Lithography-based additive manufacturing of functional metal components

Current Situation

At the moment, there is no economic additive manufacturing (AM) process available for the production of complex geometries in the Metal Injection Molding (MIM) size range (1 – 200 g component mass). The quality of components produced through established AM processes is often limited, and the surface roughness of the end products heavily depends on the part orientation and attached support structures. These AM processes often require flowable and/or weldable powders, meaning that the material options are limited.

Lithoz's Solution

Lithoz Lithography-based Metal Manufacturing (LMM) process allows for the production of accurate and precise green parts. By using a feedstock system, non-flowable powders can now be processed for the economical and small-scale part production of MIM-like components with known material properties. No support structures are needed, and the volume arrangement of parts minimizes the effort required in data pre-processing.

Machine parameters for Laboratory Systems HD40 & HD60	
Lateral resolution	40 µm (HD40) | 60 µm (HD60)
Number of pixels (X, Y)	1920 x 1080
Building volume (X, Y, Z)	76 x 43 x 150 mm | 115 x 64 x 150 mm
Slice thickness	10 – 100 µm
Slice thickness	10 – 100 µm
Building velocity	Up to 100 slices/h
Print Speed	Up to 16 cm³/h | Up to 35 cm³/h

The laboratory scale setups that are currently available — the Hammer HD40 and HD60 — are economical technology entry models, intended for material development and for the user to have their first experience with this novel technology. Larger field sizes of up to 250 x 250 mm will be available by beginning of 2020.

LMM with 316l stainless steel

The LMM feedstock consists of 316L of metal powder, homogenously dispersed in a photocurable binder system. The wiper blade applies a fresh layer of feedstock, which is then selectively polymerized by a high-power projecting unit. The building piston is lowered according to the desired layer thickness and a so-called 'green part' is built, layer by layer, as the process continues. After printing, the green parts are embedded in the self-supporting feedstock and can easily be extracted. Depending on the geometry, up to 98 % of the surrounding feedstock can be recycled.

Similar to MIM, the green parts need thermal post-treatment. Firstly, the organic binder is completely burnt off, and then, at higher temperatures, the loose powder (i.e. 316L stainless steels) can be sintered to reach up to 98 % of the theoretical density.

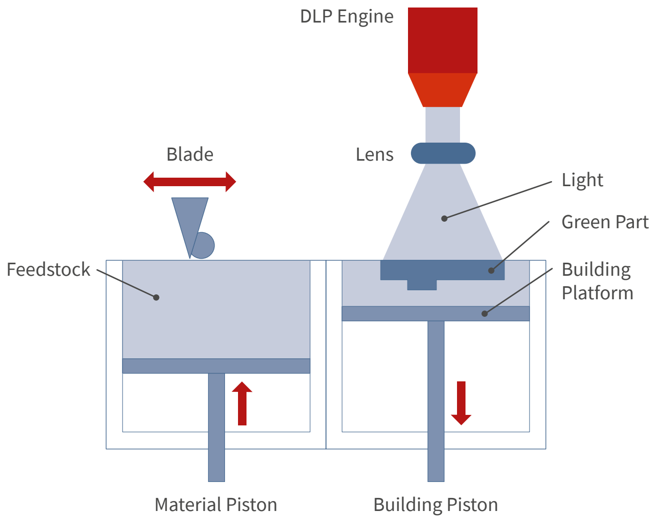


Figure 2: Description of the LMM process

No support structures

The self-supporting function of the feedstock allows for the volume-optimized placement of different geometries on a single building platform, without the need to add support structures. The 3D nesting operation prior to the printing process can be performed automatically by third-party software solutions.

