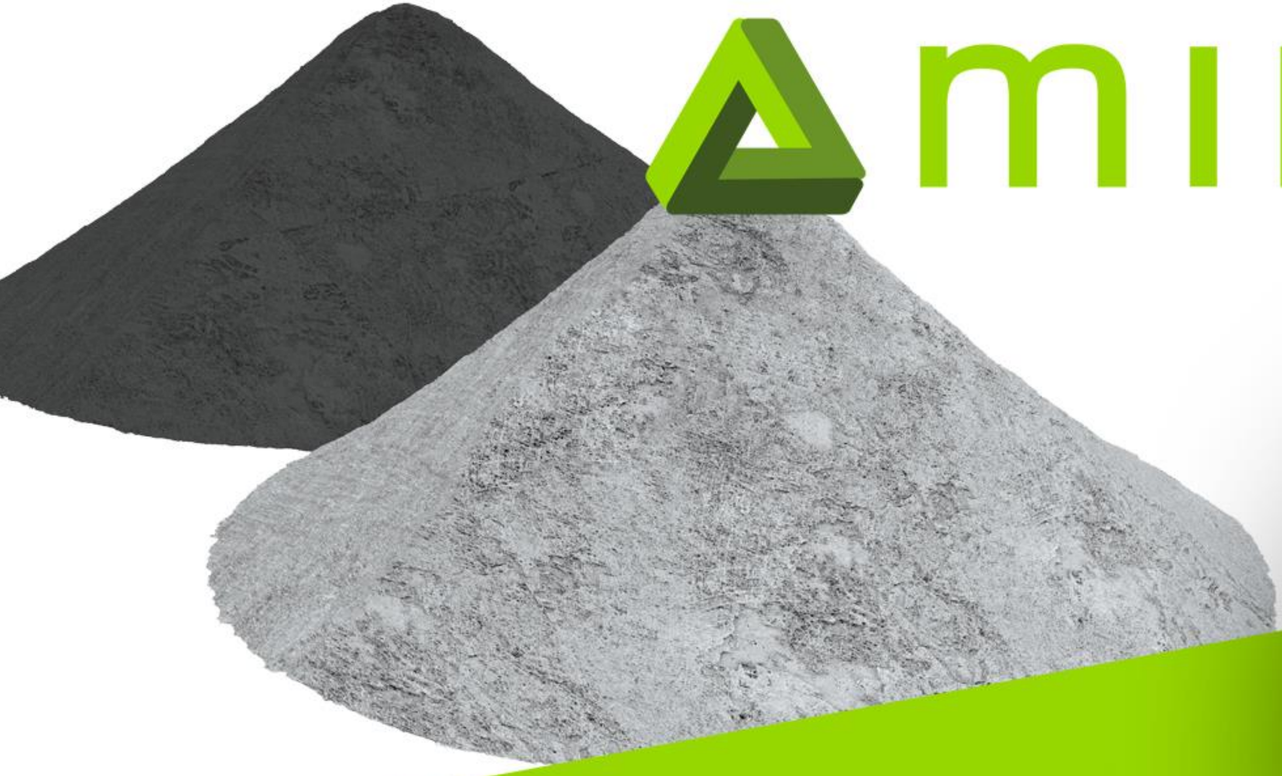
mimplus



METAL 3D PRINTING
IN SERIAL PRODUCTION

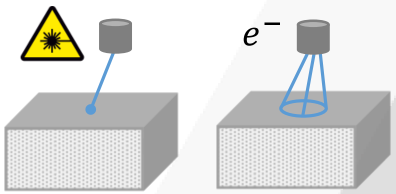
Key facts MIMplus

- 500 employees world-wide
- 25mq square metre production floor
- Over 25 Mio. parts and assemblies per year
- Customers from different industries such as medical, aerospace, automotive and luxury
- In house tool shop
- In house machine construction and automation
- Research and development with well equipped laboratory
- Network of leading suppliers
- Certified according to ISO 9001:2015
- Certified according to IATF 16949
- Certificate according to ISO 13485:2016
- Certified according to EMAS and ISO 14001

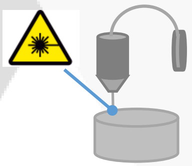
Overview of metal AM technologies

beam-based methods (direct)

Powder bed fusion



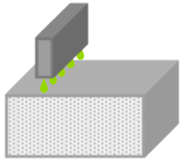
Direct energy deposition



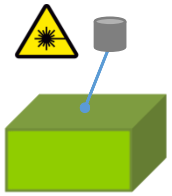
- Single-stage process
- Residual stress + thermal distortion/warping
- Support structures neccessary while printing
- Broad material portfolio (weldable)
- Low productivity

sinter-based methods (indirect)

