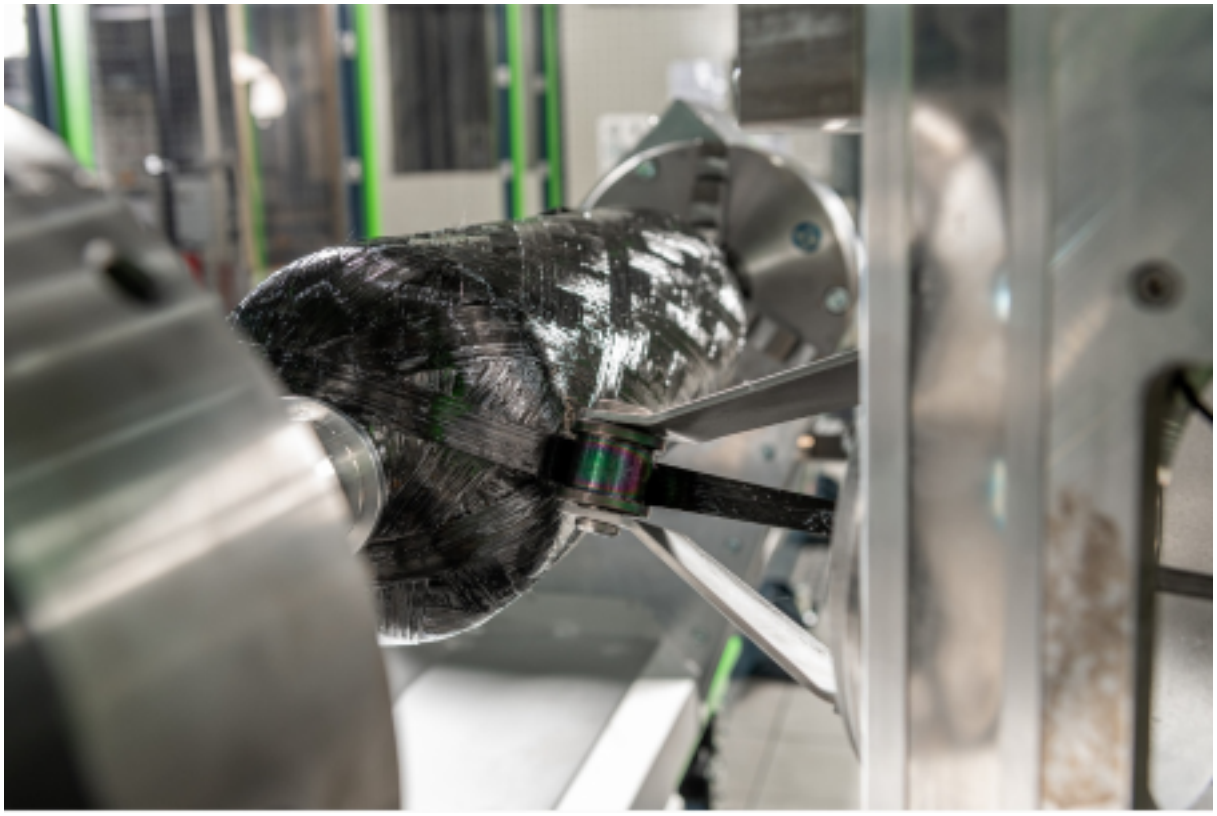
Carbon fibre composite pressure vessel for hydrogen: using materials more efficiently

About this project



DAVID

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Markets:

Material: Carbon fibres, Thermoset plastics, Elastomers, Thermoplastics, Aluminium, Steel, Yarns, rovings, 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

Hydrogen is particularly interesting for vehicles that require large amounts of energy and long ranges, such as lorries, buses, trains and ships. In order for them to run on hydrogen, it must be stored safely and in a space-saving manner. For mobile applications, low weight is also important so that energy requirements and payload are not unnecessarily impaired.

Pressure vessels made of carbon fibre reinforced plastics (CFRP) offer good conditions for this. They combine high strength with low weight and are therefore gaining in importance both in vehicles and in the hydrogen infrastructure. However, their production requires large quantities of energy-intensive carbon fibres in particular, as well as resins, thermoplastic liners, metal connectors and seals. At the same time, the complex requirements of production, operation and ageing make it difficult to utilise the material particularly efficiently. This is precisely where the DAVID research project comes in.

