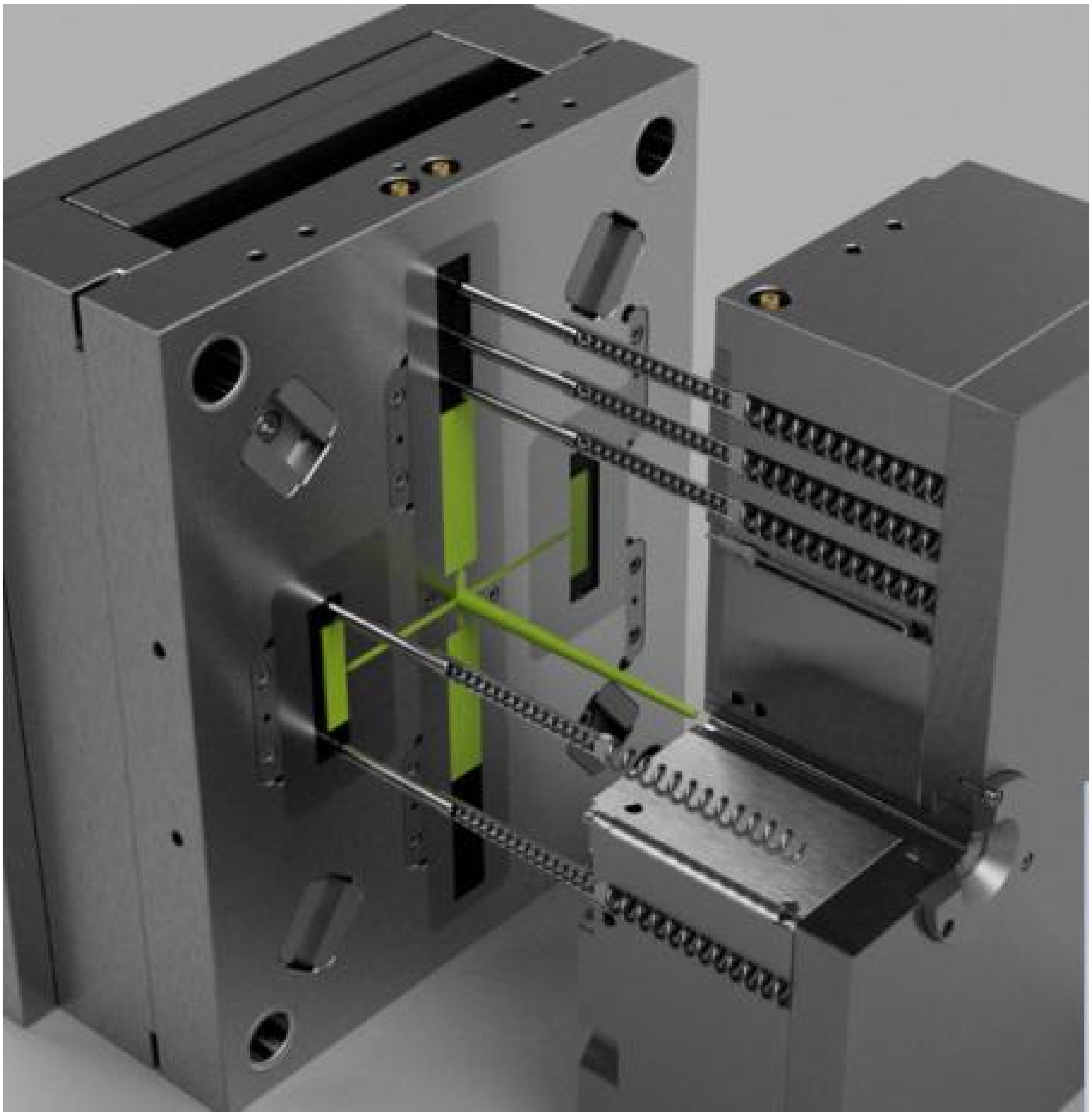
Sustainable injection moulding plastics: cost-effective production of lightweight components

About this project



T3-Hub

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About this project

Markets:

Material: Carbon fibres, Thermoplastics, Glass-fiber reinforced plastics (GFRP), Carbon-fiber reinforced plastics (CFRP), Natural fibre reinforced plastics (NFRP)

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

Injection moulded plastic parts are an integral part of everyday life. They are used in electrical appliances, household items and transport containers. Every additional millimetre of material increases the amount of energy required for production, transport and recycling.