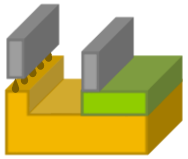
Binder Jetting



ColdMetalFusion

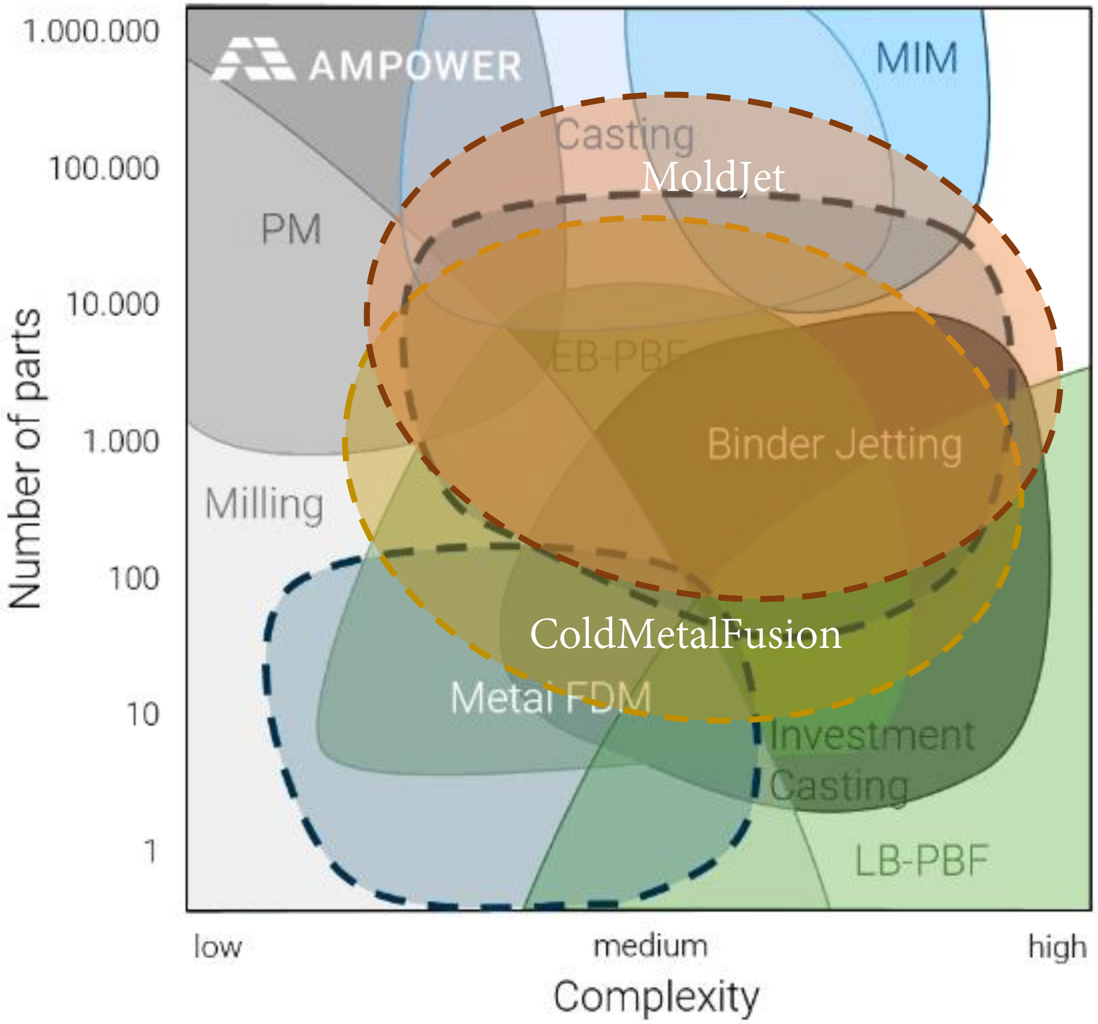


MoldJet



- Two-stage process
- Sinter distortion might occur
- No support structures neccessary while printing
- Broad material portfolio (sinterable)
- High productivity

Comparison of productivity



📖 Ampower insights: Metal Additive Manufacturing with sinter-based technologies; Vol. 3, October 2018

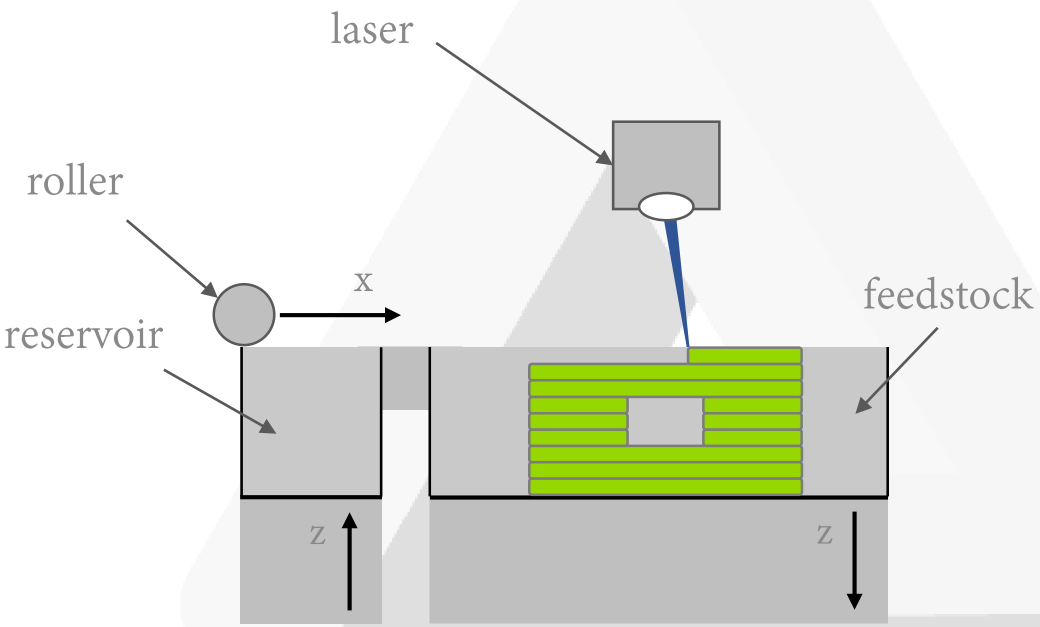
From powder to complex metal parts

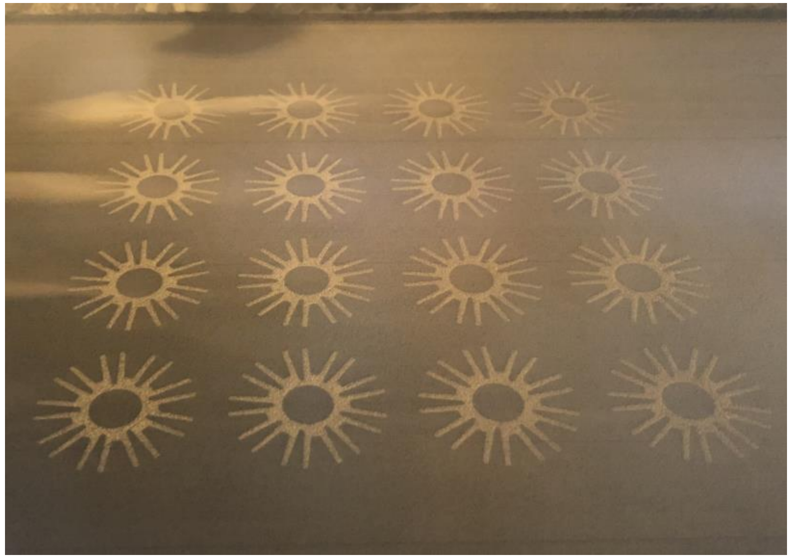
AM

MIM

1. **raw material**
   metal powder, binder
2. **shaping**
   MIM
3. **debinding**
   solvent, catalytic, thermal
4. **sintering**
   sintering furnace
5. **finished part**

