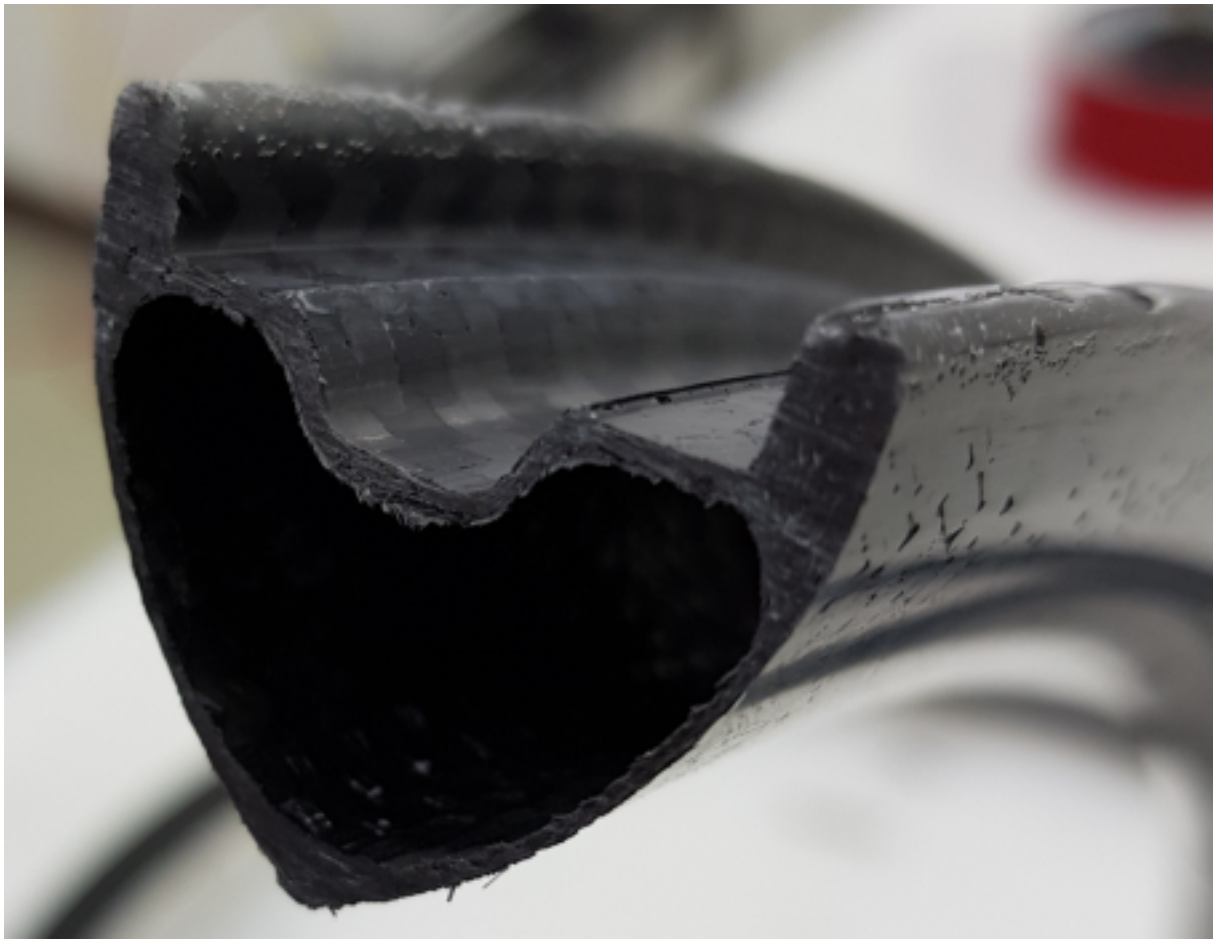
Developing lightweight and safe CFRP rims: damage detection through integrated sensors

About this project



ProVeS

Developing lightweight and safe CFRP rims: damage detection through integrated sensors

Markets:

Material: Carbon fibres, Thermoset plastics, Laid webs, Woven fabrics, Carbon-fiber reinforced plastics (CFRP)

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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 construction is a key technology for making vehicles more efficient and sustainable. In the automotive sector, the demand for components that are both lightweight and resilient is constantly growing. Carbon fibre reinforced plastics (CFRP) offer great potential for this, as they enable a significant reduction in weight with high stability. However, the industry is faced with the challenge of producing CFRP economically and sustainably in series. So far, this has mainly failed due to high production costs, complex manufacturing processes and the limited use of sustainable materials.

