MIM and AM in the medical industry

Learn how the use of Additive Manufacturing and Metal Injection Molding can enhance design freedom for developers in terms of shape and material.

07.04.2022

If you want to be fast …

… choose the right vehicle

But don't forget …

… it must fit to the road

Conclusion
the selected production process must fit to the form and function

From powder to complex metal parts…

raw material
metal powder, binder

1

AM

MIM

shaping
AM / MIM

2

debinding
solvent, catalytic, thermal

3

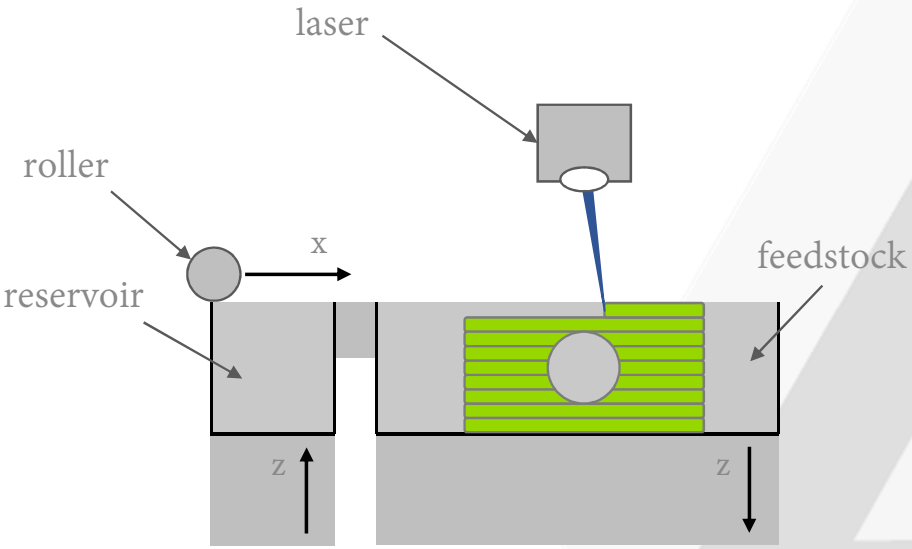
sintering
sintering furnace

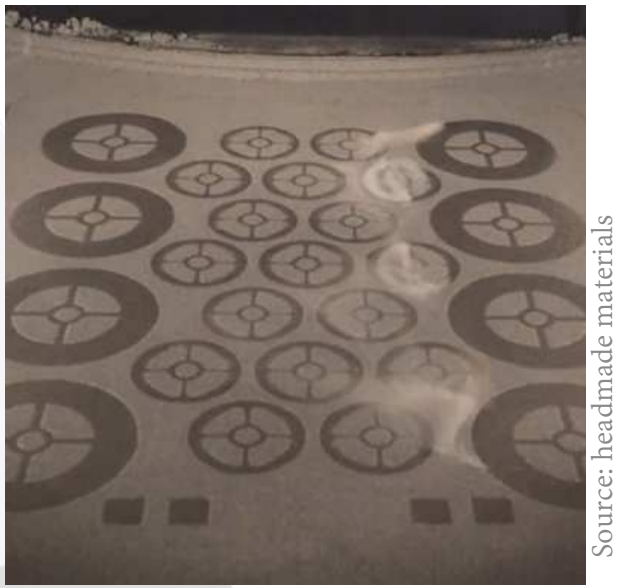
4

metal part

5

Additive Manufacturing: Cold Metal Fusion



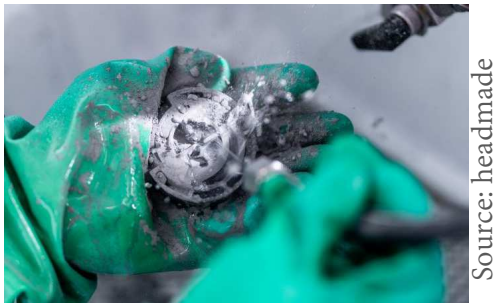


Source: headmade materials

- 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