ColdMetalFusion





- Thin layer of feedstock in which the binder is melted by a laser
- No support structure necessary
- Conventional 3D printers (SLS) for polymers can be used

ColdMetalFusion

- MfgPro230 xS from XYZprinting
- Heated build volume 230 x 230 x 230 mm
- 30 W laser power
- Layer thickness of 100 µm
- Build speed up to 20 mm/h

ColdMetalFusion – from green body to sintered part

1. Depowdering

Source: headmade materials

Removal of loose feedstock

2. Solvent debinding

Removal of base polymer

3. Sintering

Thermal debinding and sintering

- Robust green parts, suitable for green part processing
- Uniform sintering shrinkage of ~13%

Source: headmade materials

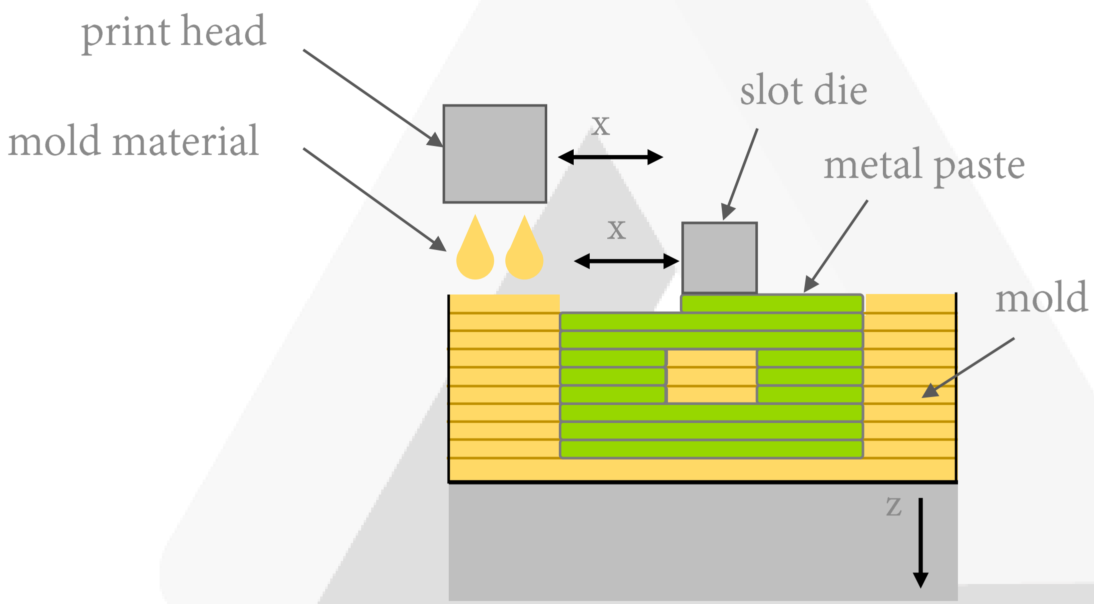
ColdMetalFusion

Design guidelines

- Wall thickness from 1 mm up to max. 15 mm
- Hole diameter starting from 1 mm
- Overhangs up to 10 mm possible
- Threads starting from M4
- Tolerances +/- 0.1 mm possible, but strongly dependent on part geometry

