Sinter-based additive manufacturing: Shaping aluminium and titanium resource-efficient

About this project

SIGNAL

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Markets:

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Material: Aluminium, Titanium

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 production of lightweight components for the mobility sector is often material- and energy-intensive. Conventional production generates a lot of waste: up to 90 percent of the material is lost when machining aluminium or titanium - with correspondingly high CO# emissions.

Although additive processes such as 3D printing offer potential, they have their limits when it comes to light metals: melt-based processes require support structures that are difficult to remove. In addition, the material properties are heavily dependent on the direction of the load, which makes it difficult to use in safety-relevant areas. Post-processing is also usually time-consuming.

New, sinter-based manufacturing processes offer an alternative approach. In this process, metal or ceramic powder is "baked" below the melting point to form a solid component. This enables near-net-shape production without support structures and saves material and energy. At the same time, the process offers greater design freedom and supports topology optimisation - i.e. the targeted use of material where it is needed.

Aluminium in particular was previously considered difficult to sinter. This is precisely where the SIGNAL project comes in: The team wants to develop manufacturing processes for titanium and aluminium alloys that are technically, economically and ecologically viable.

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Purpose

The project partners are developing new production routes for lightweight components made of aluminium and titanium alloys - with the aim of making the processes more efficient, resource-saving and digitally supported. The focus is on sinter-based, additive manufacturing processes, which are to be used in the mobility sector in particular.

The researchers are looking at the entire process chain: from the development of suitable alloys, shaping and heat treatment to the optimisation of the finished component. A key challenge is the formulation of an aluminium alloy that is suitable for sintering - as aluminium has so far been considered difficult to sinter due to its material properties. With the help of artificial intelligence, the team aims to speed up alloy development and reduce the amount of experimentation required.

The team is also planning to develop new design rules and methods for topology optimisation that meet the special requirements of the sintering process. Digital process monitoring also plays an important role: online monitoring enables errors to be recognised at an early stage and rejects to be avoided. The project is not only aimed at technical innovations, but also at significant CO# savings - both during production and when the lightweight components are later used.

Procedure

The project team is pursuing a practical and systematic approach. Based on the requirements of the mobility industry, the researchers define suitable component categories and relevant structural properties.

Based on this, they develop so-called feedstocks - printable mixtures of metal powder and binder - for various sintering-based processes. The aim is to produce green parts, i.e. unstrengthened raw components, with a high density and with as few defects as possible so that they can then be sintered in a stable manner.

At the same time, the researchers are creating precise temperature and atmosphere profiles for thermal sintering and debinding, i.e. removing the binder. These processes require a high degree of accuracy: even small deviations can lead to cracks or warping. The team therefore uses a sintering simulation to calculate shrinkage and deformation in advance. The results are fed directly into the component design, allowing geometries to be adapted at an early stage. Artificial intelligence also provides support here, for example in alloy development, in order to reduce the number of physical tests.

Digital monitoring recognises errors in real time. This results in a continuous, industry-compatible process chain - from material development to the tested component.

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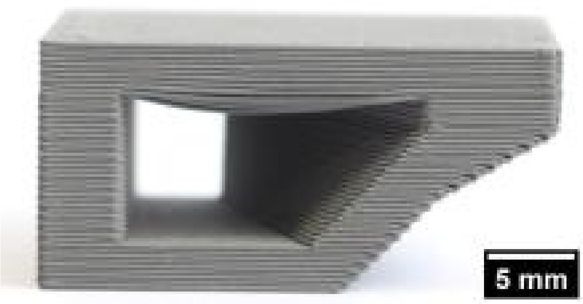

Funding duration:

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Final report

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

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Lightweighting classification

	Realisation
Offer	
Products Parts and components, Materials	✓
Services & consulting Consulting, Engineering, Others (Assembly of complex components)	✓
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	
Forming	
Joining	
Material property alteration Heat treatment	✓
Primary forming Casting, Sintering	✓
Processing and separating	
Textile technology	

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Lightweighting classification

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