Thin-walled components made of nodular cast iron: digital twin optimises processes

About this project

GJSlim

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Markets:

Material: Steel

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

Sand casting is a proven process for the economical series production of complex, functionally integrated components. In sand casting, liquid metal is poured into a mould made of compacted sand, which can be flexibly adapted to different geometries.

The process also offers potential for lightweight components. Spheroidal graphite cast iron (GJS), also known as nodular cast iron, combines high strength and rigidity with ductility - i.e. the ability to deform without breaking. At the same time, it is easy to mould. This means that thin-walled structures can be produced economically and waste is reduced. In addition, GJS is predominantly based on recycled steel scrap and therefore contributes to reducing emissions.

In practice, however, this potential is only partially utilised: wall thicknesses of less than 5 mm in particular significantly increase the demands on process control, surface quality and local properties in the component. Existing design guidelines do not yet adequately reflect these local differences and the production limits. As a result, lightweight construction potential remains unutilised - for example in safety-relevant components in vehicle or mechanical engineering. This is where the researchers in the GJSlim project come in.

Purpose

The project team is developing a transferable lightweight construction concept to safely design thin-walled GJS structures even under increased cyclic stress. To this end, the researchers are demonstrating how component shape, casting process and local properties are interrelated and are pooling knowledge from foundry technology, lightweight structural design and operational stability. A digital twin brings together production parameters, locally differing material structures, component properties and the resulting resilience and links data from production, simulation and load in order to better predict behaviour and service life.

The researchers are focussing on the implementation of wall thicknesses of less than 5 millimetres and thus the step towards ultra-lightweight construction. The influencing variables and emission values obtained in this way are mapped on a component-specific basis in the digital twin in order to enable structural optimisations with low material usage and to reduce resource consumption and CO# emissions in production and use.

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Procedure

Firstly, the team clarifies the conditions under which very thin-walled GJS structures can be reliably cast. The focus is on wall thicknesses of less than 5 millimetres, which pose particular challenges both in terms of casting technology and design under cyclic loads. Suitable moulding materials and coatings are selected and process windows are defined that support a stable surface and avoid undesirable material structures. At the same time, the team determines local characteristic values for static and cyclical loads and combines them into a design concept.

Building on this, the researchers are further developing methods of topology and shape optimisation so that they take into account low wall thicknesses, local resilience and manufacturing restrictions.

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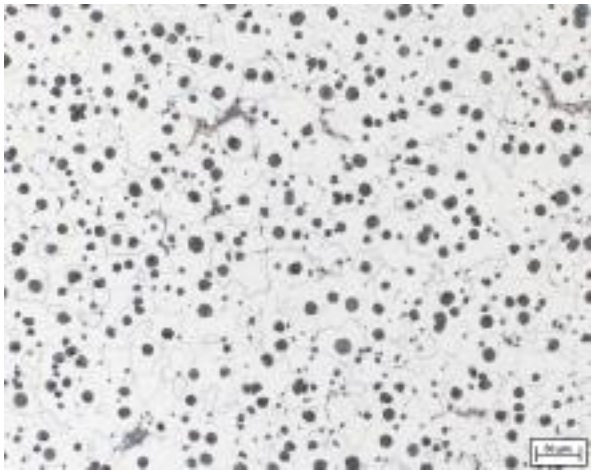

Funding duration:

Funding sign:	03LB3079A	**Funding amount:**	EUR 1.4 million

Final report

Further websites

foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB3079A - GJSlim in the federal funding catalogue

www.sla.rwth-aachen.de/go/id/bbtfrd#aaaaaa - GJSlim on the SLA website

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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, Materials, Tools and moulds	✓
Services & consulting Testing and trials, Engineering, Validation	✓
Field of technology	
Design & layout Lightweight design	✓
Functional integration	
Measuring and testing technology Materials analysis, Destructive analysis, Non-destructive analysis	✓
Modelling and simulation Life-cycle analysis, Materials, Reliability validation	✓
Plant construction & automation	
Recycling technologies	
Manufacturing process	
Additive manufacturing	
Coating (surface engineering)	
Fibre composite technology	
Forming	
Joining	
Material property alteration	
Primary forming Casting	✓
Processing and separating	
Textile technology	

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Lightweighting classification

	Realisation
Material	
Biogenic materials	
Cellular materials (foam materials)	
Composites	
Fibres	
Functional materials	
Metals Steel	✓
Plastics	
Structural ceramics	
(Technical) textiles	