Source: PIM International

MoldJet

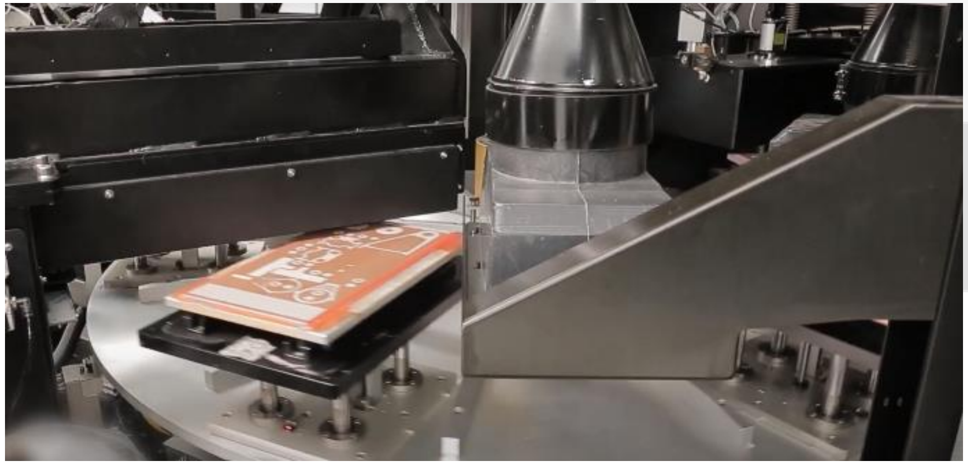


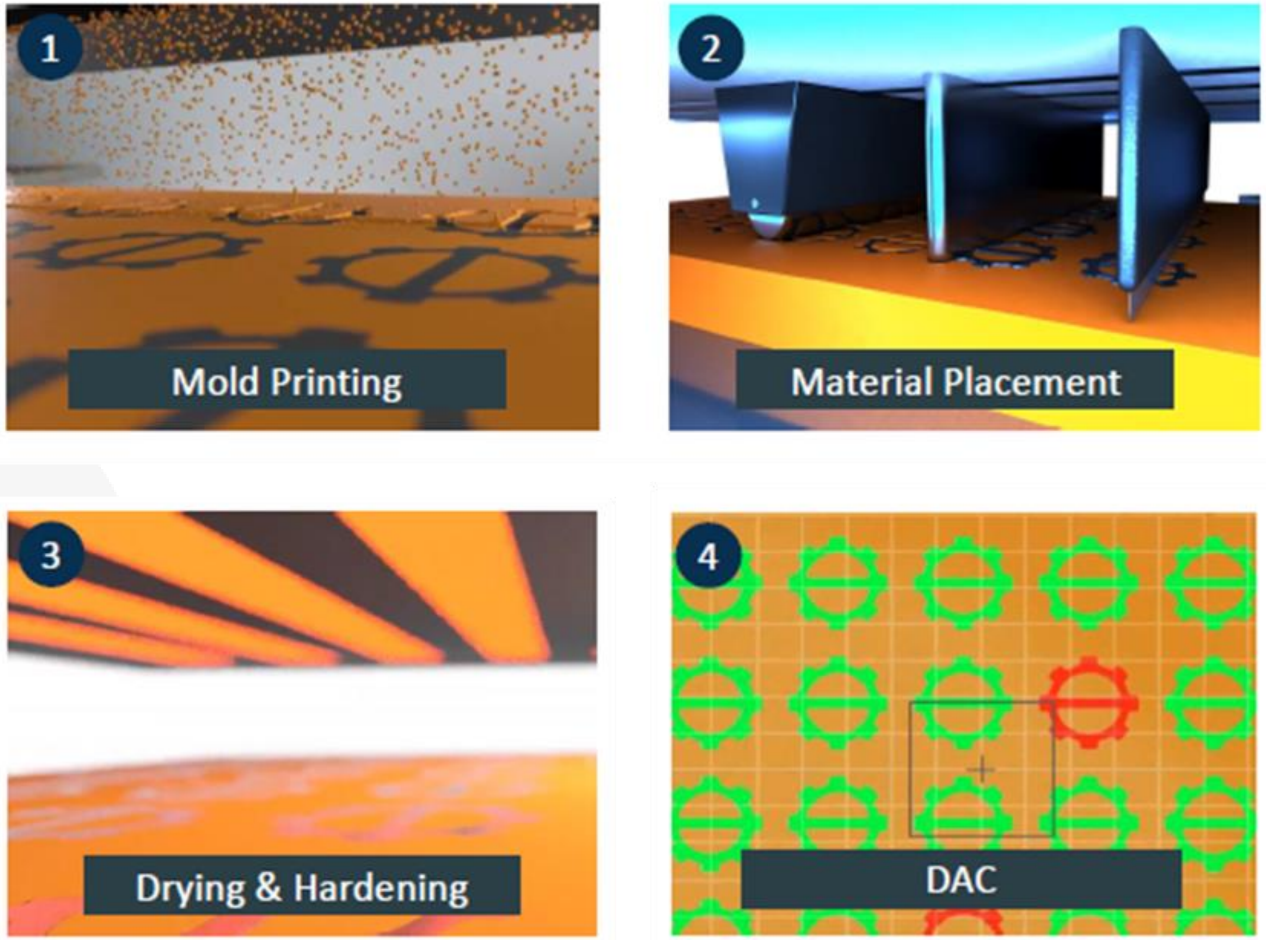
Source: Tritone

- Thin layer of mold is printed, then a metal paste is placed in the printed mold
- No support structure necessary
- Efficient printing process through nesting of parts

MoldJet

- 6 trays can be printed simultaneously
- Tray size of 400 x 240 x 120 mm
- High productivity up to 1,600 cm^3/h
- Resolution of 2,400 dpi
- Layer thickness from 40 µm to 200 µm

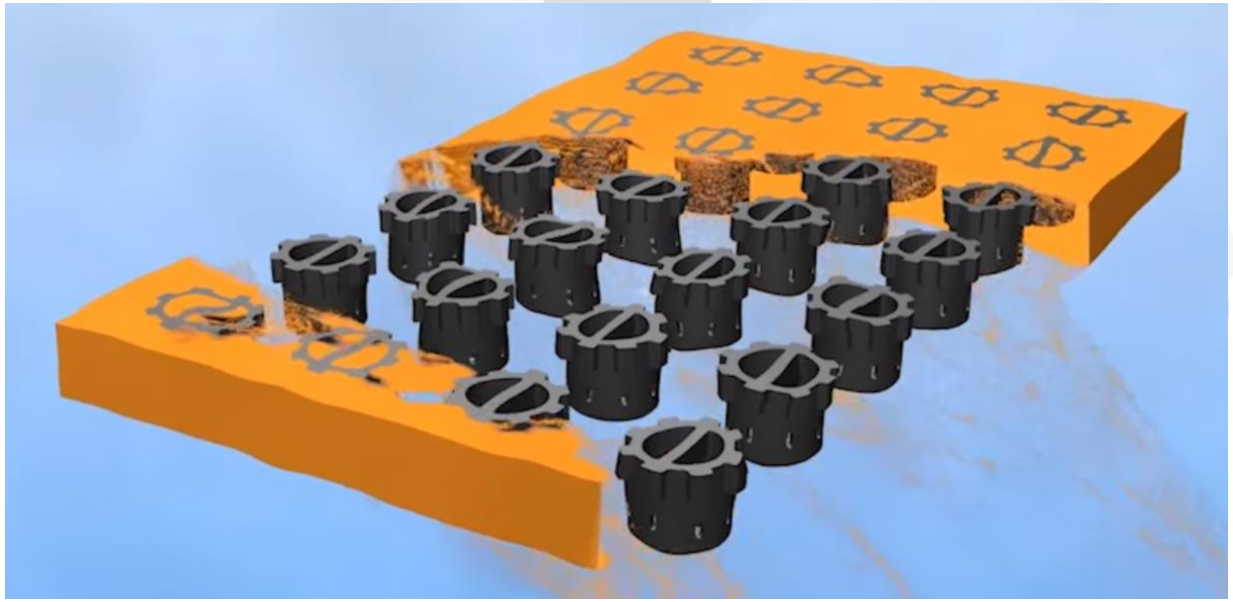




MoldJet – from green part to finished part

- Demolding of green parts using a thermal process
- Robust green parts, suitable for green part processing
- Uniform sintering shrinkage of ~13%

