



**AACHEN CENTER
FOR ADDITIVE
MANUFACTURING**



Fraunhofer
ILT



Additive Manufacturing—
Individualisierung und Komplexität als Treiber für
neue Technologien in der Zulieferindustrie

Stuttgart, 28 Januar 2016



Who we are...

Aachen Center for Additive Manufacturing

An Initiative at the RWTH Aachen Campus



Affiliated partners:



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What we see...

Additive Manufacturing

A Manufacturing Technology with Medial Hype



Source: MakerBot, Engineering.com, Forbes, Carbon3D, Aachen Center for Additive Manufacturing, Business Manager, Science, The New York Times, Wired, The Economist



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Status-Quo

Aerospace as Pioneer in AM Batch production



Fuel Nozzle (GE)



- Assembly (conv.): 20
- Weight: -25%

Batch production with SLM

- Batch size (2018): 40.000

Quelle: www.industrial-lasers.com; 27.01.2016)

Bracket (Airbus)



- Weight: -30%
- Raw material: -90%

Quelle: Airbus, (<http://www.airbus.com>, 27.01.2016)

Status quo in the Automotive Industry:

AM used for prototyping



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Challenges for Additive Manufacturing



DESIGN

1

New CAD Tools
New way of
thinking

PROCESSES

2

Optimization of
processes
Investigation of
new processes

PROCESS CHAINS

3

Effective and
efficient
combination of
processes

BUSINESS INNOVATION

4

Strategic
decisions
New business
models



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What we can...

