

Hybrid foams for lightweight impact structures: Integrating anchors into production

About this project



HSF

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Markets: 

Material: Others (Metal/PU hybrid foam), Others (Nickel, copper, nickel-cobalt), Open-pore

This project is funded by the Technology Transfer Programme Leichtbau (TTP LB) of the Federal Ministry of Economics and Energy.

[Technology Transfer Program Leichtbau](#)

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Context

Hybrid foams combine different materials in a porous structure, thus combining low weight with high energy absorption. This makes them suitable for components that absorb peak loads or perform protective functions, for example in vehicle construction, battery systems, or building envelopes.

A commonly used design utilizes open-cell polyurethane foams that are electroplated with nickel. The many open pores significantly increase the internal surface area. This allows the material to absorb energy and support additional functions such as vibration or sound absorption. Under pressure, the pores collapse gradually, causing the material to dissipate energy over a large area.

However, the open structure makes joining difficult: screws, rivets, or threaded inserts cannot hold. Adhesives often do not transfer forces reliably and can clog pore spaces. Sandwich structures are therefore used for many applications. This increases the material mix and manufacturing costs and makes it more difficult to return the components to the cycle.

Purpose

The project team is developing a process-integrated joining technology for nickel-coated polyurethane hybrid foams. The researchers are integrating fasteners into the material in such a way that resilient and reproducible joints are created without the need for downstream joining steps. To this end, the team is manufacturing semi-finished products and application-oriented demonstrators and verifying the load-bearing capacity of the joints under typical loads, including pull-out tests to determine the holding forces.

In addition, the project team is ensuring the quality and long-term durability of the coating and joint, including non-destructive testing and corrosion testing. In this way, the team aims to reduce material usage and process steps, conserve resources, and avoid additional CO₂ emissions through joining. A mobile impact protection structure and an energy-absorbing facade fastening system for reducing load peaks serve as demonstrators.

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Procedure

First, the project team inserts fasteners into the open-cell plastic foam. The researchers then electroplate the foam with nickel. The nickel deposits on the inner foam structure and bonds the foam and fastener together to form a solid unit. This creates the anchorage directly during manufacture.

The team then tests the load-bearing capacity of the connection. The researchers produce samples and demonstrator components and test them under typical loads; pull-out tests provide characteristic values for the holding forces. The team compares variants with different layer thicknesses and different shapes and sizes of fasteners and evaluates how well the coating is built up into the interior of the foam. Non-destructive testing methods support the quality assessment of the coating and integration.

At the same time, the researchers design joints and components using calculations and simulations, thereby improving process control and component design. Finally, the project team transfers the process to industrial production, including larger component formats and reproducible process control.



Funding duration:

Funding sign:

03LB1011

Funding amount:

EUR 1.5 million

Final report

Further websites

foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB1011A - HSF in the federal funding catalogue

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Project coordination

Contact:

Mr Markus Tack

+49 05252 9354-27

m.tack@fi-sch.de

Organisation:

Fichtner & Schicht GmbH

Germaniastraße 4
33189 Schlangen
North Rhine-Westphalia
Germany

www.fi-sch.de



English (EN){{ Projektpartner }}



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Lightweighting classification	
	Realisation
Offer	
Products Semi-finished parts, Materials	✓
Services & consulting Engineering, Technology transfer	✓
Field of technology	
Design & layout Lightweight manufacturing, Hybrid structures	✓
<i>Functional integration</i>	
<i>Measuring and testing technology</i>	
<i>Modelling and simulation</i>	
<i>Plant construction & automation</i>	
<i>Recycling technologies</i>	
Manufacturing process	
<i>Additive manufacturing</i>	
Coating (surface engineering) Galvanising	✓
<i>Fibre composite technology</i>	
<i>Forming</i>	
Joining Hybrid joining, Screwing	✓
<i>Material property alteration</i>	
<i>Primary forming</i>	
Processing and separating Drilling, Milling, Sawing, Cutting	✓
<i>Textile technology</i>	

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Lightweighting classification	
	Realisation
Material	
Biogenic materials Others (Metal/PU hybrid foam)	✓
Cellular materials (foam materials) Open-pore	✓
<i>Composites</i>	
<i>Fibres</i>	
<i>Functional materials</i>	
Metals Others (Nickel, copper, nickel-cobalt)	✓
<i>Plastics</i>	
<i>Structural ceramics</i>	
<i>(Technical) textiles</i>	