Demolding of green parts



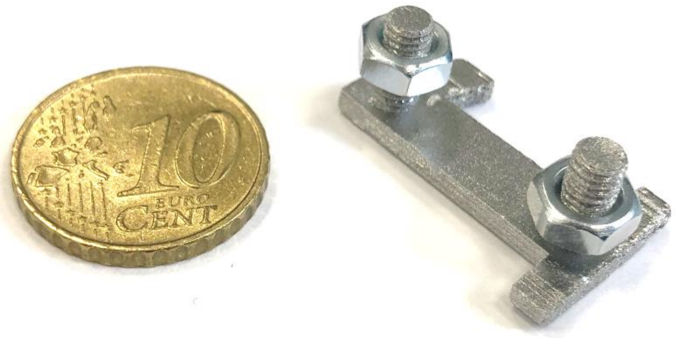
Source: Tritone

Source: Tritone

MoldJet

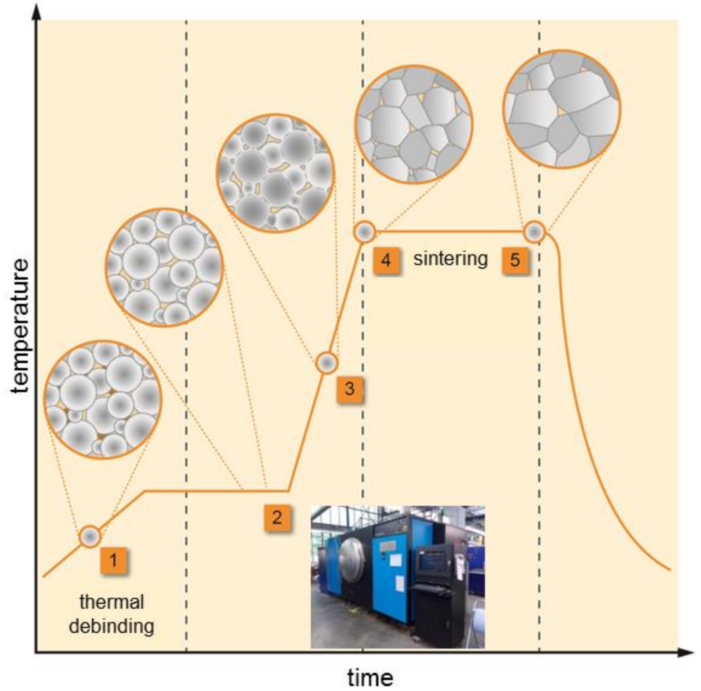
Design guidelines

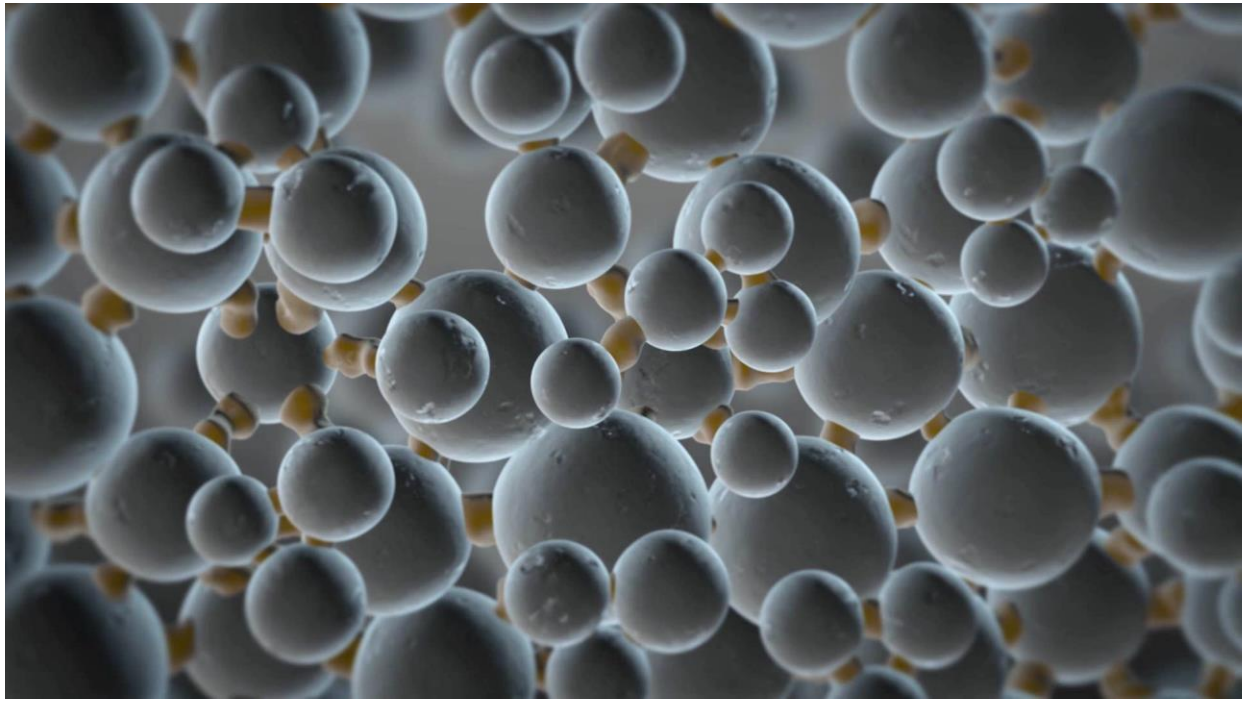
- Wall thickness from 0.2 mm up to max. 15 mm
- Hole diameter from 0.2 mm to 20 mm
- No closed hollow shapes – Mold needs to be able to flow out
- Threads starting from M3
- Tolerances of 1%, but strongly dependent on part geometry



