Additive manufacturing of metallic components

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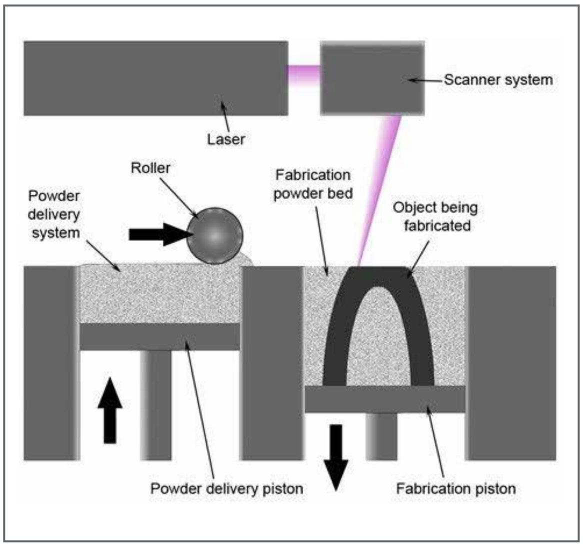
Additive manufacturing by laser powder bed fusion (3D printing)

Laser powder bed fusion (L-PBF, laser powder bed fusion), which is also known by its popular name “3D printing”, is one of two additive manufacturing technologies for the fabrication of metallic components with high quality. This technology allows the production of components having structures below 100 µm und roughness below 50 µm, besides offering nearly complete freedom of design.

This offers the possibility to produce multifunctional metallic components, which were either impossible or only feasible with unprofitable expenses using classic (subtractive) production methods.

All this results are feasible because the final component is produced by laser melting out of the powder bed – layer per layer. Limitation of precision is only given by the grain size of the used powder and the spot size of the laser beam.



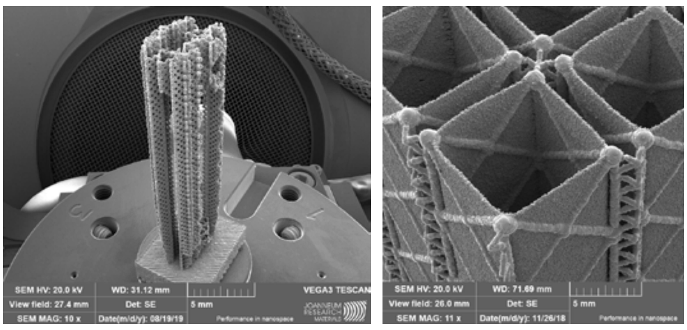
Principle of L-PBF technology (Modified by Materialgeeza - Own work, CC BY-SA 3.0) und Photo of the L-PBF process.

Two main applications of this technology currently lie in medical engineering and aerospace industries:

In medical engineering, it is possible for the first time to produce implants and dentures tailored to the individual patient.

In aerospace industries, in turn, there is now the feasibility to produce functional components with drastically reduced weight. This is enabled on one hand by nowadays simulation tools, giving the possibility to spare volume in spots that will not be stressed, and on the other hand by substituting full volumes with lattice special structures, which show similar macroscopic physical properties.

Case examples from medical engineering and aerospace industries (left: bone implants, right: engine maintenance door hinge, both made of titanium)

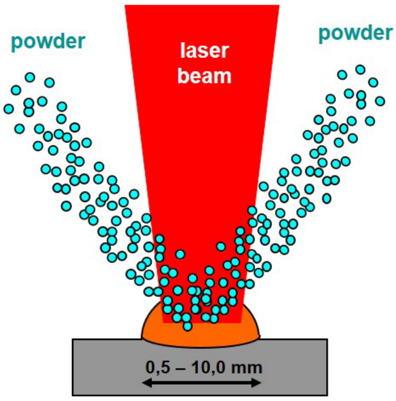


REM-pictures of lattice structures fabricated via L-PBF

Additive manufacturing by laser cladding

In addition to the well-known 3D printing out of the powder bed (L-PBF), laser cladding (L-DED) is another additive manufacturing technology for the fabrication of metallic components with high quality. Although the achievable precision cannot compete with 3DF printing, this technology makes it easy to combine different materials.

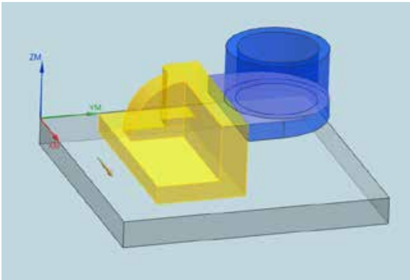
Such a combination can be done either immediately prior to the cladding process thus allowing the creation of alloy mixtures, as well as consecutively in order to produce sandwich structures. Another advantage of this technology in comparison with the powder bed technology is its production speed, which is orders of magnitude higher.



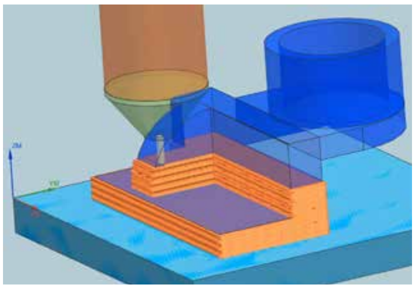
Principle of L-DED technology and additively manufactured component made up of different materials.

JR has two different systems for additive manufacturing by L-DED technology: A combined laser and milling station, which allows for the sometimes necessary post-process machining in one manufacturing chain, as well as a robot station allowing the manufacturing of very large and heavy parts.