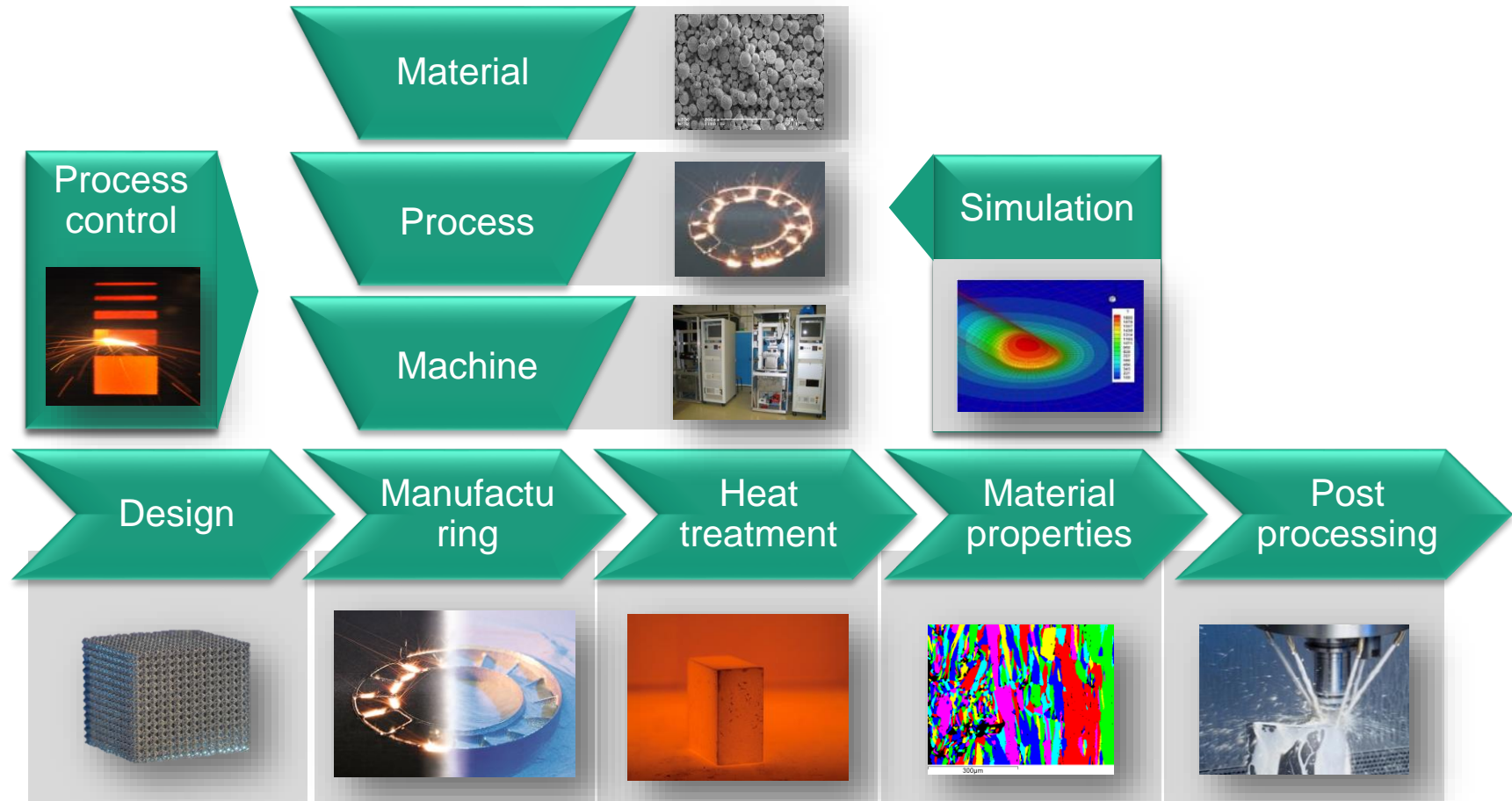


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Horizontal and vertical process chain

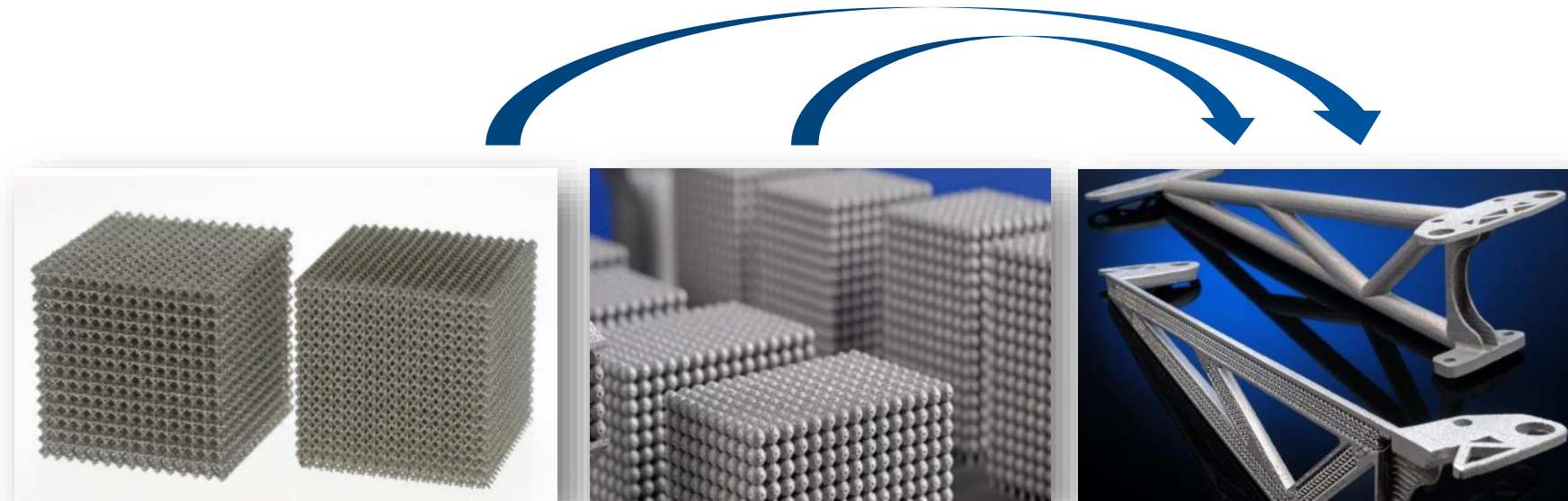


Design Expertise



- **Product:** The functionality needs to be translated into a design addressing the geometry and the material properties.





■ Lattice Structures

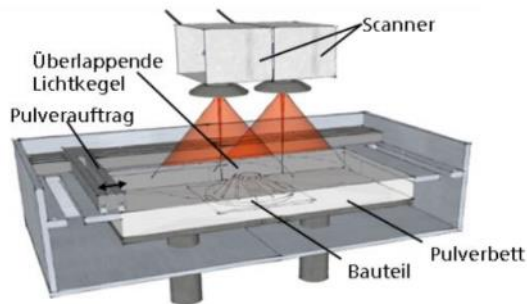
■ Hollow Spheres

■ Innovative Products

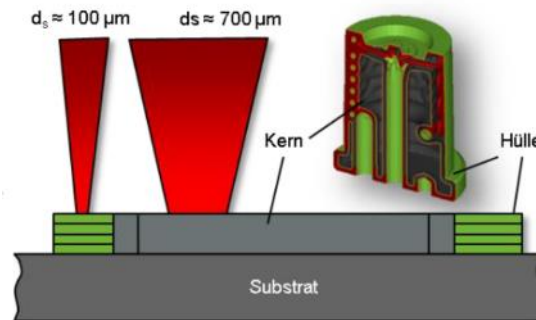




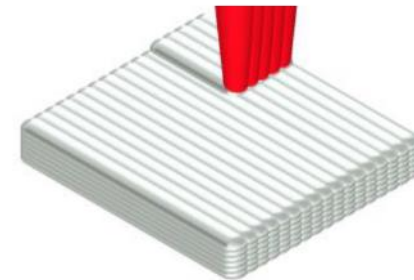
- **System Requirement:** The production system creates and optimizes the product.