This is precisely where the ProVeS project comes in: The project team is developing an improved process chain to produce CFRP rims with integrated failure sensors in a cost-efficient manner. The researchers are combining new production techniques with intelligent sensors in order to utilise materials in a more targeted manner and increase operational safety.

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Purpose

The researchers' main goal is to develop an industrially applicable process chain for the production of CFRP rims with integrated failure sensors. The aim is to detect damage such as delamination - i.e. the detachment of individual layers in material composites - or material fatigue at an early stage and make operation safer and more cost-efficient. In the future, the sensor technology should also enable integration into digital maintenance concepts (predictive maintenance).

The development of a vacuum-assisted tube blowing process - a special shaping process in which an inflatable core presses the CFRP material into the desired shape - and thermographic component testing are intended to ensure the quality of the rims and optimise the use of materials. This makes it possible to dispense with oversized safety reserves, which leads to a further reduction in weight and material.

At the same time, the team is working on automating processes such as the tube blowing process and making them suitable for series production. The aim is to reduce the use of materials and energy, minimise waste and ensure reproducible quality. The team wants to create the conditions for CFRP rims to transition from a niche solution to widespread use in vehicles of various categories - from bicycles and cars to leisure and sports applications.

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Procedure

First, the researchers analyse existing manufacturing processes for CFRP rims in order to identify weaknesses and potential for optimisation. Based on this, they are developing a vacuum-assisted tube blow moulding process that enables targeted material distribution and improved structural properties.

For structural monitoring, they define various use cases and derive the requirements for a sensor-monitored rim. Using simplified models and analyses with the finite element method (FEM) - a computer-aided process for simulating mechanical loads - they identify critical areas and optimise sensor positioning.

Carbon fibre sensors are used, which are first validated in coupon tests - i.e. standardised material tests on small samples - and then under real loads.

A specially developed thermographic testing method enables the non-destructive detection of defects. The knowledge gained flows into quality assurance and the preparation for series production.

Through this approach, the team develops practical solutions and ensures transferability to industrial practice as well as continuous improvement of the process chain.

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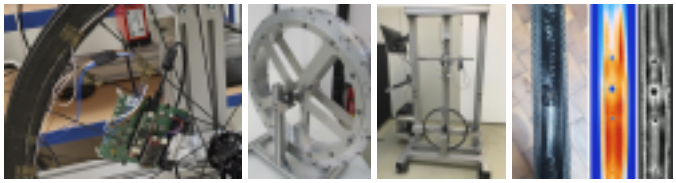

Funding duration:

Funding sign:	03LB4008	**Funding amount:**	EUR 823 thousand

Final report

Further websites foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB4008A - ProVeS in the federal funding catalogue

Project coordination

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English (EN){{ Projektpartner }}

Lightweighting classification

	Realisation
Offer	
Products	
Services & consulting	
Field of technology	
Design & layout Lightweight manufacturing	✓
Functional integration Sensor technology	✓
Measuring and testing technology Component and part analysis, Non-destructive analysis	✓
Modelling and simulation Loads & stress, Structural mechanics	✓
Plant construction & automation	
Recycling technologies	

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Lightweighting classification

	Realisation
Manufacturing process	
Additive manufacturing	
Coating (surface engineering)	
Fibre composite technology Vacuum infusion	✓
Forming	
Joining Adhesive bonding	✓
Material property alteration	
Primary forming	
Processing and separating	
Textile technology	
Material	
Biogenic materials	
Cellular materials (foam materials)	
Composites Carbon-fiber reinforced plastics (CFRP)	✓
Fibres Carbon fibres	✓
Functional materials	
Metals	
Plastics Thermoset plastics	✓
Structural ceramics	
(Technical) textiles Laid webs, Woven fabrics	✓