Additive Manufacturing: Cold Metal Fusion – from green body to sintered part

1. Depowdering



Source: headmade materials

Removal of loose feedstock

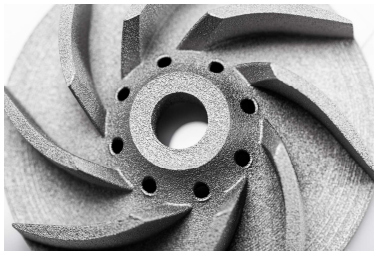
2. Solvent debinding

Removal of base polymer

3. Sintering

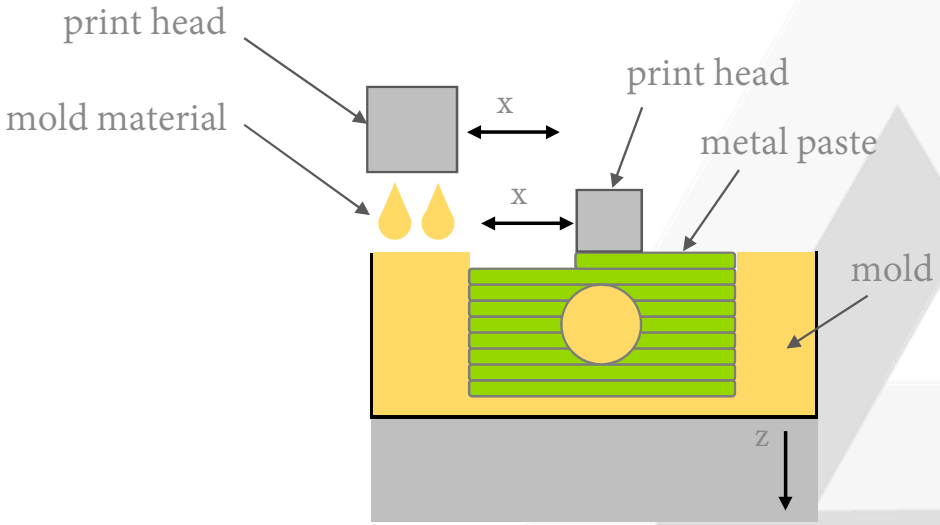
Thermal debinding and sintering

- Robust green parts, suitable for green part processing
- Sintering shrinkage is approx. 13%
- High densities ≥ 96% can be achieved



Source: headmade materials

Additive Manufacturing: MoldJet



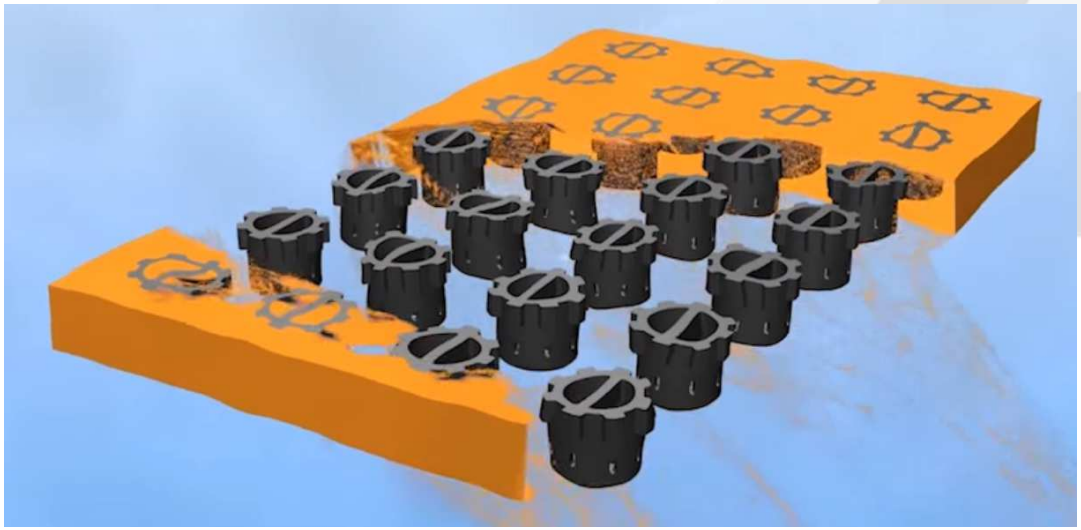
Source: Tritone

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

Additive Manufacturing: MoldJet – from green body to sintered part

- Robust green parts, suitable for green part processing
- Sintering shrinkage is approx. 14%
- High densities ≥ 96% can be achieved