■ Multiple Scan Field



■ Skin-Core Principle

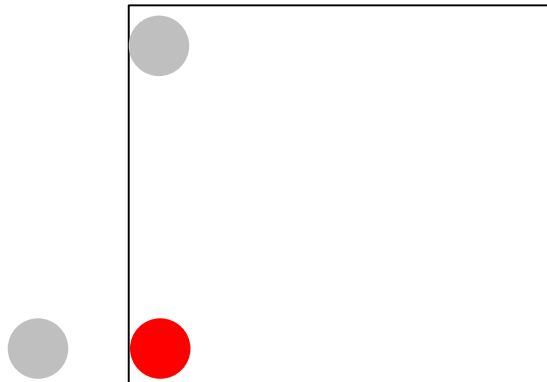


■ Multi Spot Array

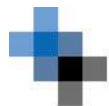
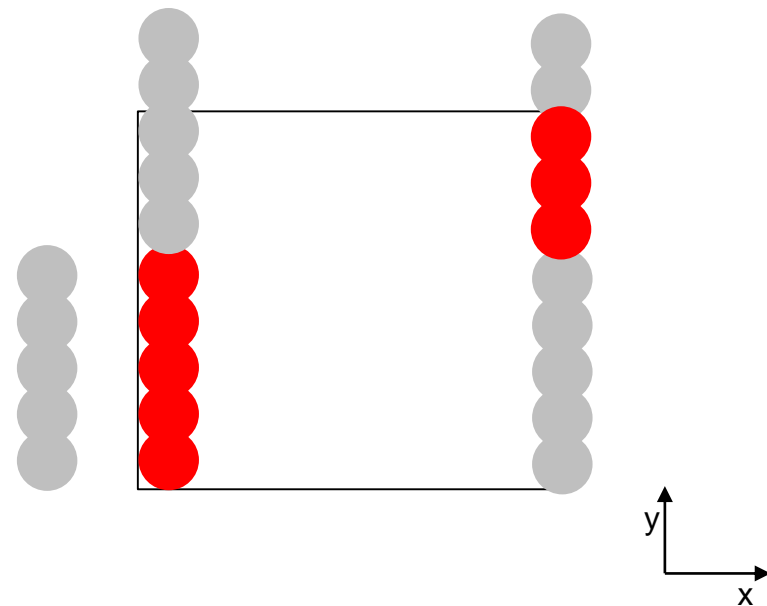
New SLM Machine Concept at ILT - Multi Spot Array