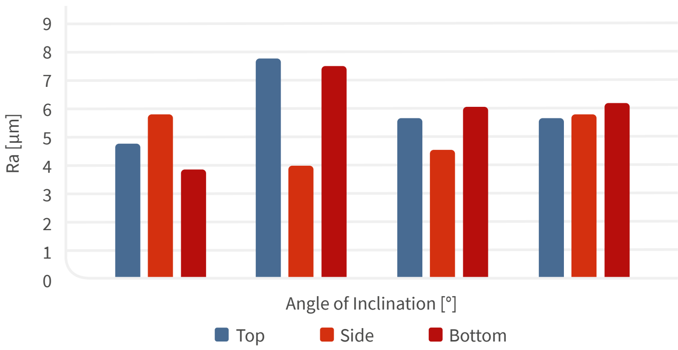
Sintered parts made of 316L

Among others, MIM-grade 316L powder is available as a standard material for LMM processing, and the resulting sintered parts have been characterized in terms of surface roughness, mechanical properties, and chemistry. The results prove that LMM can be successfully used to directly produce functional parts in a small-scale series or to manufacture prototypes prior to a mass production.

Figure 4: Sintered air intake made of 316L stainless steel

Surface roughness

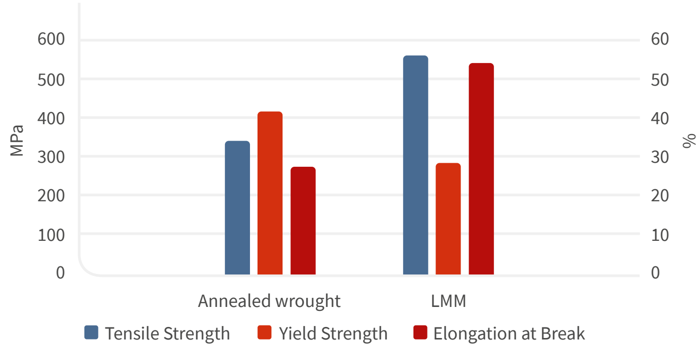
An Alicona confocal microscope was used to measure the surface roughness of sintered plates (5 x 10 x 1,5 mm), built at varying angles without any post-treatment, and the Ra was determined for the top, bottom and side surfaces of each plate. The average value measured for Ra was 5.77 µm, highlighting how this high level of surface finish quality in every direction and part orientation is a major strength of the LMM process.



Chemical and mechanical properties

By making slight adjustments to a MIM debinding cycle, the carbon content of sintered cubes 10 mm^3 in dimension was able to be optimized, and a carbon value of 0.05 wt% was measured, and besides the carbon content all other elements were as specified by ASTM Standard.

Tensile testing was performed on specimens machined from cylinders built with dimensions 7 x 48 mm (ASTM E8). The properties observed were comparable to the wrought standard for 316L, while Archimedes' Principal density measurements gave a density of 98.2 - 99.0%, based on a theoretical density of 7.87 g/cm^3.



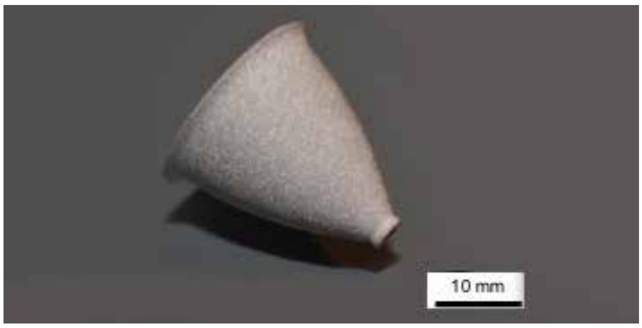


Figure 5: Sintered bell-shaped diffusor made of 316L stainless steel

If you would like to find out more about our LMM process or look into our customer-specific material development service and feasibility studies, do not hesitate to send a short inquiry to Mr. Gerald Mitteramskogler at **geraldmitteramskogler@lithoz.com**, or call us at **+43 1 9346612–225.**

Discover the advantages of LMM

- Highest achievable surface quality compared to other AM processes
- High accuracy and resolution of printed parts
- Possibility of processing non-flowable and non-weldable materials
- Easy preparation of printing jobs and handling of machine
- Quick exchange of materials
- No danger to the operator (no metal dust or high-power laser)

Why LMM is complementary to MIM?

- Both are indirect manufacturing processes
- Same range of metal powders as raw materials
- Similar furnace equipment for thermal post-processing
- Comparable mechanical properties and microstructure after sintering
- LMM as a ramp-up technology or for small-scale manufacturing