

Additively manufactured metal components: reducing production costs with optimised control

About this project



APFeL

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Markets:

Material: Aluminium

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

Laser-based additive manufacturing enables the production of complex metallic components with a high degree of geometric freedom. The process offers great potential, particularly for lightweight construction. It can be used to produce bionic structures and functionally integrated components in a targeted manner. In industrial applications, however, high manufacturing costs have so far limited its wider use.

A major cost driver is the long build time. Companies usually manufacture components using standardised process parameters and to very high quality standards. This results in components with high density and good surface quality – even in areas where these properties are not required for the component's function. At the same time, the stresses within a component often vary significantly.

To date, there has been no automated method for specifically adapting manufacturing parameters to the local requirements of a component. Furthermore, process parameters, material properties and post-processing influence one another. These interactions make it difficult to design processes that are both cost-effective and application-oriented.

Purpose

The researchers in the APFeL project are developing a process chain for the laser-based additive manufacturing of lightweight metal components. They tailor manufacturing parameters specifically to the component's geometry, load conditions and quality requirements, and assign them to individual areas of the component.

The central idea is not to aim for the highest quality level across the entire component. Instead, the project team adapts the process control to the functional requirements of individual component areas. In areas subject to lower loads, for example, a higher level of porosity may be acceptable. This allows production to be accelerated.

This differentiated process design enables the manufacturing costs of additively manufactured components to be significantly reduced. At the same time, it makes it more economically viable to produce resource-efficient lightweight structures. The process chain lays the foundation for new applications across various industrial sectors and contributes to the reduction of CO₂ emissions.

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Procedure

To begin with, the researchers analyse the requirements for typical lightweight components and the mechanical stresses they are subjected to. From this, they derive quality requirements for different component areas. Building on this, the participants develop methods for cost-oriented component design. These include optimisation methods that take geometry, material properties and manufacturing costs into account collectively. Simulations help to identify component areas where adapted process parameters can be applied.

In parallel, the researchers are investigating the relationship between process parameters, local material properties and surface quality. On this basis, they are developing strategies for time- and cost-optimised additive manufacturing.

Another focus is on tailored post-processing. The partners are analysing how different manufacturing parameters affect surface quality, which post-processing methods are suitable, and how these can be automated.

Finally, they are integrating the developed methods into a digital and physical process chain and validating them on demonstrator components in the form of a bicycle crank and a bracket for a racing car. In addition, the researchers are assessing the resource efficiency of the new process chain using life-cycle analyses.

Funding duration:

Funding sign:	03LB2053	Funding amount:	EUR 1.8 million
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Final report

Further websites foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB3053A - APFeL in the federal government's funding catalogue

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Project coordination

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PRIME
ENGINEERING
IDEAS

3N-Kompetenzzentrum Niedersachsen Netzwerk Nachwachsende Rohstoffe und Bioökonomie e.V.

Lightweighting classification

Realisation

Offer

Products

Parts and components, Software & databases,
Systems and end products



Services & consulting

Consulting, Testing and trials, Engineering,
Prototyping, Validation, Simulation, Technology
transfer



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Lightweighting classification	
	Realisation
Field of technology	
Design & layout Lightweight manufacturing, Lightweight design	✓
<i>Functional integration</i>	
Measuring and testing technology Component and part analysis, Visual analysis (e.g. microscopy, metallography), Materials analysis, Destructive analysis	✓
Modelling and simulation Loads & stress, Life-cycle analysis, Optimisation, Processes, Structural mechanics, Materials	✓
Plant construction & automation Automation technology	✓
<i>Recycling technologies</i>	
Manufacturing process	
Additive manufacturing Selective laser melting (SLM, LPBF, ...)	✓
<i>Coating (surface engineering)</i>	
<i>Fibre composite technology</i>	
<i>Forming</i>	
<i>Joining</i>	
<i>Material property alteration</i>	
<i>Primary forming</i>	
Processing and separating Milling, Grinding, Others (Polishing)	✓
<i>Textile technology</i>	

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Lightweighting classification	
	Realisation
Material	
<i>Biogenic materials</i>	
<i>Cellular materials (foam materials)</i>	
<i>Composites</i>	
<i>Fibres</i>	
<i>Functional materials</i>	
Metals	✓
Aluminium	
<i>Plastics</i>	
<i>Structural ceramics</i>	
<i>(Technical) textiles</i>	