Purpose

The project partners are developing methods with which CFRP pressure vessels for hydrogen applications can be designed and manufactured in a more material-efficient, economical and climate-friendly way. To this end, the team is recording and evaluating influences from production, material behaviour, stress and ageing. On this basis, the researchers want to adapt the use of materials more specifically to the requirements of the container. The aim is to reduce the need for carbon fibres to ensure safe operation.

At the same time, the researchers want to avoid rejects, improve quality assurance and make production more efficient by developing process monitoring methods. Over the entire service life of the containers, they also want to describe the damage behaviour more reliably than has been possible to date. The knowledge gained will be incorporated into digital methods for development, evaluation and quality assurance. In this way, the project team is creating the basis for high-performance and safe CFRP pressure vessels with reduced resource consumption and lower CO2 emissions during production.

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Procedure

The project partners are combining production technology, material development, digital modelling and testing into an integrated development approach. Firstly, they are developing an inline-capable process monitoring system for winding the containers. This will enable them to detect production-related deviations, such as in fibre placement, fibre volume content or layer structure, much more accurately than before. The partners are also testing alternative materials and production strategies, such as the use of towpregs, i.e. pre-impregnated carbon fibre bundles, and new approaches for liner production.

At the same time, the researchers are expanding the digital 3D reconstruction of the container and linking it with models for design and evaluation. On this basis, the team is building a digital twin that combines production data, material characteristics and loads over the service life.

It also analyses materials and components under application-related conditions. These include cyclical and thermal loads as well as the influence of hydrogen as a medium. The investigation serves as a basis for the application-oriented modelling of the pressure vessels, taking into account realistic boundary conditions and factory behaviour.

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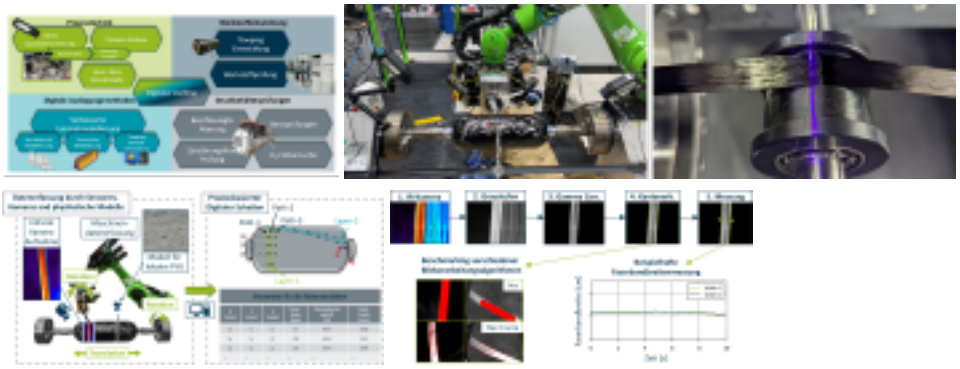

Funding duration:

Funding sign: 03LB3099 **Funding amount:** EUR 4.3 million

Final report

Further websites foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB3099A - DAVID 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, Systems and end products, Materials	✓
Services & consulting Consulting, Testing and trials, Engineering, Prototyping, Validation, Simulation, Technology transfer	✓
Field of technology	
Design & layout Lightweight manufacturing, Hybrid structures, Lightweight material construction	✓
Functional integration Sensor technology	✓
Measuring and testing technology Component and part analysis, Materials analysis, Destructive analysis, Non-destructive analysis	✓
Modelling and simulation Loads & stress, Life-cycle analysis, Multiphysics simulation, Optimisation, Processes, Structural mechanics, Materials, Reliability validation	✓
Plant construction & automation Plant construction, Automation technology	✓
Recycling technologies	

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Lightweighting classification

	Realisation
Manufacturing process	
Additive manufacturing	
Coating (surface engineering)	
Fibre composite technology Filament winding, Pre-preg processing	✓
Forming	
Joining	
Material property alteration	
Primary forming Extrusion	✓
Processing and separating	
Textile technology	
Material	
Biogenic materials	
Cellular materials (foam materials)	
Composites Carbon-fiber reinforced plastics (CFRP)	✓
Fibres Carbon fibres	✓
Functional materials	
Metals Aluminium, Steel	✓
Plastics Thermoset plastics, Elastomers, Thermoplastics	✓
Structural ceramics	
(Technical) textiles Yarns, rovings	✓