Demoulding of green parts

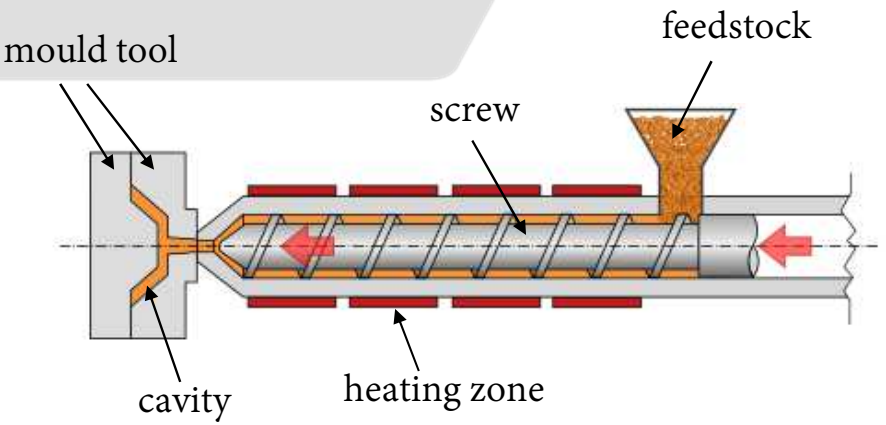


Source: Tritone

Source: Tritone

Metal Injection Moulding: Injection Moulding

- Injection molding is performed on conventional injection moulding machines
- Feedstock is plasticized at elevated temperature
- Molten feedstock is injected into the cavity

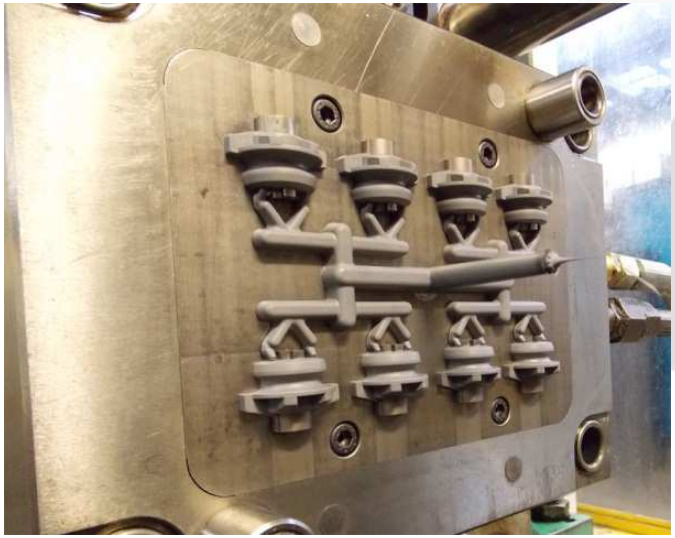


Source: www.maschinenbau-wissen.de

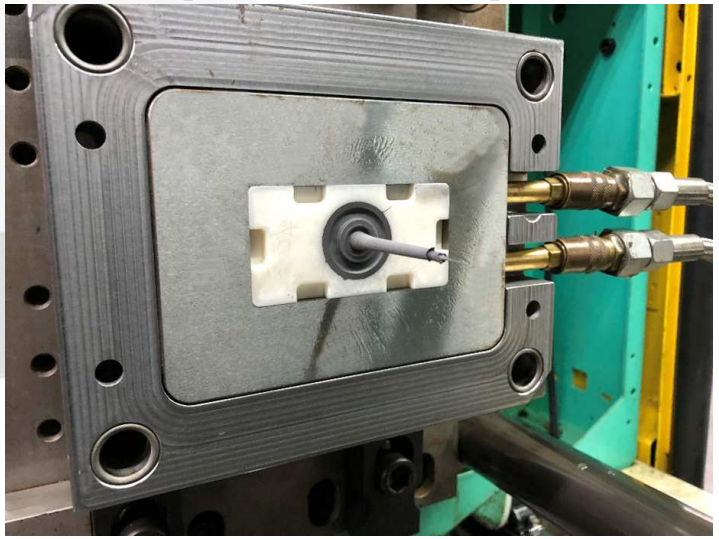
Metal Injection Moulding: Injection Moulding