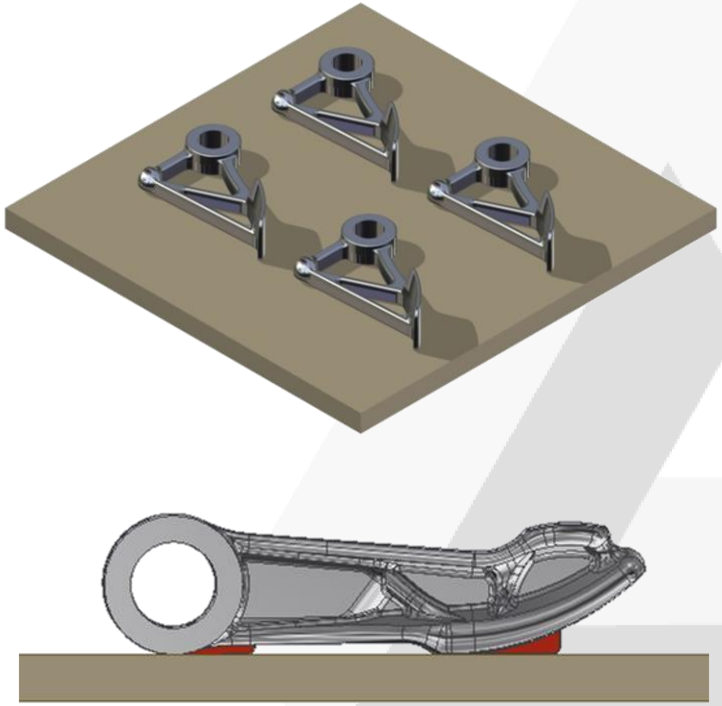
Sintering of AM and MIM parts

- Sintering is essential to transform green parts into a fully metallic part
  → Densification of the porous structure to receive a dense (> 96%) metal part
- Sintering temperature is close to the melting temperature of the material
  → Consideration of creep and friction to avoid sintering distortion

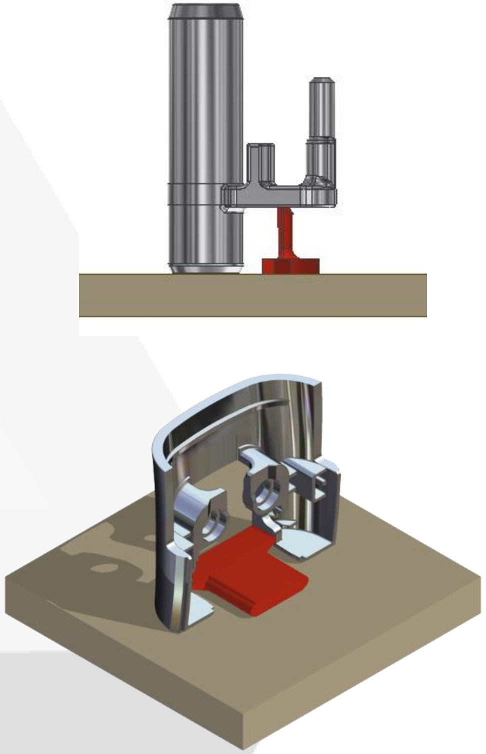




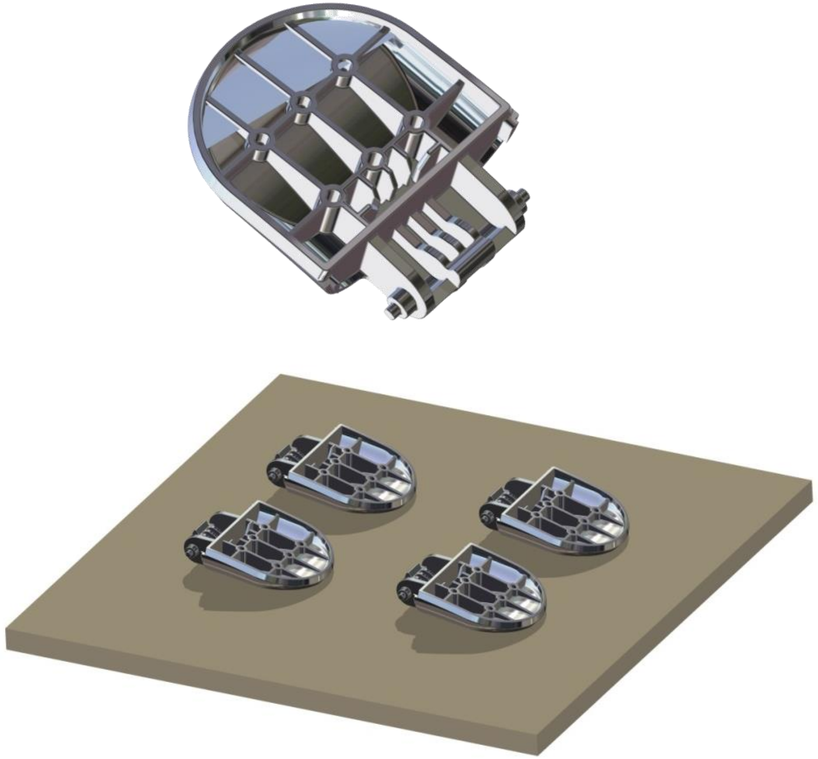
Sintering of AM and MIM parts – Design guidelines



