incus

Lithography-based additive manufacturing of functional metal components

Figure 1: Metal 3D Printer Hammer Lab35

Current situation

Until now there has not been a functional solution 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 Additive Manufacturing (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.

The Incus solution

Incus' Lithography-based Metal Manufacturing (LMM) process allows to produce accurate and precise green parts. By using a feedstock system, non-flowable powders can now be processed for the economical, small-scale part production of MIM quality 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 System Hammer Lab35	
Lateral Resolution	35 µm
Number of Pixels (X, Y)	2560 x 1600 px
Building Volume (X, Y, Z)	89.6 x 56.0 x 120.0 mm
Layer Thickness	10 – 100 µm
Print Speed	up to 250 layers/h up to 100 cm^3/h

The laboratory scale setup that is currently available – the Hammer Lab35 – is the economical technology entry model for material developmentand small-scale production. The production series will be launched by beginning of 2022.

LMM technology

The LMM feedstock consists of metal powder (e.g. 316L stainless steel, Titanium, copper etc.), 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 99% of the surrounding feedstock can be recycled.

Similar to MIM, the green parts need to be sintered. Firstly, the organic binder is completely burnt off, and then, at higher temperatures, the loose powder (e.g. 316L stainless steel) can be sintered to reach up to 99% of the theoretical density.

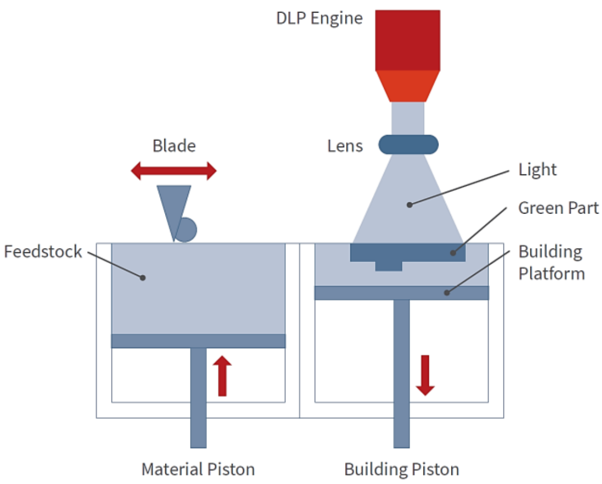


Figure 2: Description of the LMM process

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.

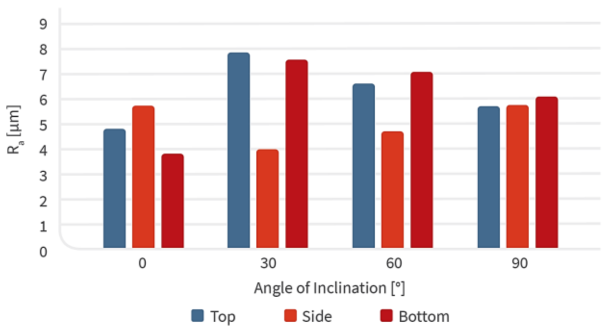
Sintered parts made of 316L

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: Cooling device (33 x 27 x 7 mm)

Surface roughness

An Alicona confocal microscope was used to measure the surface roughness of sintered plates (5.0 x 10.0 x 1.5 mm), built at varying angles without any post-treatment, and the roughness value (R_a) was determined for the top, bottom and side surfaces of each plate. The average value measured for R_a was 5.77 µm, highlighting how excellent surface aesthetics 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. Besides the carbon content all other elements were as specified by ASTM Standard E8.

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.2 – 99.0%, based on a theoretical density of 7.87 g/cm^3.

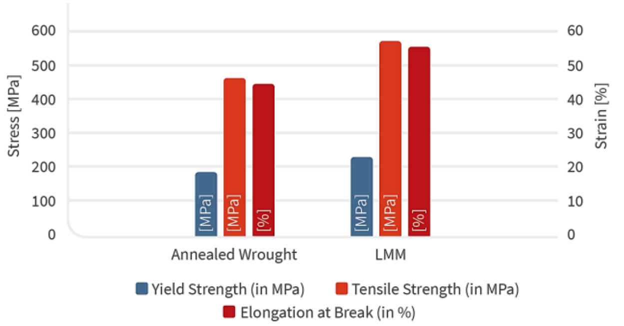


Figure 5: Drill head with integrated coolant passages (46 mm height, 20 mm diameter on top)

If you would like to find out more about our LMM process or look into our customer-specific material development service and innovation studies, do not hesitate to send a short inquiry to Dr. Gerald Mitteramskogler at **office@incus3d.com**

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

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