- Mould tool necessary for shaping of green parts
- Depending on part geometry mould tool manufacturing can be expensive and time-consuming
  → MIM is economically reasonable for medium to large scale production
- *Alternative:* 3D printed plastic tool inserts for prototypes or small series production

conventional tool (steel)

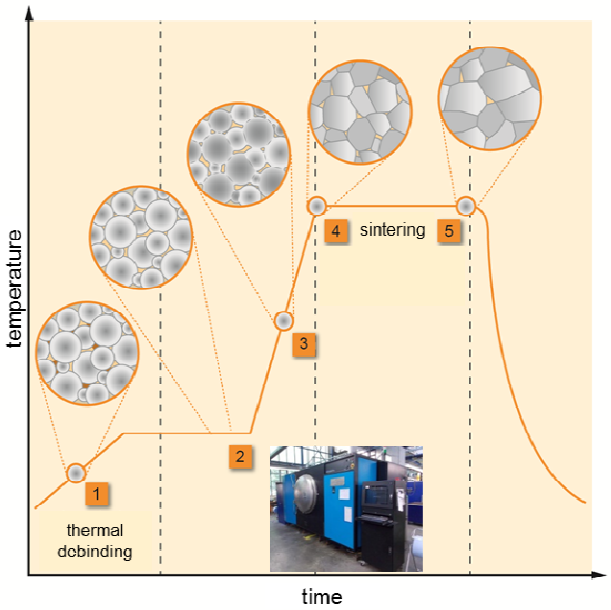


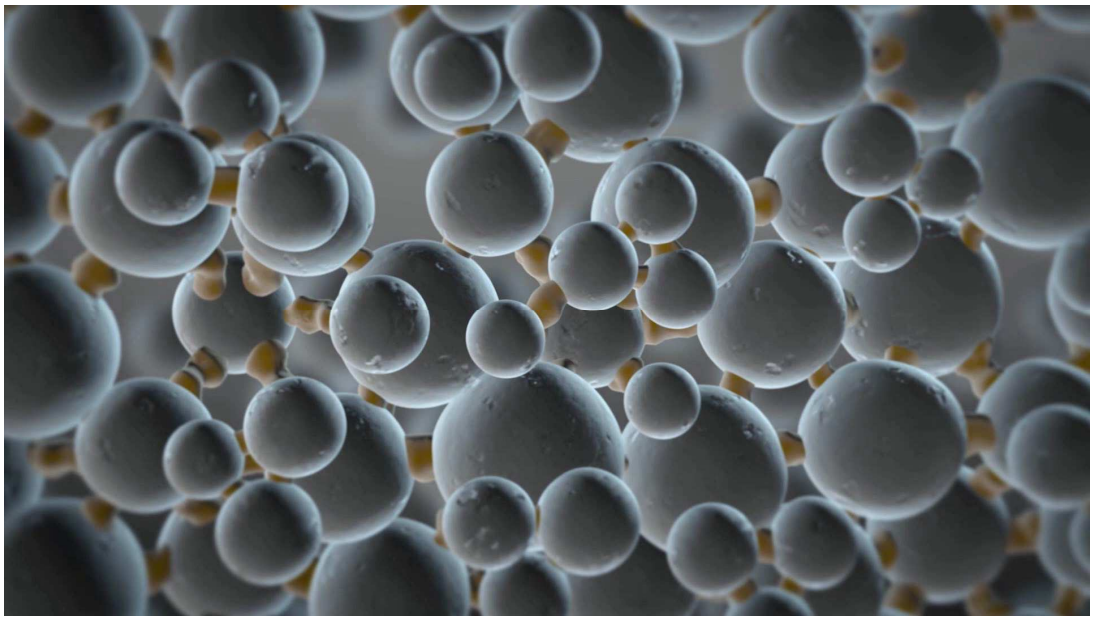
3D printed tool insert (plastics)