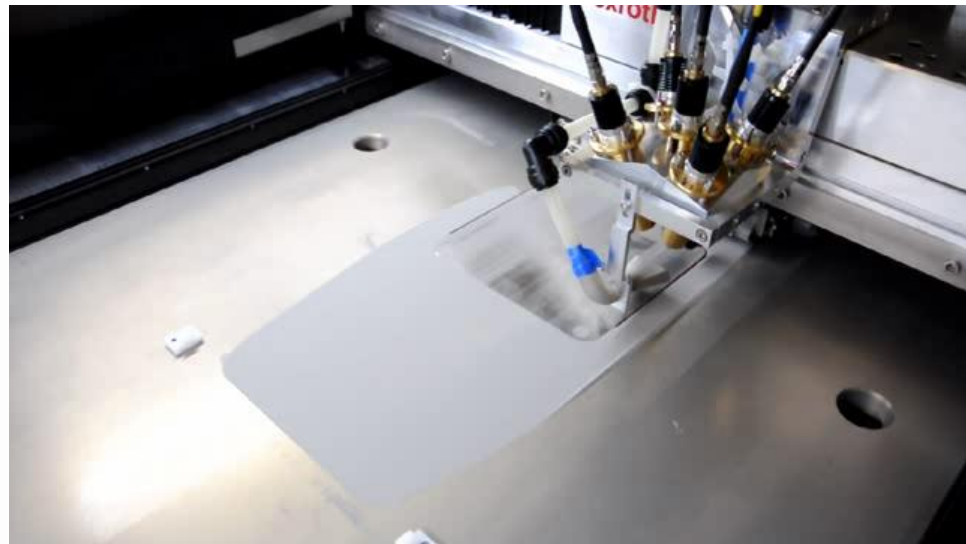
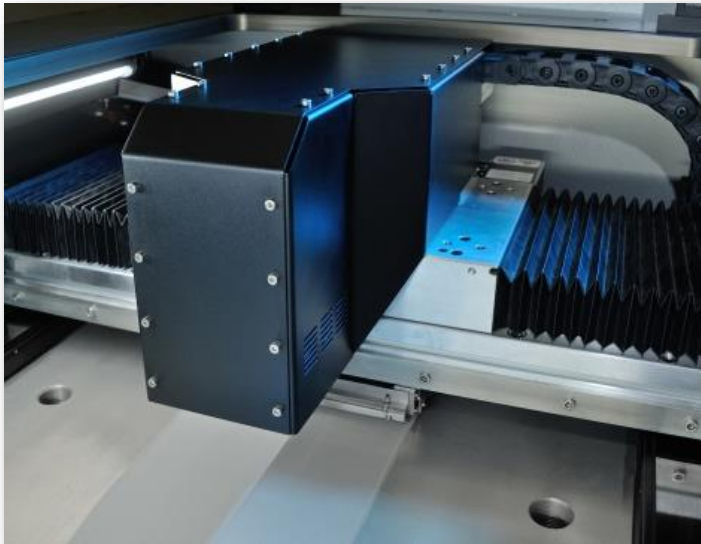
Conventional SLM



New Multispot Concept



New SLM Machine Concept at ILT - Multi Spot Array

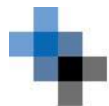


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Example Wheel Carrier In Cooperation with the BMW Group



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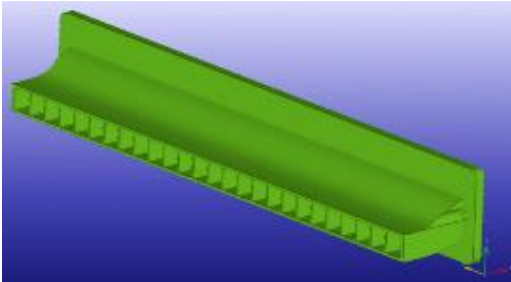
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Example Wheel Carrier In Cooperation with the BMW Group