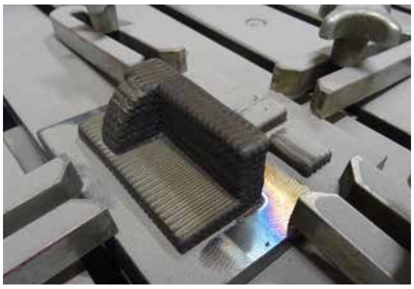
With Siemens NX, a powerful software tool is available for path planning. Not only is this software capable of simulating different cladding parameters, also the complete machining station is virtually included thus allowing for a complete simulation in advance. This is especially important when using a robot station, not only for the preemptive avoidance of possible collisions, but also for production optimization by the use of appropriate axis configurations.



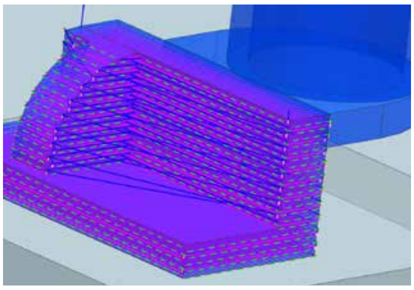
CAD data of a complex component and visualization of path planning

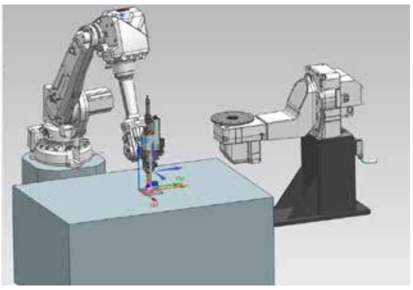


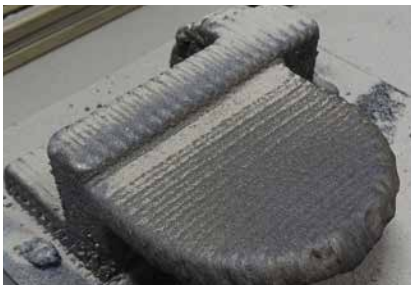
Simulation of material deposition and simulation of the complete manufacturing station



Component at different stages of completion







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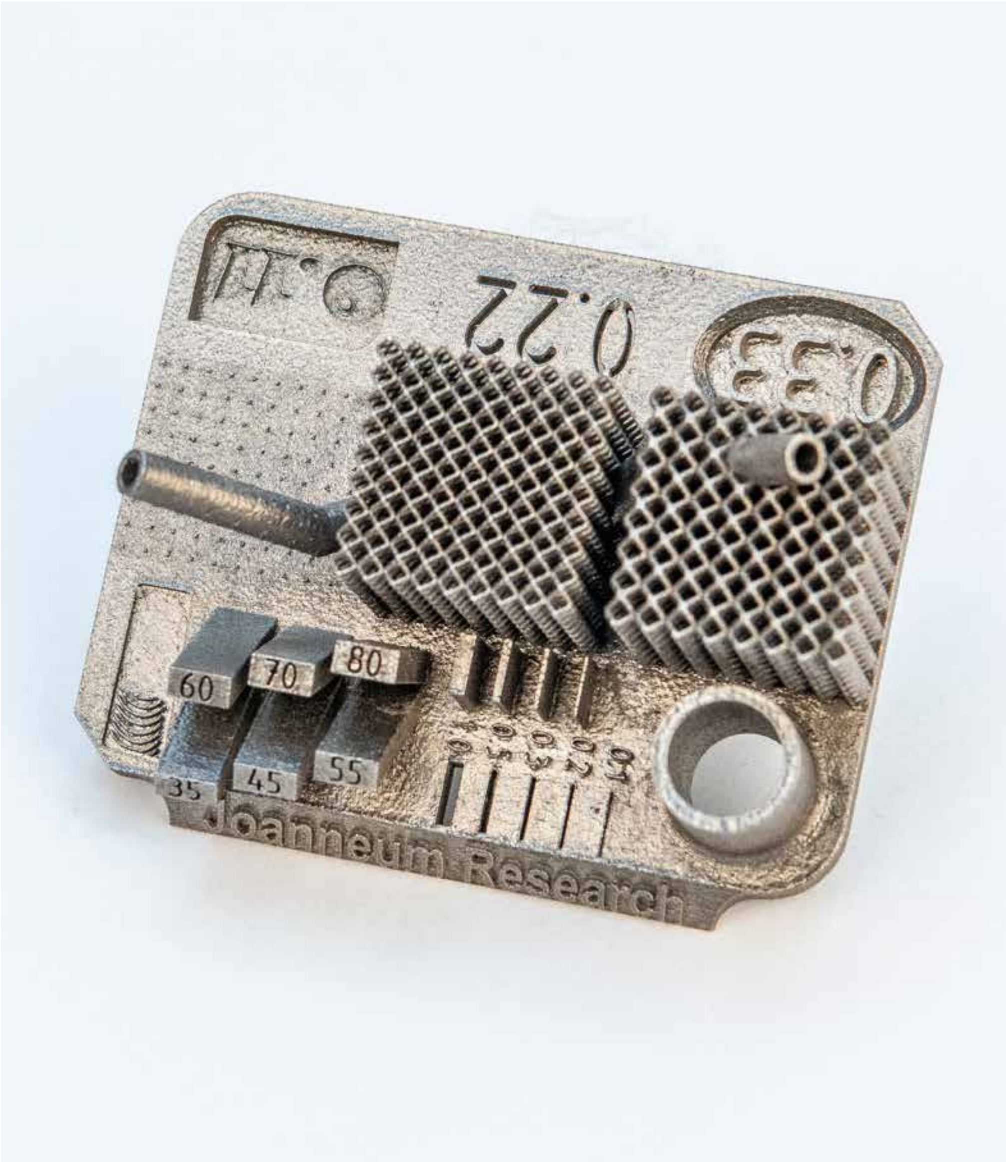

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