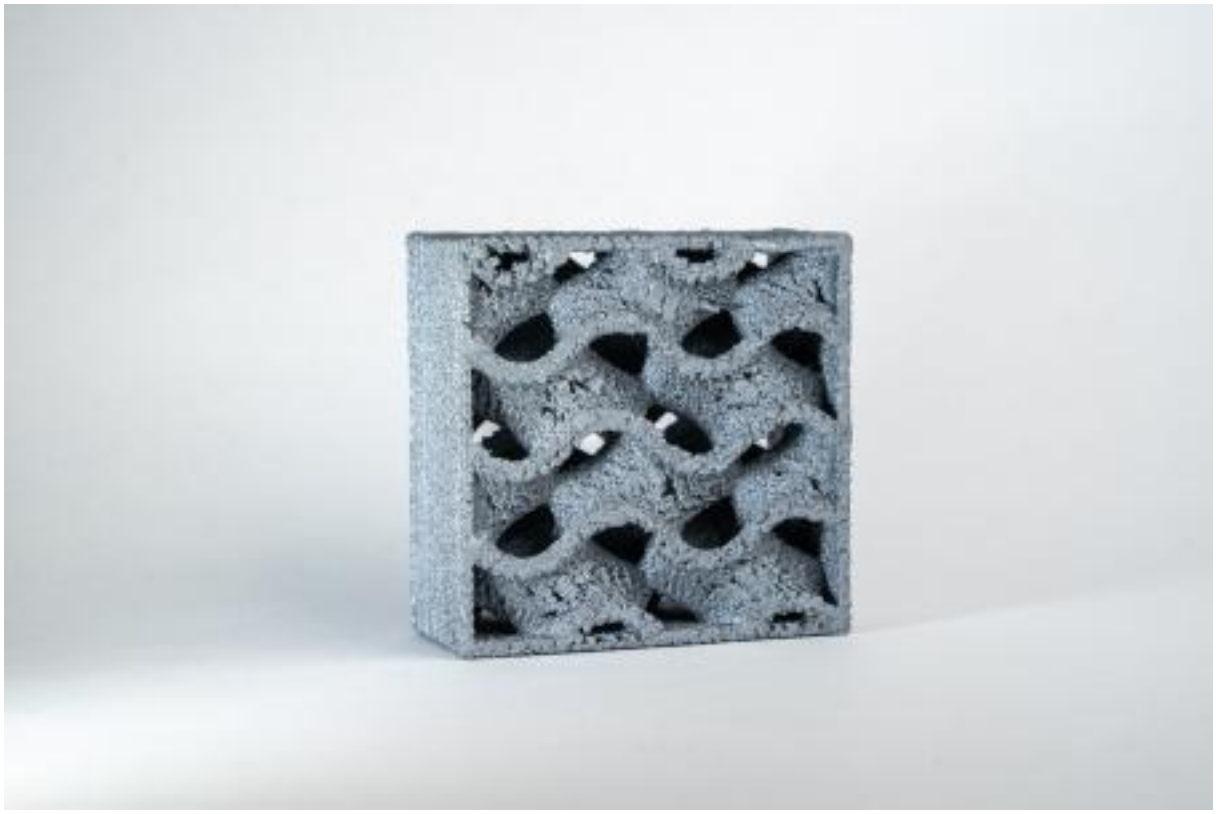
Additive manufacturing of ceramic components: Digital twin optimises entire process chain

About this project



ProDenker

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Markets:

Material: Carbon fibres, Non-oxidic ceramics, Ceramic matrix composite (CMC)

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

Fibre-reinforced ceramic composite materials (CMC) offer great potential for lightweight construction. They combine temperature resistance with high strength and are therefore particularly suitable for high-temperature applications, for example in turbines, heat exchangers or chemical plants. At the same time, the production of CMC is complex, processing is resource-intensive and quality assurance takes a lot of time. Finishing in particular accounts for up to 80 per cent of manufacturing costs. These hurdles have so far prevented the widespread use of these promising materials. This is where the ProDenker research project comes in.

Purpose

The project team is developing an AI-supported process chain that optimises all steps from additive manufacturing to mechanical post-processing. The aim is to make production processes more efficient, flexible and sustainable. With the help of a digital twin, the researchers want to analyse process data in real time, detect deviations at an early stage and automatically adjust parameters. This approach should reduce material consumption, increase energy efficiency and improve component quality.

They are also working on environmentally friendly lubricants, innovative clamping techniques for vibration damping and simulation-based tools that speed up the machining process and make it more economical.

Procedure

The researchers are developing the process chain step by step and testing their methods directly on demonstrators such as a turbine blade and a recuperator. They print blanks from highly filled materials and convert them into dense CMC components. During machining, they continuously analyse process data using AI algorithms in order to improve machining parameters and tool designs. Using specially developed clamping techniques, they minimise vibrations and increase machining quality. A central data platform connects all work steps and enables end-to-end quality assurance. The researchers are developing the process chain so flexibly that it can be transferred to other materials and sectors, such as the energy, chemical and automotive industries.

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Funding duration:

Funding sign:	03LB4000	**Funding amount:**	EUR 2 million

Final report

Further websites foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB4000A - ProDenker in the federal funding catalogue

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Project coordination

Contact:

Mr Michael Brunner

+49 07571 108-22 365

michael.brunner@guehring.de

Organisation:

Gühring KG

Herderstraße 50-54
72458 Albstadt
Baden-Württemberg
Germany

www.guehring.de

English (EN){{ Projektpartner }}

ISBE GmbH, Rhenus Lub GmbH & Co KG, Römheld GmbH Friedrichshütte

Lightweighting classification

	Realisation
Offer	
Products	
Services & consulting Others (Complex IoT digitisation)	✓

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Lightweighting classification

	Realisation
Field of technology	
Design & layout	
Functional integration	
Measuring and testing technology	
Modelling and simulation Processes, Materials	✓
Plant construction & automation	
Recycling technologies	
Manufacturing process	
Additive manufacturing 3D printing	✓
Coating (surface engineering)	
Fibre composite technology Others (3D printing)	✓
Forming	
Joining	
Material property alteration Thermochemical treatment, Others (Sintering and infiltration of silicon)	✓
Primary forming Sintering	✓
Processing and separating Drilling, Milling, Grinding	✓
Textile technology	

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Lightweighting classification

	Realisation
Material	
Biogenic materials	
Cellular materials (foam materials)	
Composites Ceramic matrix composite (CMC)	✓
Fibres Carbon fibres	✓
Functional materials	
Metals	
Plastics	
Structural ceramics Non-oxidic ceramics	✓
(Technical) textiles	