Manufacturers are therefore reducing wall thicknesses to save weight - but are coming up against physical limits. Thin cross-sections fail under load or deform too much, while expensive full composite laminates made of fibre-reinforced thermoplastics (FRP) increase costs and often also the CO2 footprint in production. The industry is therefore looking for a solution that combines lightweight construction, resource efficiency and resilience.

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Purpose

The T3-Hub research project aims to close this gap. The project team wants to reduce the amount of material used in standard technical injection moulded parts and thus make them more sustainable - and this for series production. To achieve this, the researchers are reinforcing conventional components with wafer-thin thermoplastic tapes that are only a few tenths of a millimetre thick and 5-25 mm wide. The tapes contain glass, carbon or natural fibres in the same plastic matrix as the component. This means that the components, which are otherwise produced with material-intensive ribbing or high wall thicknesses, can be manufactured using less material. The material consumption translates directly into weight, CO2 footprint and production costs.

The new technology can reduce material consumption and thus improve all three properties. As the same material is used in all components, the components are recyclable on the one hand, but the reinforcement with tapes also facilitates the use of recycled materials in the components themselves (design-for-recycling).

With this method, the scientists aim to reduce material requirements by up to 20 per cent and significantly reduce CO2 emissions in all phases of life. At the same time, the unit costs remain competitive and the recycling process simple.

Procedure

The researchers initially selected around 100 typical injection moulded components from industries such as transport, sport and leisure, household and logistics. They use digital simulations (finite element method) to identify the main load paths. They then determine the ideal, force-flow-compliant tape arrangement and produce corresponding prototypes.

In the laboratory, the project team tests the production influences and component properties and compares the CO2 footprint with that of unreinforced original parts.

A modular system consisting of various tools and software solutions enables the efficient redesign of injection moulded components and makes the effects of warpage manageable. An injection moulding simulation with consideration of the influences on warpage, in combination with an algorithm for warpage compensation, ensures the derivation of optimal insert configurations.

The project partners are setting up all the manufacturing equipment required for the development and production of injection moulded components with minimally invasive local tape reinforcement. This includes the manufacture of cost-efficient tapes, the production of tape inserts, tools for sampling and the development of materials through to a full-scale injection moulding cell for component production. The project participants are using all the expertise and systems they have developed to transfer the results to other use cases.

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  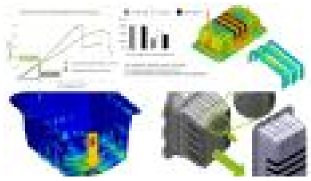

Funding duration:

Funding sign:	03LB3055	**Funding amount:**	EUR 2.3 million

Further websites

- foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB3055A - T3 hub in the federal funding catalogue
- ikv-aachen.de/rp/t3-hub-simulative-methode-zur-optimierung-von-verstaerkten-spritzgussbauteilen-mit-thermoplastischen-tapes/ - Project website IKV Aachen

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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, Machines and plants, Software & databases, Systems and end products, Materials, Tools and moulds	✓
Services & consulting Training, Consulting, Testing and trials, Engineering, Prototyping, Validation, Simulation, Technology transfer	✓
Field of technology	
Design & layout Lightweight manufacturing, Lightweight design, Hybrid structures, Lightweight material construction	✓
Functional integration	
Measuring and testing technology Component and part analysis, Materials analysis, Destructive analysis	✓
Modelling and simulation Crash behaviour, Loads & stress, Life-cycle analysis, Multiphysics simulation, Optimisation, Processes, Structural mechanics, Materials, Reliability validation, Others (Injection moulding simulation software CADMOULD)	✓
Plant construction & automation Plant construction, Automation technology, Handling technology	✓
Recycling technologies Recycling, Upcycling	✓

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Lightweighting classification

	Realisation
Manufacturing process	
Additive manufacturing	
Coating (surface engineering)	
Fibre composite technology Pre-preg processing, Others (Tape laying)	✓
Forming Thermal converting	✓
Joining	
Material property alteration	
Primary forming Extrusion, Pultrusion, Injection moulding	✓
Processing and separating	
Textile technology Preforming, Others (Tape production)	✓

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Lightweighting classification

	Realisation
Material	
Biogenic materials	
Cellular materials (foam materials)	
Composites Glass-fiber reinforced plastics (GFRP), Carbon-fiber reinforced plastics (CFRP), Natural fibre reinforced plastics (NFRP)	✓
Fibres Carbon fibres	✓
Functional materials	
Metals	
Plastics Thermoplastics	✓
Structural ceramics	
(Technical) textiles	