Impeller for a hydrogen compressor: Manufactured using highly productive metal 3D printing

About this project

H2ERON

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Markets:

Material: Aluminium

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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

The hydrogen economy requires efficient components that reliably transmit high power whilst conserving resources. One example is the impellers in H# turbo-compressors. These must be able to withstand high rotational speeds. At the same time, weight, geometry and surface quality all influence the compressor's efficiency.

Companies can manufacture such components using the inherent advantages of the laser powder bed fusion (LPBF) process. In this process, a laser fuses metal powder layer by layer to form a component.

LPBF offers considerable design freedom for sophisticated lightweight structures. However, for widespread industrial use, the process is often still too expensive, too slow and not stable enough for complex geometries. High-strength aluminium alloys and component areas with very shallow overhangs, which are to be manufactured without support structures, present particular challenges.

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Purpose

In the H2ERON research project, the partners are optimising powder-bed-based laser beam melting for industrial use. The focus is on a high-strength aluminium alloy processed on high-performance LPBF systems. To this end, the researchers are improving the process capability and productivity of the method. At the same time, they are recording process data during production and using it for data-driven control. This results in an additive manufacturing process that is more productive, more resource-efficient and easier to monitor.

The industrial demonstrator is an impeller for an H# turbocharger. The project team is specifically coordinating the material, manufacturing strategy and component geometry. The unit costs of additive manufacturing are set to fall by a quarter to less than 50 cents per cubic centimetre, whilst the production's carbon footprint is set to decrease by 30 per cent.

In addition, the researchers are developing a topology optimisation method that can be automated and applied to impellers of varying sizes. This enables them to tailor the component's geometry specifically to loads, manufacturing conditions and lightweight construction requirements, and to design the component in a sustainable and scalable manner. The aim is to achieve a 30 per cent reduction in weight whilst maintaining at least the same strength.

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Procedure

The researchers are first designing the process control for a high-strength aluminium alloy. To this end, they are determining the exposure and system parameters on an LPBF system equipped with a 1-kilowatt laser with integrated beam shaping. By adjusting the shape of the laser beam at the focal point, the system's output can be significantly increased. The partners then transfer and test these parameters on industrial multi-laser systems. In this way, they are investigating how high productivity can be combined with consistent component quality.

Throughout the entire fabrication process, the project team collects data from process monitoring during production and from the machine's sensors. The data is fed into a machine-independent platform. There, the researchers analyse spatial and temporal process data and develop a data-driven process control system designed to make the LPBF process more stable and resource-efficient.

At the same time, the partners are adapting the process to the industrial demonstrator. They are developing an automatable approach to topology optimisation that takes into account impellers of varying sizes and incorporates the entire process chain. New exposure strategies are intended to enable very shallow overhangs without support structures.

In addition, the partners are investigating key material properties, such as fatigue strength under air and hydrogen conditions. Powder recycling and the application's carbon footprint are also factored into the assessment.

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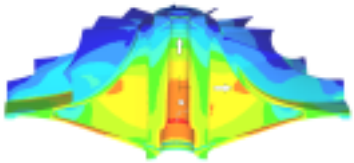

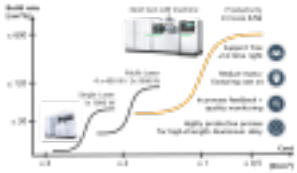

Funding duration:

Funding sign:	03LB1019	**Funding amount:**	EUR 3.7 million

Final report

Further websites foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB1019A - H2ERON in the federal government's 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, Software & databases, Systems and end products	✓
Services & consulting Training, Consulting, Testing and trials, Prototyping, Validation, Simulation, Technology transfer	✓
Field of technology	
Design & layout Lightweight material construction	✓
Functional integration	
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, Structural mechanics, Materials	✓
Plant construction & automation Plant construction	✓
Recycling technologies	

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Lightweighting classification

	Realisation
Manufacturing process	
Additive manufacturing 3D printing, Selective laser melting (SLM, LPBF, ...)	✓
Coating (surface engineering)	
Fibre composite technology	
Forming	
Joining	
Material property alteration Heat treatment	✓
Primary forming	
Processing and separating	
Textile technology	
Material	
Biogenic materials	
Cellular materials (foam materials)	
Composites	
Fibres	
Functional materials	
Metals Aluminium	✓
Plastics	
Structural ceramics	
(Technical) textiles	