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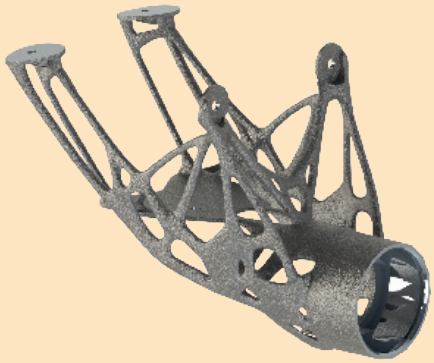

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1 *Steering column mount for Formula Student race car, material Ti-6Al-4V*
2 *Feasibility demonstrator turbocharger wheel, material TiAl*

ADDITIVE MANUFACTURING - SELECTIVE ELECTRON BEAM MELTING

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CAD TO METAL®
Arcam AB®

Electron Beam Melting (EBM) is a powder-based process for the additive manufacturing of 3D parts. The powder bed is selectively melted layer-by-layer by an electron beam under high vacuum atmosphere.

Advantages compared to manufacturing routes like casting / forging are:

- No additional auxiliary equipment needed
- Increased efficiency in raw material use
- Significantly reduced amount of finishing operations
- Freedom in design – "design for function"
- Processing of high-melting and / or highly reactive materials
- Decreased lead times for design and fabrication, shorter time-to-market
- High degree of component customization

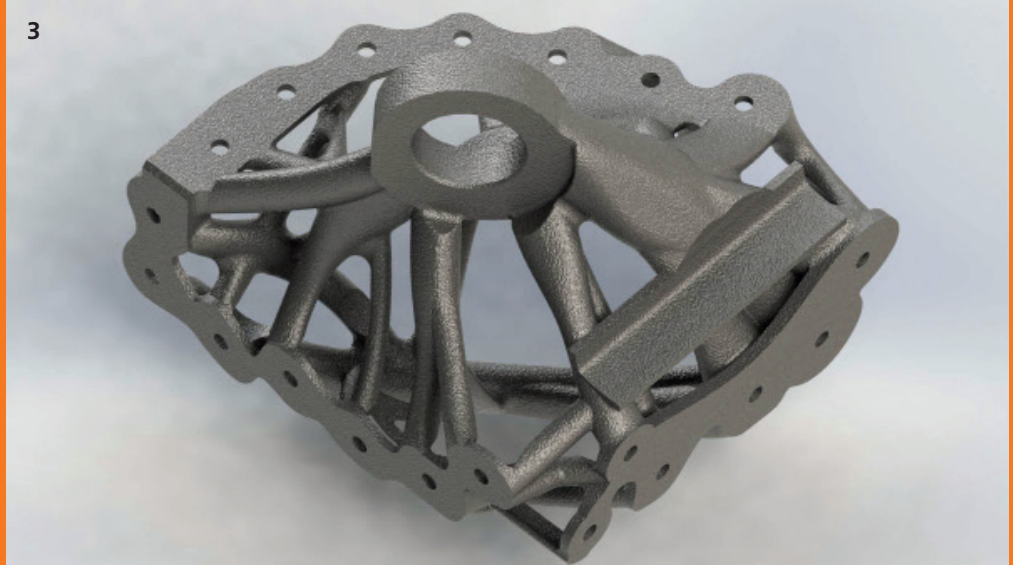
Areas of Application & Selected Examples

- Aerospace
  - Turbine blades
  - Pump impeller
- Automotive
  - Turbocharger wheel
- Medical engineering
  - Implants

Material Systems

In principle all metal powders can be used as long as they can be adapted to the process in terms of particle size distribution and shape. The following materials have been qualified for EBM:

- Grade 2 Titanium
- Ti-6Al-4V
- CoCr



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Other possible materials which can be developed for EBM within the frame of further R&D work at Fraunhofer IFAM Dresden are:

- Aluminium and its alloys
- Steels
- Superalloys
- Intermetallics
- Refractory metals and alloys

Equipment

- EBM machine Arcam A2X
  - Build space (200 x 200 x 380) mm³
  - Scan speed up to 8,000 m/s
  - Build rates 55[1] - 80[2] cm³/h (Ti-6Al-4V) ([1]fine surface quality, [2]high build speed)
  - Beam power 50 - 3500W
- Analysis
  - Powder characterization (e.g. particle size, particle shape, impurities)
  - Part characterization (e.g. density, microstructure, impurities, mechanical and thermal properties at room and elevated temperature)

Process Description

EBM is a powdermetallurgical process which includes the following main steps:

- Design of part ➔ CAD drawing
- Positioning of part(s) within build space, addition of support structures (if needed)
- Slicing of 3D part into 2D layers
- Building the part layer-by-layer
- Removal of part from the machine, blow off surplus powder

R&D Capacity

- Material evaluation
- Component design
- Process efficiency (depending on part and material)
- Prototype & small series production
- Component test (see Equipment ➔ Analysis)

A demonstration facility will be established at Fraunhofer IFAM Dresden through which the above mentioned areas and further specific R&D issues can be addressed.

Customer Benefits

Market forecasts certify a strong growth for additive manufacturing. In this area, EBM especially has a very high potential for the future additive manufacturing of highly complex 3D parts. Combining EBM technology with the extensive knowledge in powder metallurgy, Fraunhofer IFAM Dresden is a strong and reliable R&D partner in these fields.

Advantages:

- Net shape components which can be used with minimal additional finishing
- Processing of high-melting and / or highly reactive materials
- Processing of hard-to-machine materials
- New degrees of freedom in design
- "Rapid manufacturing"
  – quick availability of parts

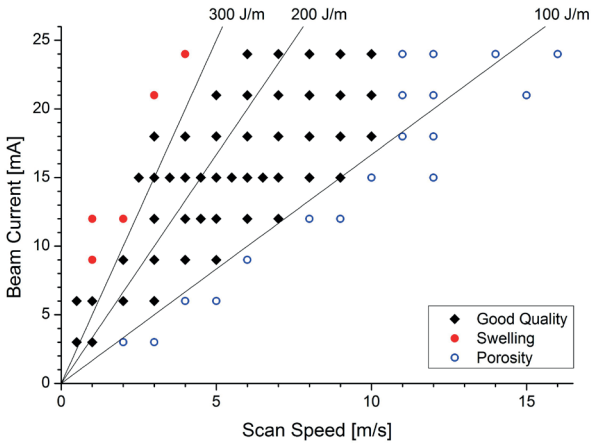

Fig. 1
Processing window for SEBM of Ti-6Al-4V. Blue circles indicate specimens with more than 1% porosity; red circles indicate pronounced swelling of the surface

3 *Topology optimized component „Main Gear Bracket Rear" (Demonstrator)*