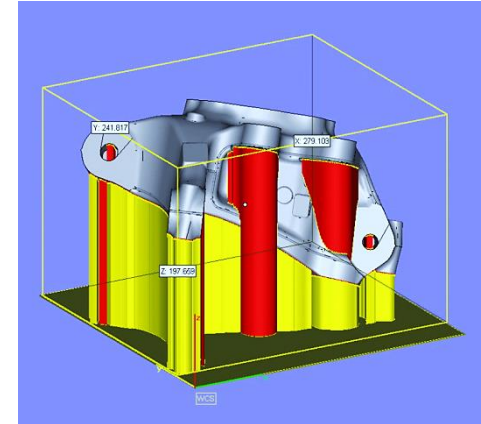
Machine Development



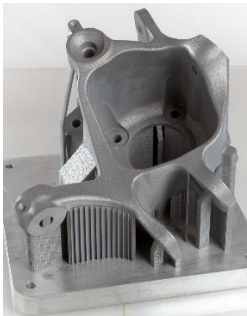
Reference Tests



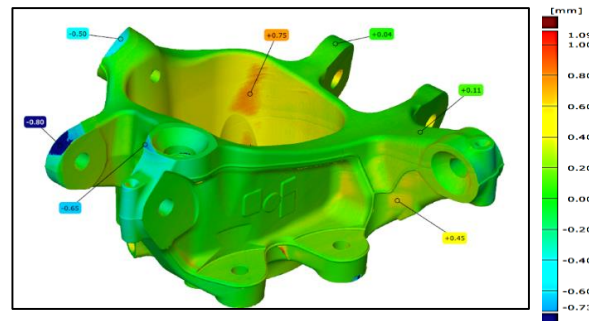
Process Development



AM of Reference Part



Metrology



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Example Wheel Carrier

In Cooperation with the BMW Group

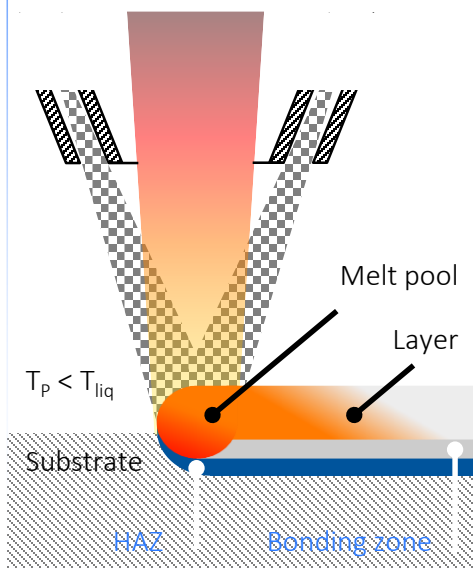


Example Highspeed Laser Metal Deposition

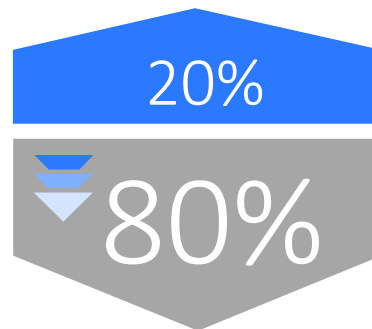


Conventional LMD

Primary energy deposition into substrate



Particle temperature
below melting
temperature



Ultra-high-speed LMD

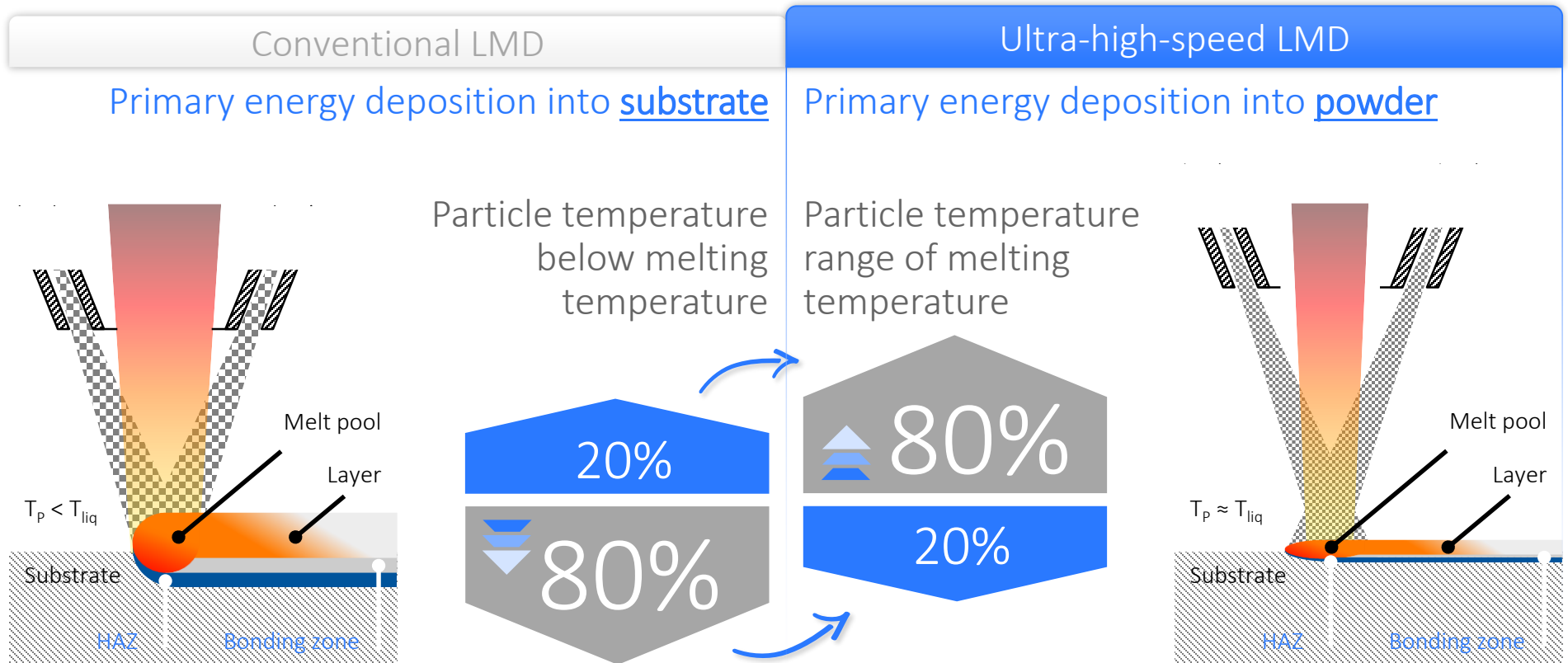


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Example Highspeed Laser Metal Deposition