flat contact surface



support structure



reinforcement structure

Comparison of AM and MIM

Material porfolio

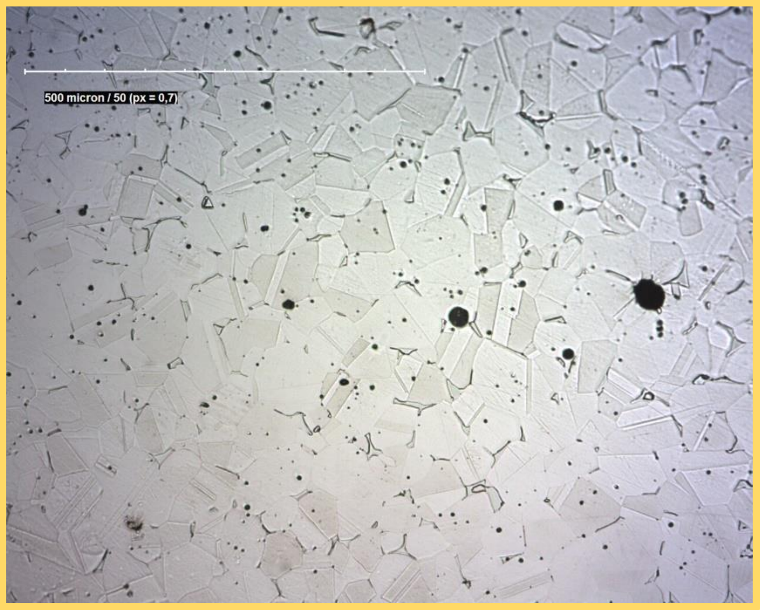
	ColdMetal Fusion	MoldJet	MIM
Stainless Steel	●	●	●
Low Alloy Steel		●	●
Tool Steel	●	●	●
Super Alloy	○	○	●
Titanium	●	●	●
Copper		○	●

● available ○ under development

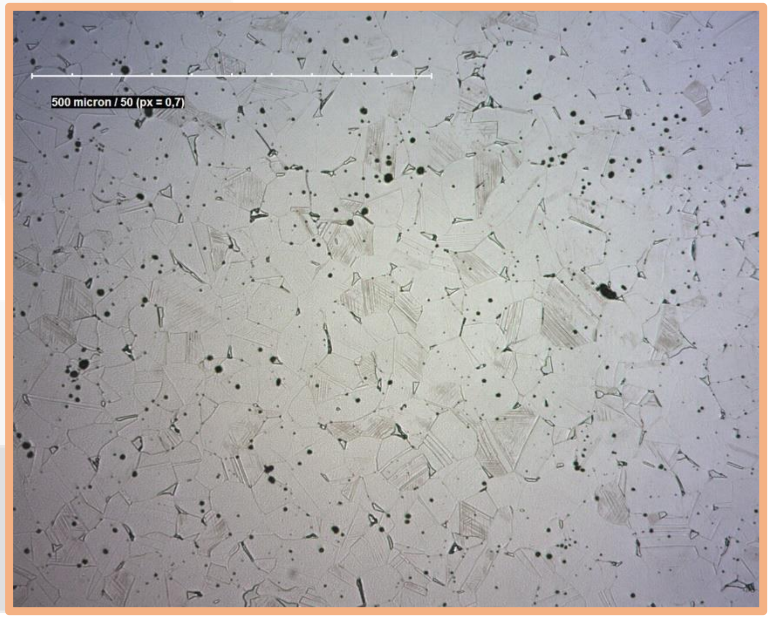
Comparison of AM and MIM

Microstructure for 316L

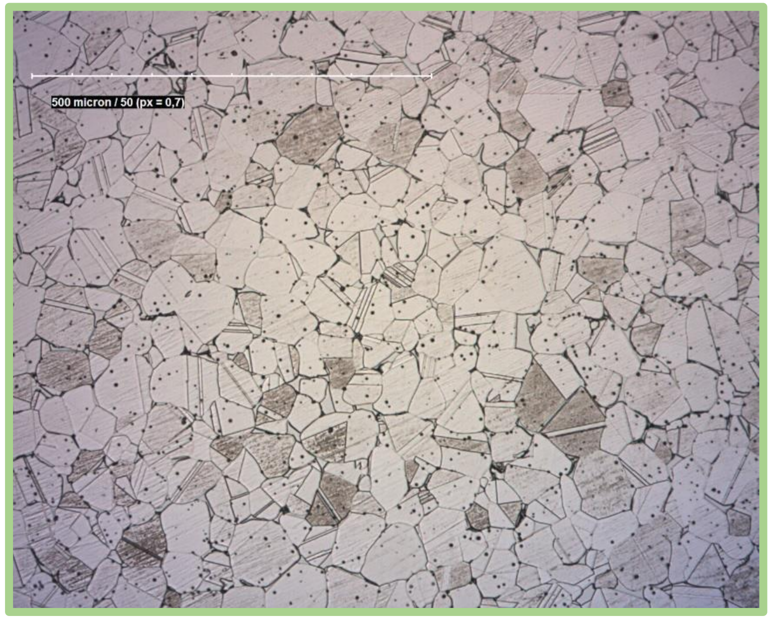
ColdMetalFusion



MoldJet



MIM



Comparison of AM and MIM

	ColdMetal Fusion	MoldJet	MIM
part size	2 - 20 cm	0.2 - 30 cm	0.2 - 10 cm
min. wall thickness	1 mm	0.2 mm	0.2 mm
surface quality Ra	15 – 20 µm	5 - 7 µm	1 - 2 µm
density	≥96%	≥96%	≥96%
part complexity	very high	very high	high
lead time	3 - 4 weeks	3 - 4 weeks	16 -20 weeks

Business Cases

Cost advantage through toolless production

Backround:

- Tools were at end of life and invest in stamping and bending tools were necessary
- One time Demand 2 x 1,500 pcs.
- Tolerances < 0.1 mm
- Material 1.4404 (316L)
- Dimensions: 24 mm x 20 mm x 9 mm

Realized with Cold Metal Fusion Technology

- Capacity per print job → 1,200 pcs.