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





Think MIM and AM

The way to design machined parts:

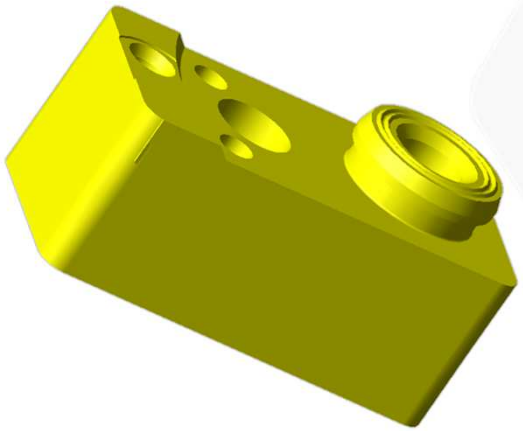
„I created a vision of David in my mind and simply carved away everything that was not David“

Michelangelo 16th Century

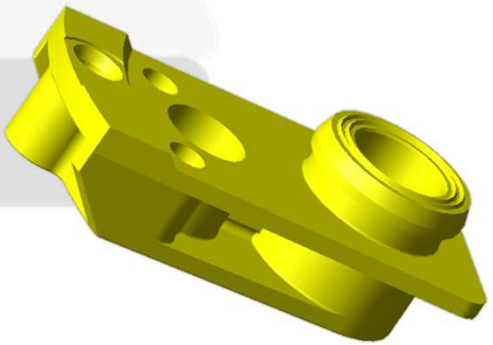
The way to design MIM and AM parts:

„Visualize the function of your part and only add material where you need it for the function“