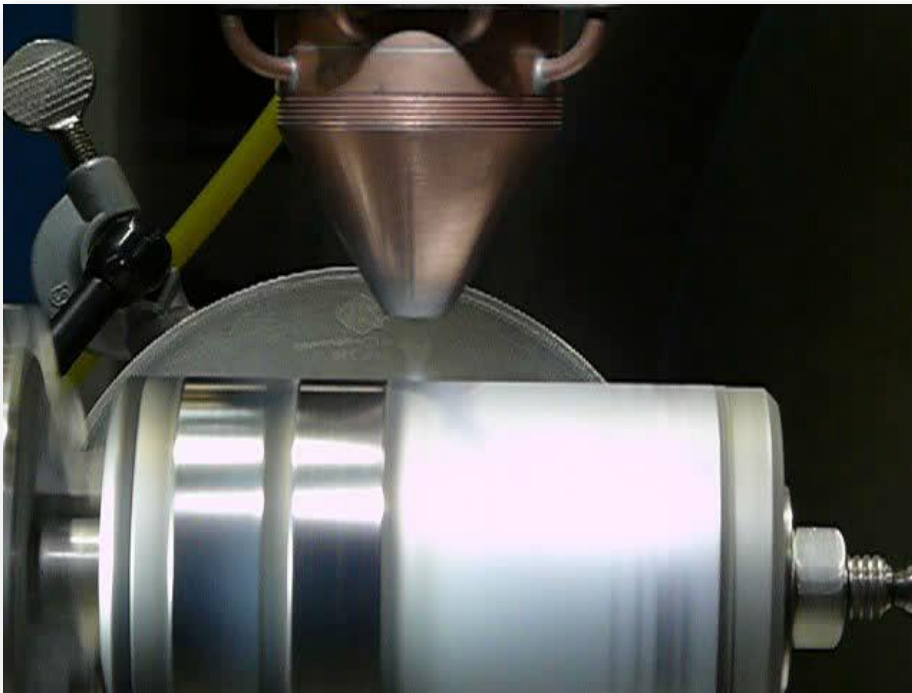


Process and System Expertise

Example Highspeed Laser Metal Deposition



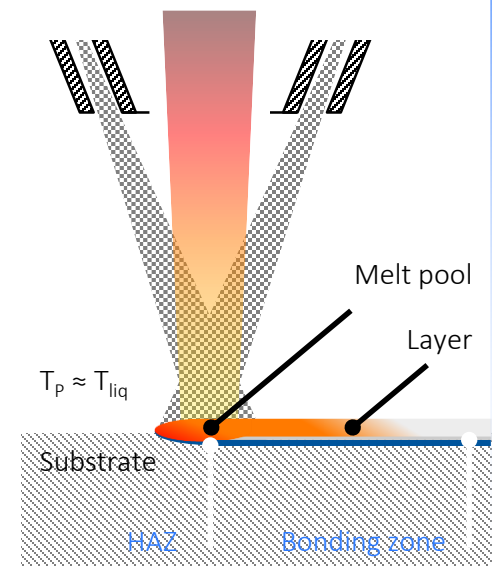
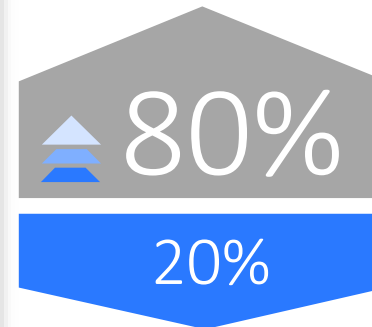
Conventional LMD



Ultra-high-speed LMD

Primary energy deposition into powder

Particle temperature range of melting temperature



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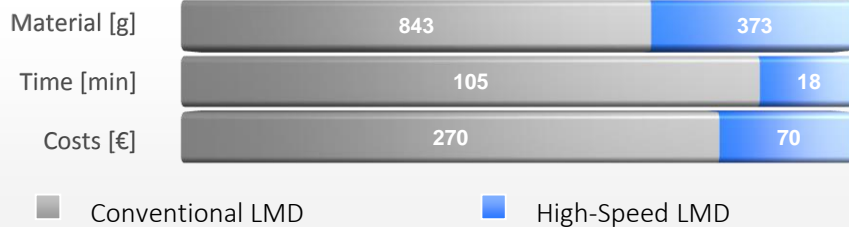


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High-Speed LMD vs. Conventional LMD



