Reliably joining steel and aluminium: Space-saving composite casting for vehicle parts

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About this project

CastCo

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Markets: 

Material: Aluminium, Intermetallic alloys, Steel, Laminates

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

To reduce CO# emissions, vehicle structures must become lighter. At the same time, installation space and safety requirements remain unchanged.

Pure steel construction methods offer high strength, but lead to higher weight. Cast aluminium enables functionally integrated and geometrically complex components, but does not always achieve the required rigidity in limited installation space. A combination of both materials can resolve these conflicting objectives.

In dynamically loaded structural components, this approach often fails due to the connection between steel and aluminium. Form and force locking alone are not sufficient for changing loads. What is needed is a permanently load-bearing connection that can be produced economically and does not worsen the carbon footprint. This is where the CastCo project comes in.

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Purpose

The researchers are developing a composite casting technology for highly stressed structural components in vehicle construction. To do this, they are using a coating made of aluminium and silicon, which enables a permanently stable bond between sheet steel and cast aluminium. In the research project, the coating is no longer applied to the steel substrates exclusively using the energy-intensive PVD coating process, but also by means of a more cost- and energy-efficient galvanic process. The coating is deposited electrochemically from ionic liquids. To this end, the team is developing a system for electrochemical coating in an inert gas atmosphere. As a demonstrator, the researchers are designing a hybrid strut dome that combines a steel insert for reinforcement and a cast aluminium structure for functional integration.

The team is aiming for a weight reduction of 25 per cent compared to a pure steel construction. At the same time, the CO# balance across production and use is to be improved. The team uses component tests in which the interface between steel and aluminium remains intact as proof of a load-bearing connection. If the component fails under load, the fracture should occur in the aluminium structure and not at the joint.

Procedure

The team is initially developing the composite casting technology with the new coating technology, new test specimens and adapted test methods in such a way that the transition from the laboratory level to near-series applications in vehicle construction is possible. The results provide a detailed understanding of the chemical, material-mechanical and production-related relationships along the entire process chain. This includes surface preparation and coating, the plant technology required for this, the casting process and the formation of the interface between steel and aluminium.

The team also investigates component behaviour under static and dynamic loads. From this, the team derives design principles for composite casting and designs the strut dome to suit the installation space. It matches the geometry, steel inserts and joining surfaces to the load paths in the vehicle and takes into account the CO# balance in the life cycle.

It then transfers the concepts to sand casting and die casting processes, defines tool design and process parameters and uses simulations to validate filling behaviour and temperature control.

The team then manufactures the demonstrator, tests it statically, dynamically and under crash-relevant loads and compares the results with numerical models. Finally, it assesses weight, CO# savings potential and transferability to other structural components.

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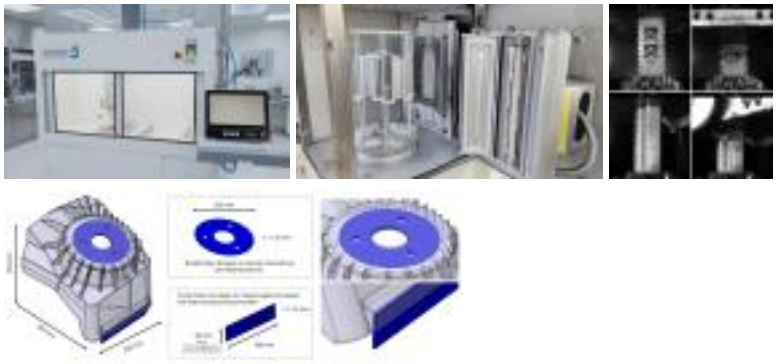

Funding duration:

Funding sign:	03LB2046	**Funding amount:**	EUR 2.4 million

Final report

Further websites foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB2046A - CastCo 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, Machines and plants, Materials, Tools and moulds	✓
Services & consulting Training, Consulting, Testing and trials, Prototyping, Validation, Simulation	✓
Field of technology	
Design & layout Lightweight manufacturing, Hybrid structures	✓
Functional integration Material functionalisation	✓
Measuring and testing technology Component and part analysis, Visual analysis (e.g. microscopy, metallography), Materials analysis, Destructive analysis	✓
Modelling and simulation Crash behaviour, Loads & stress, Optimisation, Processes, Structural mechanics, Materials, Others (Casting process simulation)	✓
Plant construction & automation Plant construction	✓
Recycling technologies Recycling, Others (Service life extension)	✓

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Lightweighting classification

	Realisation
Manufacturing process	
Additive manufacturing 3D printing	✓
Coating (surface engineering) Galvanising, Sputtering, Others (Physical vapour deposition (PVD))	✓
Fibre composite technology	
Forming	
Joining	
Material property alteration Heat treatment, Others (Chemical treatment)	✓
Primary forming Casting	✓
Processing and separating	
Textile technology	
Material	
Biogenic materials	
Cellular materials (foam materials)	
Composites Laminates	✓
Fibres	
Functional materials	
Metals Aluminium, Intermetallic alloys, Steel	✓
Plastics	
Structural ceramics	
(Technical) textiles	