Machined design



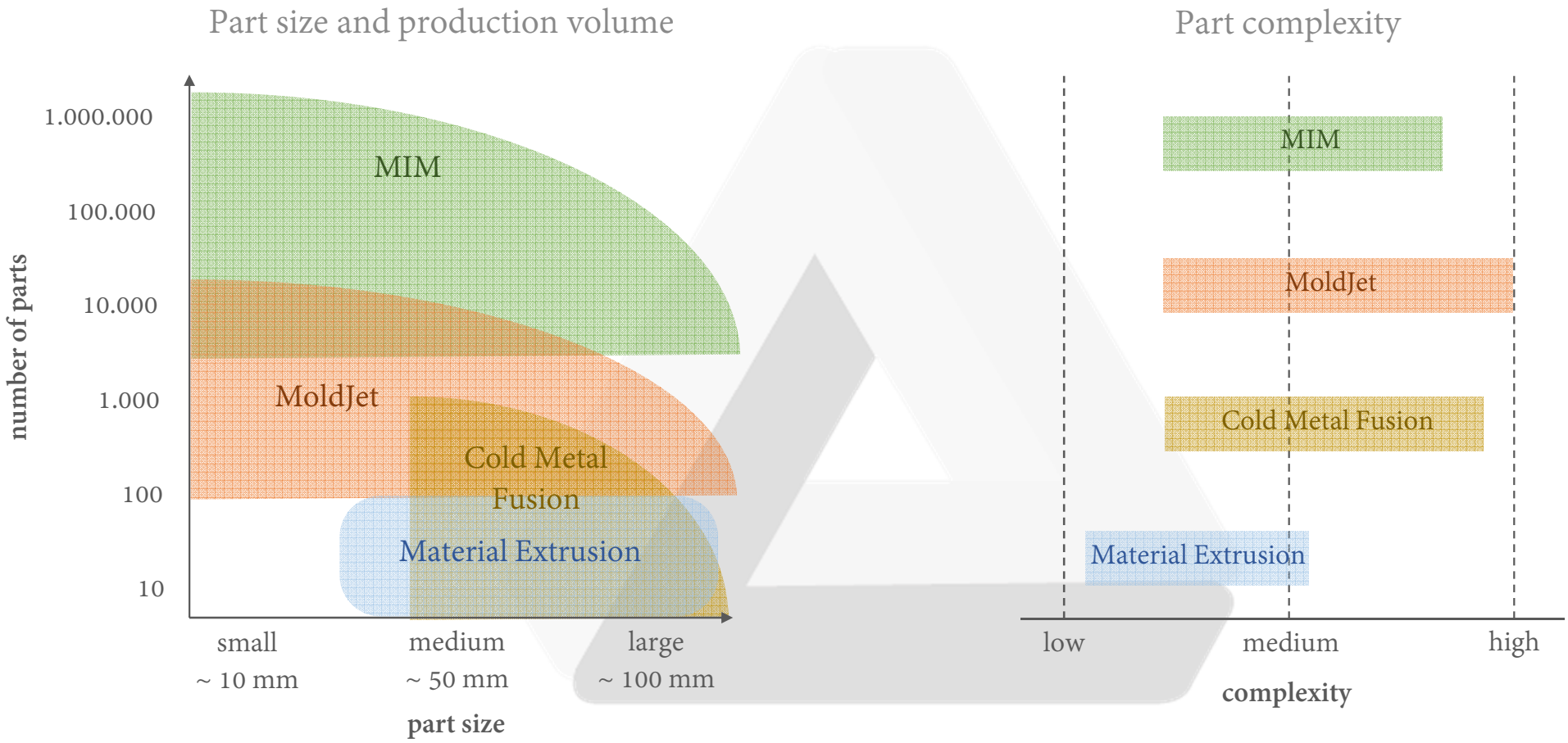
MIM and AM design



Comparison of MIM and Sinter based AM

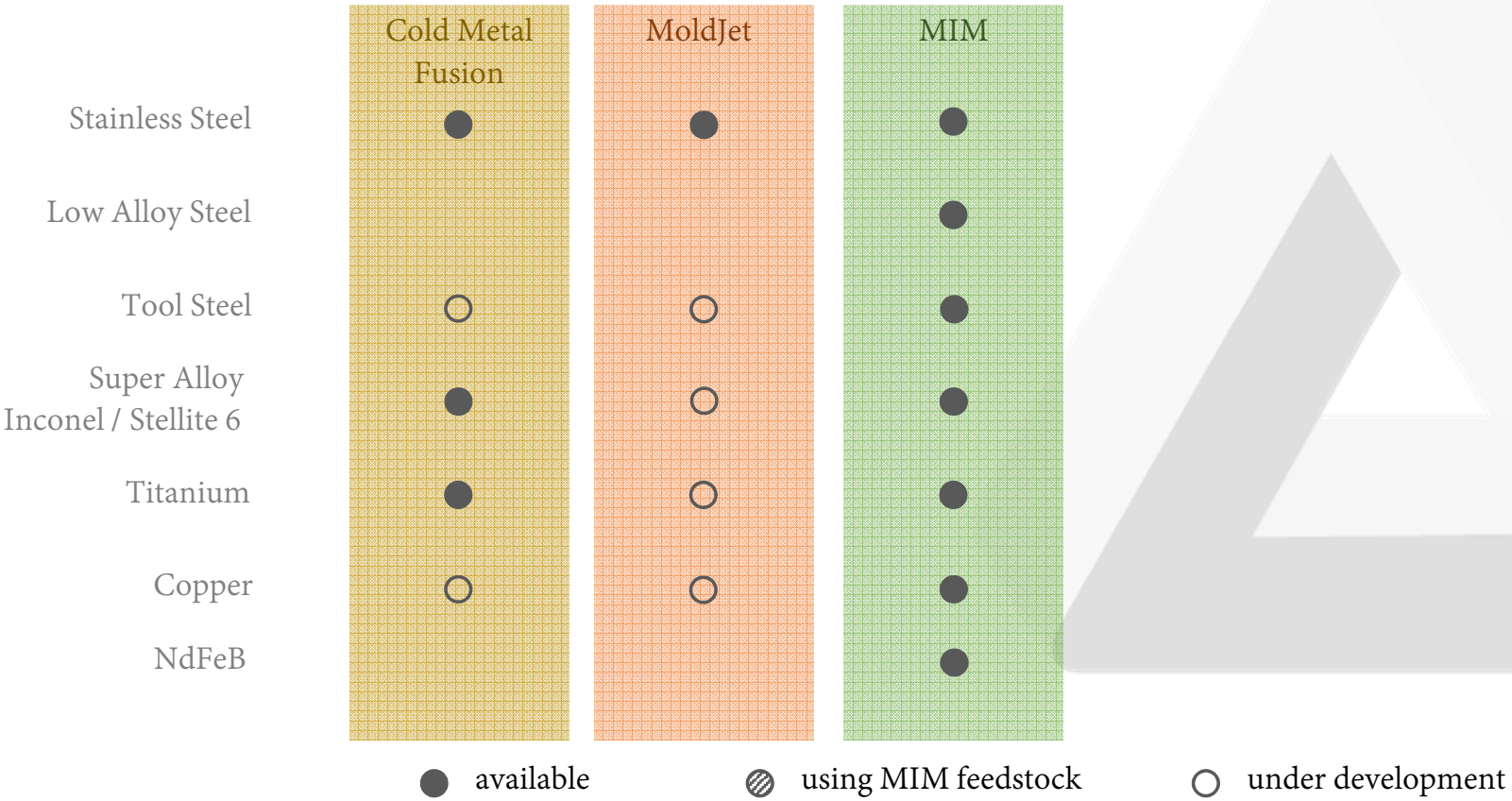
	MIM	AM
High Volumes	++	+
Low Volumes	0	++
Surface quality	++	0
Non-demouldable cavities	0	++