Resource Consumption



Parameters

Conventional LMD

- $v_v = 1.5$ m/min
- $\dot{m}_p = 8$ g/min
- $s = 500$ μm

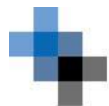
High-Speed LMD

- $v_v = 25$ m/min
- $\dot{m}_p = 21$ g/min
- $s = 250$ μm

Hydraulic Plunger



- Length: 1 m
- Diameter: \varnothing 50 mm



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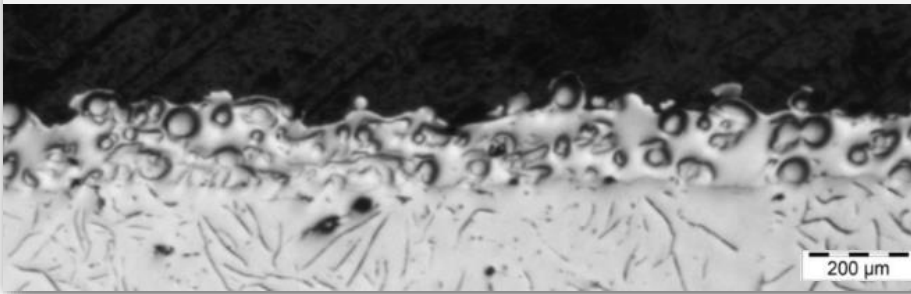


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Unconventional Material Pairings



