Optimising additive manufacturing: Quality assurance with acoustic analysis and AI

About this project

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ML-S-LeAF

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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

Context

In the automotive and aerospace industries in particular, there is a growing demand for components that are stable but as light as possible. Additive manufacturing processes such as laser beam melting in a powder bed (PBF-LB/M) enable complex and weight-optimised structures that would not be possible using conventional methods. However, quality assurance poses a major challenge: During the melting process, defects such as pores, cracks or distortion can occur, jeopardising component stability. Existing optical monitoring systems often provide unreliable data, as the melting process is influenced by significant changes in temperature and material. An alternative, promising method is to analyse the process acoustically. Researchers in the ML-S-LeAF project are investigating how acoustic signals can be used to detect defects at an early stage and ensure the quality of lightweight components in additive manufacturing.

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Purpose

The project team is developing an intelligent, acoustics-based monitoring system for laser beam melting. The researchers are analysing the sounds generated during the process in order to identify defects in real time. Using machine learning methods, they want to assign characteristic sound patterns to specific defect types.

The team is focussing in particular on the use of virtual data: Numerical simulations are used to generate artificial acoustic signals in order to train the algorithms in a targeted manner. This enables the system to reliably recognise even rare defects without the need for extensive physical test series. In the long term, the system should reduce rejects and stabilise production processes.

Procedure

The project team integrates highly sensitive microphones into a PBF-LB/M system and systematically records the resulting process noise. At the same time, the researchers are developing numerical simulations that reproduce the acoustic signals of typical error cases. The recorded and simulated data serve as input data for machine learning processes that can recognise even the smallest deviations in the melting process. Through continuous testing, the scientists refine the algorithms and integrate them into the process control system. Finally, validation takes place: the researchers test the system on real components and check whether it reliably recognises errors and improves the quality of production. The aim is to develop a robust and practical solution that will increase the efficiency of additive manufacturing in the long term.

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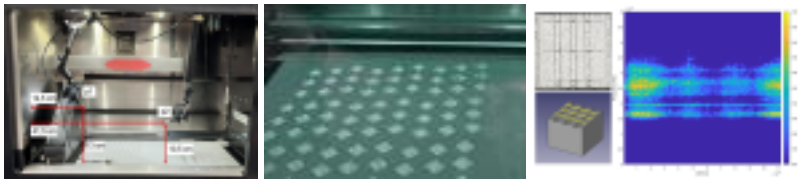

Funding duration:

Funding sign:	03LB5006	**Funding amount:**	EUR 1.8 million

Further websites foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB5006A - ML-S-LeAF in the federal funding catalogue

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Project coordination

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English (EN){{ Projektpartner }}

Lightweighting classification

	Realisation
Offer	
Products Parts and components, Software & databases, Materials	✓
Services & consulting Training, Testing and trials, Simulation	✓

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Lightweighting classification

	Realisation
Field of technology	
Design & layout Lightweight manufacturing	✓
Functional integration	
Measuring and testing technology Component and part analysis, Visual analysis (e.g. microscopy, metallography), Materials analysis	✓
Modelling and simulation Optimisation, Processes, Materials, Reliability validation	✓
Plant construction & automation	
Recycling technologies	
Manufacturing process	
Additive manufacturing Selective laser melting (SLM, LPBF, ...)	✓
Coating (surface engineering)	
Fibre composite technology	
Forming	
Joining	
Material property alteration	
Primary forming	
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	