adapting existing round textiles for use in resin injection and winding processes. The aim is to develop a manufacturing process for resilient, electrically insulating tube components that is suitable for series production. To this end, they are developing a hybrid pipe connector in pipeline construction as a demonstrator.

The team is also investigating how hybrid textiles can be specifically integrated as local reinforcing elements in the injection moulding process.

The project partners are testing all processes using practical demonstrators. They are analysing mechanical characteristics, material transitions and interfaces. At the same time, they evaluate the recyclability and ecological impact using life cycle analyses. A continuous transfer of knowledge between the technical lines ensures that the technologies developed are scalable and can be used across industries.

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Funding duration:

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Final report

Further websites foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB2043A - Hybrid switch in the federal funding catalogue

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Project coordination

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English (EN){{ Projektpartner }}

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Lightweighting classification

	Realisation
Offer	
Products Parts and components, Semi-finished parts, Software & databases	✓
Services & consulting Consulting, Testing and trials, Engineering, Validation, Simulation, Technology transfer	✓
Field of technology	
Design & layout Hybrid structures, Lightweight construction concepts, Lightweight material construction	✓
Functional integration	
Measuring and testing technology Component and part analysis, Destructive analysis, Non-destructive analysis	✓
Modelling and simulation Loads & stress, Life-cycle analysis	✓
Plant construction & automation	
Recycling technologies Material separation, Recycling	✓

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Lightweighting classification

	Realisation
Manufacturing process	
Additive manufacturing	
Coating (surface engineering)	
Fibre composite technology Filament winding, Resin infusion process, Resin transfer moulding, Vacuum infusion, Others (Pultrusion)	✓
Forming	
Joining Hybrid joining, Adhesive bonding, Welding	✓
Material property alteration	
Primary forming Pultrusion	✓
Processing and separating	
Textile technology Knitting	✓

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Lightweighting classification

	Realisation
Material	
Biogenic materials	
Cellular materials (foam materials)	
Composites Glass-fiber reinforced plastics (GFRP), Carbon-fiber reinforced plastics (CFRP), Metal-fibre-polymer composite	✓
Fibres Glass fibres, Carbon fibres, Metal fibres	✓
Functional materials	
Metals Aluminium, Steel	✓
Plastics Thermoset plastics, Thermoplastics	✓
Structural ceramics	
(Technical) textiles Yarns, rovings, Laid webs, Crocheted fabrics, Woven fabrics	✓