Integrating sensors via pultrusion: Measuring loads in fibre composite components

About this project

FI:IL

Integrating sensors via pultrusion: Measuring loads in fibre composite components

Markets:

Material: Glass fibres, Thermoset plastics, Yarns, rovings, Woven fabrics, Nonwovens, mats, Glass-fiber reinforced plastics (GFRP)

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Technology Transfer Program Leichtbau

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Context

Fibre-reinforced plastics (FRP) enable lightweight yet strong components. However, the potential of this lightweight material has not yet been fully utilised. A central starting point lies in the targeted integration of additional functions: If components not only act mechanically, but also provide information about their load and condition, maintenance strategies can be optimised, resources saved and service life extended.

In practice, however, this functional integration often fails due to high costs or complex technology. Sensors are usually retrofitted, which is costly, inaccurate and not very robust. In addition, the market for smart FRP components has so far been limited to expensive high-performance applications.
In order to change this, new approaches are needed that are economical and transferable to many applications - such as bridges, wind turbines or cargo bikes. This is where the FI:IL project comes in.

Purpose

The project participants are developing an intelligent FRP component with integrated sensors - the so-called "functionally integrated intelligent lamella". This new component should be able to permanently measure how much strain is placed on it - for example through stretching. Unlike existing systems, the project partners are using a textile carrier material with embedded sensors that are precisely integrated into the structure during production.

The sensors are coupled with a simple BUS system, short for Binary Unit System, a structured data connection via which several electronic components can communicate with each other. This makes the measurements not only robust and reliable, but also inexpensive to realise and therefore economically attractive.

The researchers are also aiming to combine sensor integration with the pultrusion process, which is suitable for large-scale production. This results in a lightweight, resilient and at the same time cost-effective structural component. In terms of predictive maintenance, this component can provide information for the maintenance and design of future components. The aim is to reduce CO# emissions not only during operation, but also through improved component design during development.

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Procedure

The project team is developing a textile semi-finished product that combines sensor technology and data transmission. The aim is to record strains along the component axis in a spatially resolved manner - with high accuracy and low effort. The sensor elements are positioned precisely on the carrier material before moulding. The partners then integrate this semi-finished product into the plastic component - using pultrusion, an energy- and material-efficient process for manufacturing continuous fibre-reinforced profiles. In this way, they create an intelligent structural component that can be produced economically in series.

To demonstrate the broad application potential, the project team is developing three exemplary use cases: In bridges, the stress state can be continuously monitored and the service life extended. In cargo bikes, the sensor system warns of overloading, protects the riders and extends the service life. In wind turbine rotor blades, the system enables permanent load measurement. All three applications illustrate how mechanical functionality, sensor integration and production-ready manufacturing technology can be combined in one component - with the aim of realising resource-efficient and resilient structures.

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Funding duration:

Funding sign:	03LB3024	**Funding amount:**	EUR 1.2 million

Final report

Further websites foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB3024A - FI:IL in the federal funding catalogue

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English (EN){{ Projektpartner }}

Lightweighting classification

	Realisation
Offer	
Products Semi-finished parts, Materials	✓
Services & consulting	

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Lightweighting classification

	Realisation
Field of technology	
Design & layout	
Functional integration Sensor technology	✓
Measuring and testing technology Component and part analysis	✓
Modelling and simulation	
Plant construction & automation	
Recycling technologies	
Manufacturing process	
Additive manufacturing	
Coating (surface engineering)	
Fibre composite technology	
Forming	
Joining	
Material property alteration	
Primary forming Pultrusion	✓
Processing and separating	
Textile technology	

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Lightweighting classification

	Realisation
Material	
Biogenic materials	
Cellular materials (foam materials)	
Composites Glass-fiber reinforced plastics (GFRP)	✓
Fibres Glass fibres	✓
Functional materials	
Metals	
Plastics Thermoset plastics	✓
Structural ceramics	
(Technical) textiles Yarns, rovings, Woven fabrics, Nonwovens, mats	✓