Die casting for aluminium components: Increasing strength and saving material

About this project

TALoF

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Markets: 

Material: Aluminium, Intermetallic alloys, Magnesium

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

Aluminium components are often used in the automotive sector due to their weight. Thin-walled components reduce the use of resources, but require precise control of strength. The strength depends on the solidification time - the phase in which the liquid metal turns into solid material during casting. With thin walls, the aluminium cools quickly. This leads to a fine-grained microstructure, which improves the mechanical strength.

At the same time, the components must remain stable even at high operating temperatures. The strength is usually increased by a so-called T6 heat treatment. This involves heating and artificially ageing the cast parts after casting in order to improve their properties. However, this additional process consumes a lot of energy and causes high CO# emissions. Engineers are therefore working on alternative approaches that start directly in the casting process.

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Purpose

The TALoF research project aims to develop manufacturing processes for aluminium die-cast parts that offer higher strength at critical points. The researchers actively control the solidification time in order to produce a fine-grained microstructure - without resorting to T6 heat treatment. They use two types of alloy for this purpose: Al-Si-Cu alloys, in which the copper content ensures particularly high strength, and Al-Si-Mg alloys, which offer a good balance between strength and ductility (malleability) thanks to the magnesium content.

With this process, the project team aims to achieve material savings of over 7 per cent, in some cases significantly more, generally up to 30 per cent, and to reduce energy consumption during production and operation. The material parameters obtained are incorporated into digital simulations and enable more precise component calculations.

Procedure

The researchers are realising the test setup on the camshaft bearing housing, an important component in commercial vehicles with a complex geometry. They develop a specially designed die-casting mould that limits the recycled metal content to a maximum of 30 per cent. They then cast components with precisely customised process parameters. The researchers analyse the microstructure using optical and electronic microscopy, measure the solidification times and carry out mechanical stress tests.

At the same time, they are optimising the mould in order to recover around half of the energy required to melt the aluminium, for example to heat industrial water or buildings. The data collected enhances existing simulation programmes. This provides designers with reliable material parameters.

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Funding duration:

Funding sign:	03LB3042	**Funding amount:**	EUR 1 million

Final report

Further websites foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB3042A - TALoF in the federal funding catalogue

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Project coordination

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English (EN){{ Projektpartner }}

Fraunhofer ICT

Bosch Formenbau GmbH

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Lightweighting classification

	Realisation
Offer	
Products Parts and components, Machines and plants, Software & databases, Materials, Tools and moulds	✓
Services & consulting Training, Consulting, Testing and trials, Engineering, Prototyping, Validation, Simulation, Technology transfer	✓
Field of technology	
Design & layout Lightweight design, Lightweight material construction	✓
Functional integration	
Measuring and testing technology Component and part analysis, Visual analysis (e.g. microscopy, metallography), Materials analysis, Destructive analysis, Non-destructive analysis	✓
Modelling and simulation Loads & stress, Life-cycle analysis, Optimisation, Structural mechanics, Materials	✓
Plant construction & automation Plant construction, Handling technology	✓
Recycling technologies Recycling	✓

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Lightweighting classification

	Realisation
Manufacturing process	
Additive manufacturing	
Coating (surface engineering)	
Fibre composite technology	
Forming	
Joining	
Material property alteration Mechanical treatment, Thermochemical treatment, Heat treatment	✓
Primary forming Casting	✓
Processing and separating	
Textile technology	
Material	
Biogenic materials	
Cellular materials (foam materials)	
Composites	
Fibres	
Functional materials	
Metals Aluminium, Intermetallic alloys, Magnesium	✓
Plastics	
Structural ceramics	
(Technical) textiles	