Comparison of AM and MIM



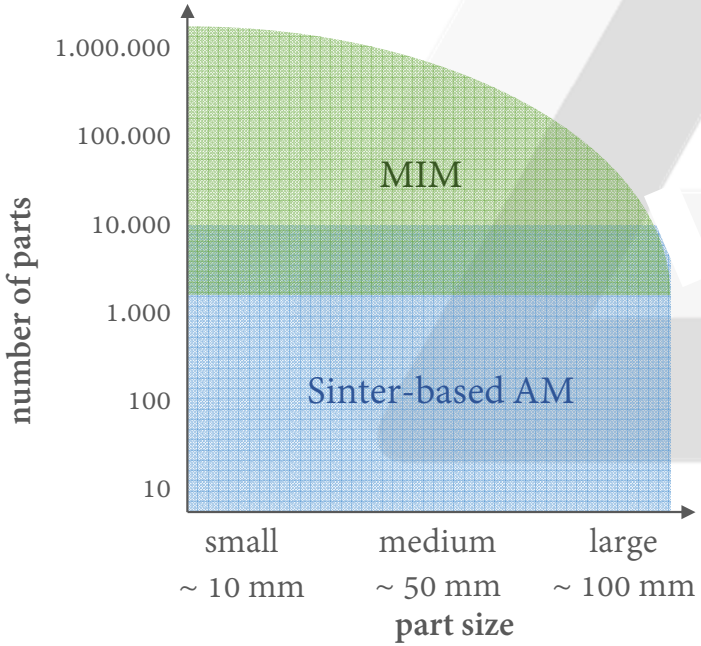
Comparison of AM and MIM

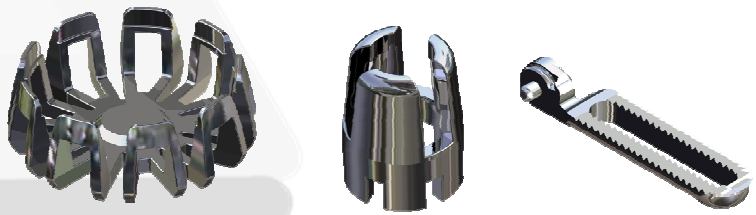
Material portfolio



Conclusion

- Sinter-based AM and MIM is capable of producing complex metal parts
- Each technology has its pros and cons
- Sinter-based AM and MIM are complementary to each other