Cost savings:

Compared with building new stamping/ bending tools customer saved approximately 30,000 €

Cost advantage through cooling channels

<u>Backround:</u>

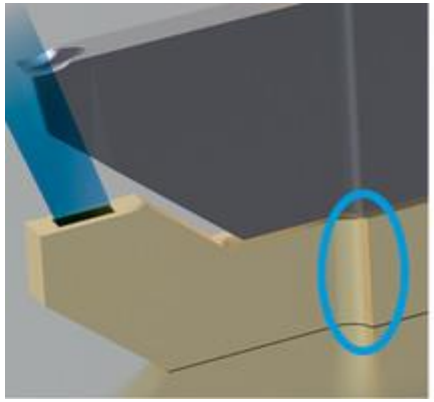
- Tool holder with integrated cooling system to improve lifetime of cutting inserts by up to 185%
- 24 different versions in 6 sizes up to 3 cooling channels
- Material 1.3342 (M2)
- Dimension up to 138 mm x 22 mm x 22 mm
- High flexibility and short lead times required

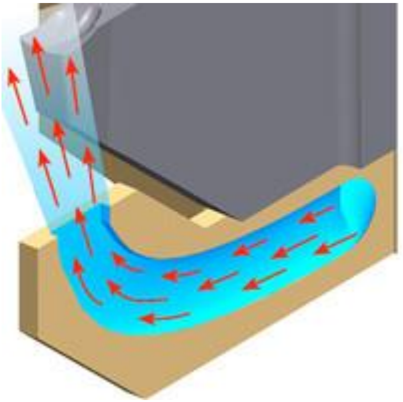
<u>Realized with Cold Metal Fusion Technology</u>

- Capacity per print job → 72 pcs.
- Process steps after sintering: Milling – Coating – Laser marking

<u>Cost savings:</u>

Increasing life time of cutting inserts up to 185%





Cost advantage through flexibility in size and individual design

Backround:

- Inquiries from different industries regarding haptics, lightweight control button made out of real metal
- Demand for Customizable & personalisable Control buttons out of different materials like stainless steel or titanium
- Dimension Ø20 mm x 7 mm

Realized with MoldJet Technology

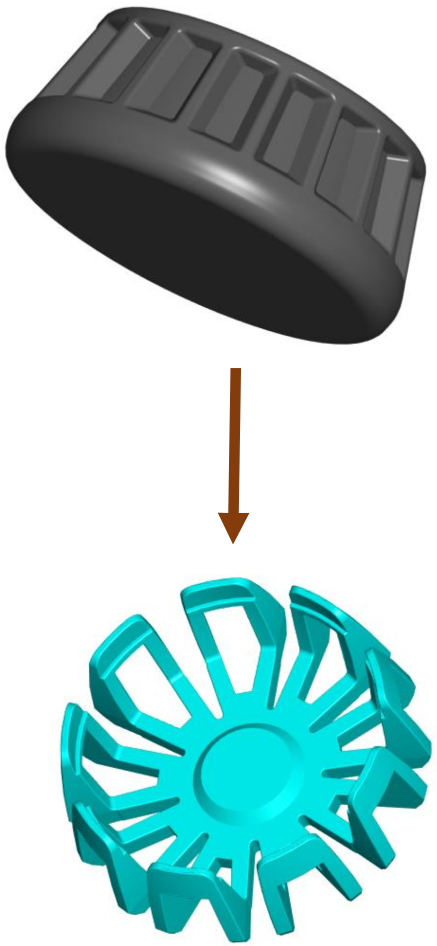
- Material: 1.4404 (316L) / 3.7035 (TiAl6V4)
- Capacity per print job → 13,440 pcs.

Cost savings:

Out cored version is 51% lighter

316L: Old: 5.73g New: 2.74 g

Titan: Old: 3.14 g New: 1.50 g



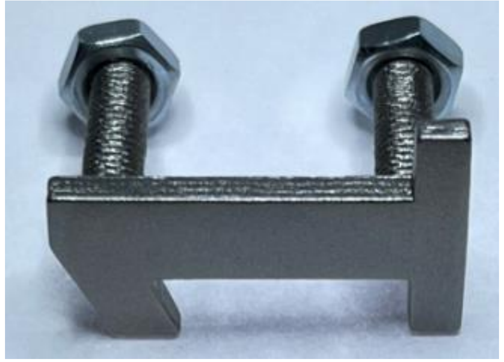
Cost advantage through toolless production and integrated thread

Backround:

- Material: 1.4404 (316L)
- Few thousand Pins needed
- Visual front view with radius, Cosmetic surface required
- 2 Threads M4 and 14 mm long   Dimensions: 25 mm x 16,5 mm x 15,5 mm

Realized with MoldJet Technology

- Capacity per print job → 8,000 pcs.
- Functional thread without additional rework.
- Surface Treatment: Vibratory grinding & sand blasting on the sintered pin.
- R_A < 1 µm



Cost savings:

Toolless production. Adjustment of thread geometry could be done without tool modification.

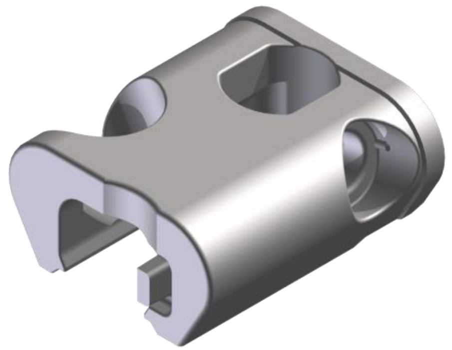
Cost advantage through realization of high compley geometry

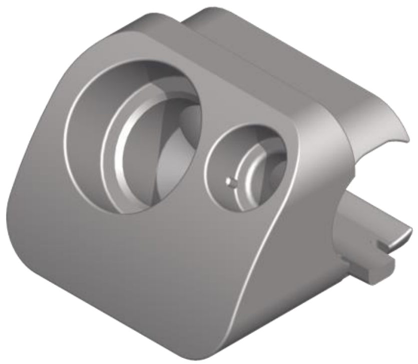
Backround:

- Small parts 4 mm x 2.5 mm x 5 mm
- Highly complex internal shapes
- Requested volumes 200,000 pcs. per year
- Industry: Locking systems

Realized with MoldJet Technology

- Material: 1.4404 (316L)
- Part 1: Capacity per print job → 400,000 pcs
- Part 2: Capacity per print job → 275,000 pcs
- Short lead time of 6 weeks





Cost savings:

Due to the complex internal form, the MIM injection tool would have been expensive and limited to maximum 2 cavities.

Thank you !

www.mimplus.com