Digitalisation for circularity: design for recycling in lightweight fibre construction

About this project

DiDe4Rec

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Markets: 

Material: Glass fibres, Thermoplastics, Nonwovens, mats, Glass-fiber reinforced plastics (GFRP)

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

Lightweight components made from fibre-reinforced plastics are stable and light at the same time. Their low weight reduces the consumption of resources - both during production and during use. To ensure that this advantage is not lost, the components must be designed in such a way that their materials can be separated, recycled and reused after use.

However, a method that systematically combines design, material selection and material behaviour over the entire life cycle is still lacking. Many approaches only consider individual materials or process steps without recognising their interactions. Hybrid structures and fluctuating properties of recycled materials are particularly challenging.

This is where the DiDe4Rec project comes in. The focus is on the "Design for Recycling" approach - in other words, the design of products whose recyclability is considered from the outset. The research team links product design, material selection and process data from production to the recycling process. This makes it possible to understand how design decisions affect recyclability, energy requirements and material efficiency.

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Purpose

The researchers are pursuing the goal of systematically developing the "design for recycling" approach for fibre-reinforced lightweight structures. The project team combines ecological, technical and economic requirements in an end-to-end development process. To this end, the researchers are collecting material, process and environmental data along the entire product life cycle - from separation and processing to reuse and utilisation.

Building on this, the scientists are developing digital tools that can be used to assess recyclability and product quality as early as the development phase. Dynamic material maps that depict the proportion of recycled material and material history play a central role. They enable simulations that realistically depict the behaviour of components with recyclates. The researchers' aim is to significantly increase the proportion of recycled materials without compromising function or safety. The approach is transferable to different materials, processes and industries.

Procedure

The research team is investigating two production routes: Thermoforming and injection moulding. Firstly, the researchers collect data on simple samples in order to validate measurement systems and digital models. They then transfer the processes to complex demonstrators. In doing so, they document material flows from thermoset and thermoplastic starting materials, analyse property fluctuations and develop strategies for adaptive process control.

AI-supported analyses detect deviations in real time and suggest adjustments to ensure product quality despite fluctuating recyclate properties. At the same time, dynamic material maps are created that describe the behaviour of the materials over several life cycles. The information obtained flows into simulations and supports a "design for recycling" in which function, durability and recyclability are considered together from the outset.

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Funding duration:

Funding sign:	03LB3047	**Funding amount:**	EUR 2.6 million

Final report

Further websites foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB3047A - DiDe4Rec in the federal funding catalogue

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Project coordination

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Lightweighting classification

	Realisation
Offer	
Products Parts and components, Machines and plants, Software & databases, Materials	✓
Services & consulting Testing and trials, Simulation, Technology transfer	✓
Field of technology	
Design & layout Lightweight manufacturing, Hybrid structures	✓
Functional integration	
Measuring and testing technology Component and part analysis, Environmental simulation, Materials analysis	✓
Modelling and simulation Life-cycle analysis, Materials, Reliability validation	✓
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	
Forming Thermal converting	✓
Joining	
Material property alteration	
Primary forming Injection moulding	✓
Processing and separating	
Textile technology Nonwoven & mats production	✓
Material	
Biogenic materials	
Cellular materials (foam materials)	
Composites Glass-fiber reinforced plastics (GFRP)	✓
Fibres Glass fibres	✓
Functional materials	
Metals	
Plastics Thermoplastics	✓
Structural ceramics	
(Technical) textiles Nonwovens, mats	✓