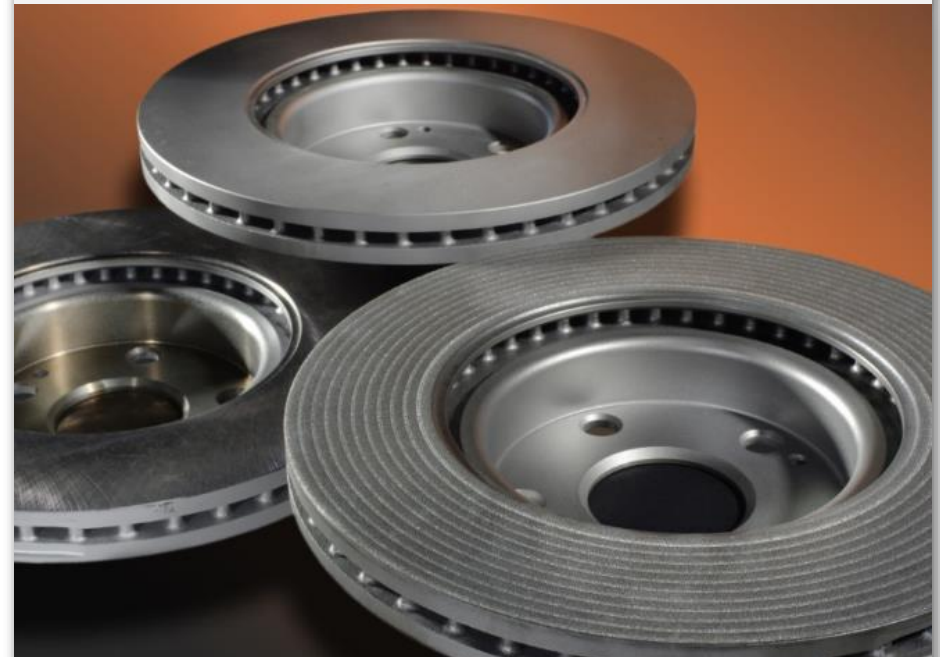
Cross-section



Results

- 1:1 wt.-% | WC : IN625
- Dilution < 1 %
- Single layer thickness approx. 60 μm

Disc brakes



- Diameter: Ø 300 mm

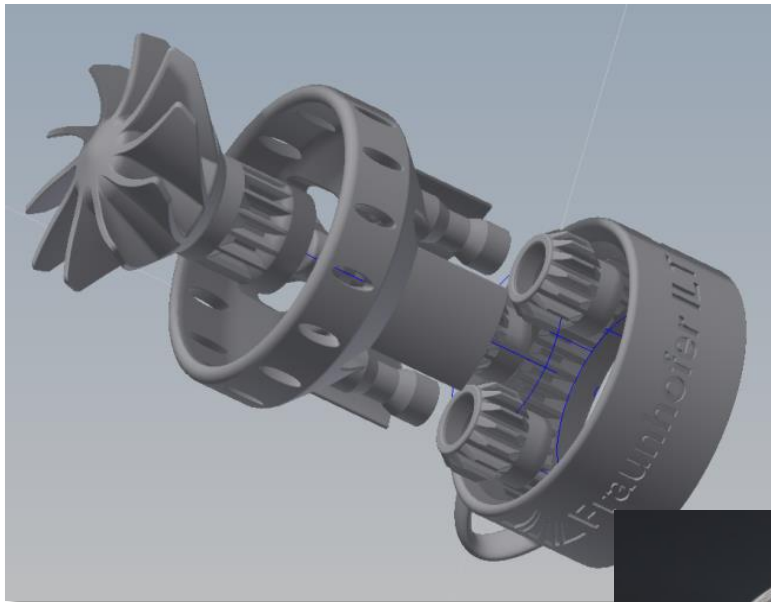


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From Prototypes....



**Monolithic design of
assembly with
moveable parts**



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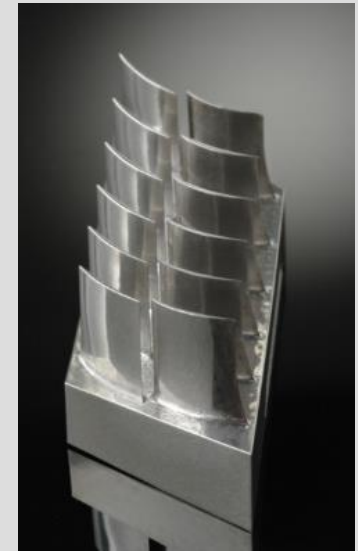
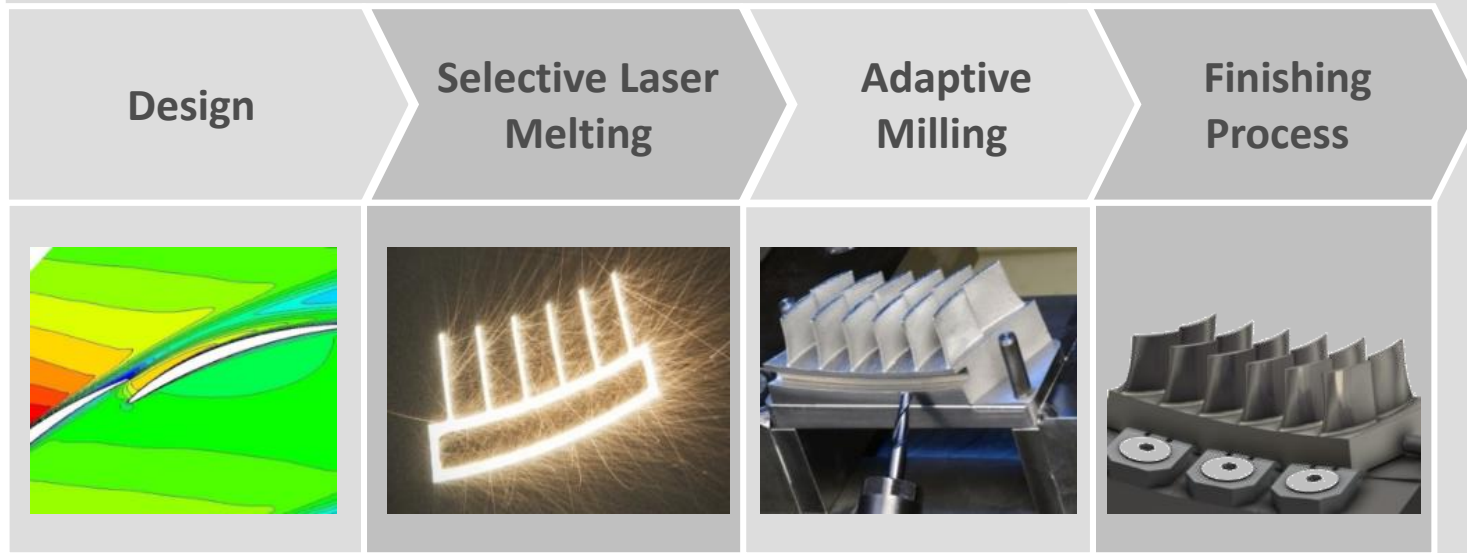
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From Prototype...to Products



Additive Manufacturing of Gas Turbine Vane Cluster



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Thank You very much for Your Attention!



Aachen Center for Additive Manufacturing &

Fraunhofer-Institute for Laser Technology

Dr. –Ing. Johannes Witzel

Steinbachstraße 15

52074 Aachen, Germany



www.acam-aachen.de

www.ilt.fraunhofer.de



j.witzel@acam-aachen.de



+49 241 8906-8686



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