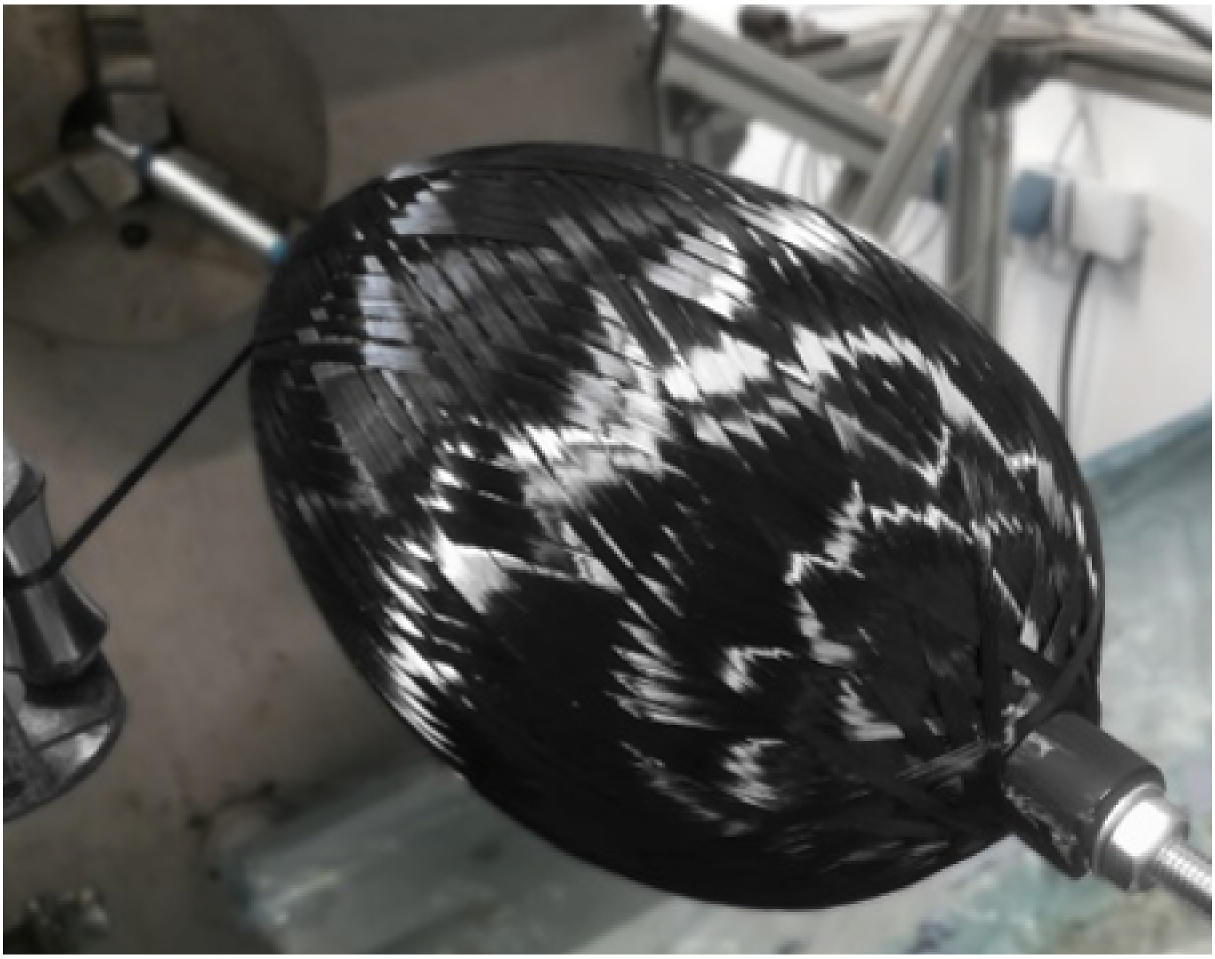
Optimising high-pressure storage for hydrogen: load-bearing liner made of FRP

About this project



SelbsttragenderLiner

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Markets:

Material: Carbon fibres, Others (Electrically conductive material/ lacquer), Thermoset plastics, Aluminium, Steel, Titanium, Others (Metal coating material; titanium almunium nitride, nickel-chrome, zinc, nickel, copper, chrome, tin), Yarns, rovings, 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

Hydrogen-based drives make an important contribution to climate-neutral mobility - especially in areas such as aviation, heavy goods transport and shipping. In order to achieve the high storage densities, hydrogen is generally stored in pressurised containers. Currently, the focus is on type IV pressurised containers due to their high load capacity and excellent performance. These tanks consist of an inner plastic liner, which provides the necessary diffusion tightness, and a laminate structure (usually wet-wound) made of carbon fibre reinforced plastic (CFRP), which is applied on top and serves to absorb the load. This makes the containers light and efficient. However, their storage life is limited, as hydrogen can gradually escape through the material. Maintenance and servicing are also costly.

Lightweight construction offers the opportunity to further reduce mass, material usage and energy requirements. At the same time, digitally monitorable structures are becoming increasingly important in order to make operation safer, more economical and controllable based on data.

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Purpose

In the Self-SupportingLiner research project, the team is developing a new high-pressure storage system for hydrogen that is significantly lighter, more durable and more economical than previous systems. For the first time, the participants are combining a load-bearing liner made of fibre-reinforced plastic (FRP) with a laminate structure made of the same material. In this case, the liner functions both as a diffusion seal and as a load-bearing structure and serves as a winding core for the laminate structure. An intermediate diffusion barrier layer increases the diffusion tightness.

In addition, the partners are integrating a sensor system (Structural Health Monitoring - SHM) that continuously records mechanical loads during operation. This combination allows safety reserves to be designed more precisely and maintenance measures to be planned in a targeted manner.

The researchers are pursuing several goals with their approach: They want to reduce the overall weight of the container by around 30 per cent, cut manufacturing costs by around 20 per cent and limit hydrogen loss to a maximum of 50 grams per hour. The storage system developed should be suitable for use across all sectors - in commercial vehicles, trains, ships and light aircraft. The project partners are thus creating a basis for efficient and resource-saving storage solutions that can contribute to the broad application of hydrogen mobility.

Procedure

The project team combines further developments in materials technology with automated production and digital structure monitoring. The focus is on Automated Fiber Placement (AFP) - a computer-controlled fibre placement process from the aviation industry. It enables carbon fibre tapes to be applied precisely along predefined load paths. The researchers use AFP to wind a load-bearing laminate structure directly onto a load-bearing liner made of fibre-reinforced plastic. Between the two components, they apply a diffusion-tight barrier layer - made of metal or thermoplastic, for example - to improve the long-term impermeability of the container.

At the same time, the project partners are integrating a structural health monitoring system based on fibre Bragg grating sensors. These sensors record strains in the material in real time and provide continuous data on the structural condition. The researchers use this information to control container operation safely and efficiently.

Maintenance is no longer carried out at fixed intervals, but when actually required. This creates an overall technical concept - from material selection and automated production to digital condition monitoring. The project thus brings together the key requirements of lightweight construction, hydrogen technology and digitalisation.

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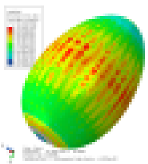
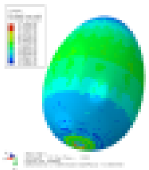
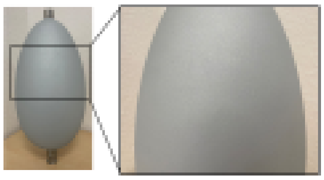

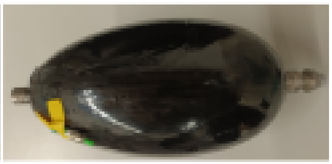
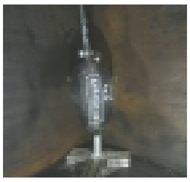

Funding duration:

Funding sign:	03LB2032	**Funding amount:**	EUR 1.2 million

Final report

Further websites

foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB2032A - Self-supporting liner in the federal funding catalogue

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Project coordination

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English (EN){{ Projektpartner }}

Lightweighting classification

	Realisation
Offer	
Products Semi-finished parts, Machines and plants, Software & databases, Materials	✓
Services & consulting Testing and trials, Engineering, Prototyping, Validation, Technology transfer	✓

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Lightweighting classification

Field of technology	Realisation
Design & layout Lightweight manufacturing, Lightweight construction concepts	✓
Functional integration Sensor technology, Material functionalisation	✓
Measuring and testing technology Component and part analysis, Materials analysis, Destructive analysis, Non-destructive analysis	✓
Modelling and simulation Crash behaviour, Loads & stress, Optimisation, Structural mechanics, Materials, Reliability validation	✓
Plant construction & automation Plant construction, Automation technology	✓
Recycling technologies Recycling	✓

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Lightweighting classification

	Realisation
Manufacturing process	
Additive manufacturing Others (Automated fibre placement (winding process))	✓
Coating (surface engineering) Galvanising, Painting, Plasma process, Powder coating, Sputtering, Others (Laminating)	✓
Fibre composite technology Manual lamination, Pre-preg processing	✓
Forming	
Joining Adhesive bonding, Others (Form-fit connection by wrapping the various container components and subsequent curing)	✓
Material property alteration Thermomechanical treatment, Heat treatment	✓
Primary forming	
Processing and separating Others (winding)	✓
Textile technology Yarn & roving production, Preforming, Others (winding)	✓

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Lightweighting classification

	Realisation
Material	
Biogenic materials	
Cellular materials (foam materials)	
Composites Carbon-fiber reinforced plastics (CFRP)	✓
Fibres Carbon fibres	✓
Functional materials Others (Electrically conductive material/ lacquer)	✓
Metals Aluminium, Steel, Titanium, Others (Metal coating material; titanium almunium nitride, nickel-chrome, zinc, nickel, copper, chrome, tin)	✓
Plastics Thermoset plastics	✓
Structural ceramics	
(Technical) textiles Yarns, rovings, Woven fabrics	✓