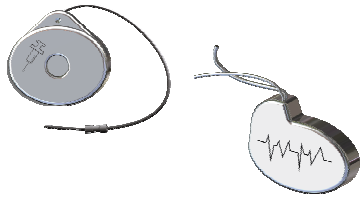


Products from MIMplus for the medical industry

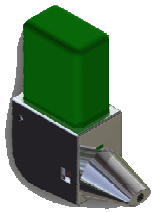
Dental / Orthodontics
(handles and brackets)

Surgical Implants

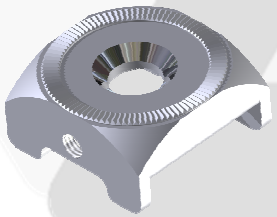
Hearing Aids



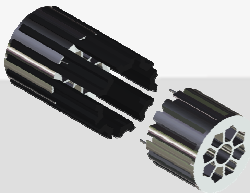
Pacemaker / Painkiller Pump



Medical Devices (inhaler,
blood glucose meter, ..)



Orthopaedic



MIM-Magnets
Sensors and Drives

Surgical Robotic Instruments /
Endoscopy

Advantages and Requirements of MIM and AM in Medical Industry

Single use

→ Increased volumes and increased cost pressure requires fully automated processes
→ MIM Tool costs are amortized more quickly

Small dimensions

→ Minimally invasive surgical methods require the smallest of instruments
→ Machining costs increase due to the small milling cutter sizes that have to be used
→ MIM and AM costs goes down due to reduced part weight and increased furnace loading

Precision

→ MIM and AM offers greater precision compared to cast iron. Post-processing of free-form surfaces can be largely avoided

Parts identification / Traceability

→ Due to the great possibilities of shaping, cost-neutral solutions can be offered both in MIM and AM for complete traceability and part identification

Advantages and Requirements of MIM and AM in Medical Industry

Materials

→ Materials that are difficult to machine, such as titanium ect. can be efficiently manufactured by MIM and AM.

Design and functional integration

→ The integration of several parts into one results in new solution concepts ➔ Competitive advantage

→ Combination of several individual parts into one component ➔ Cost advantage

→ The consistent use of MIM and AM results in new solutions due to high degree of design freedom

→ AM offers even more design freedom (inner contours that cannot be demolded)

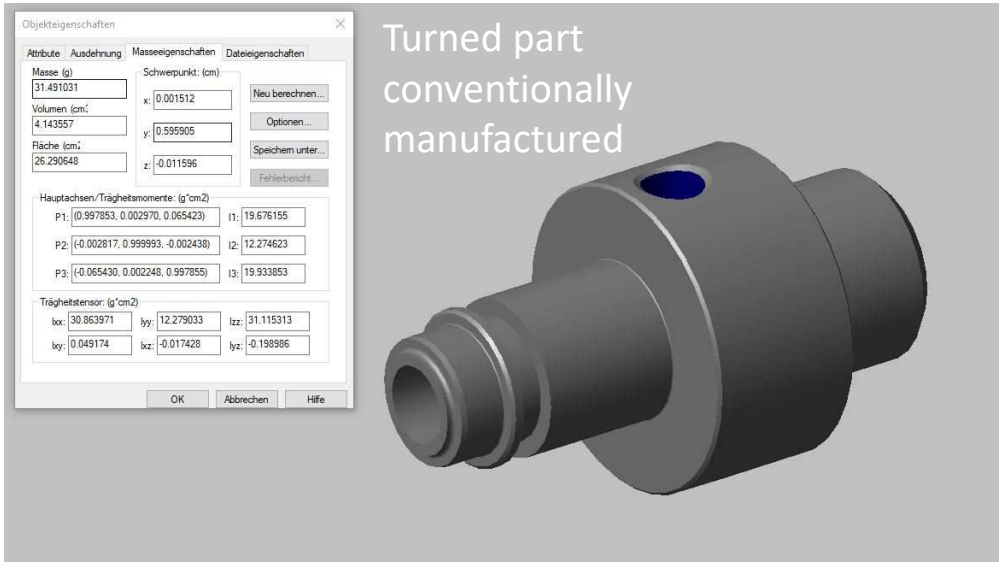
→ Early involvement of our manufacturing specialists enables new innovative solution concepts, as the potential of new manufacturing technology can be fully exploited

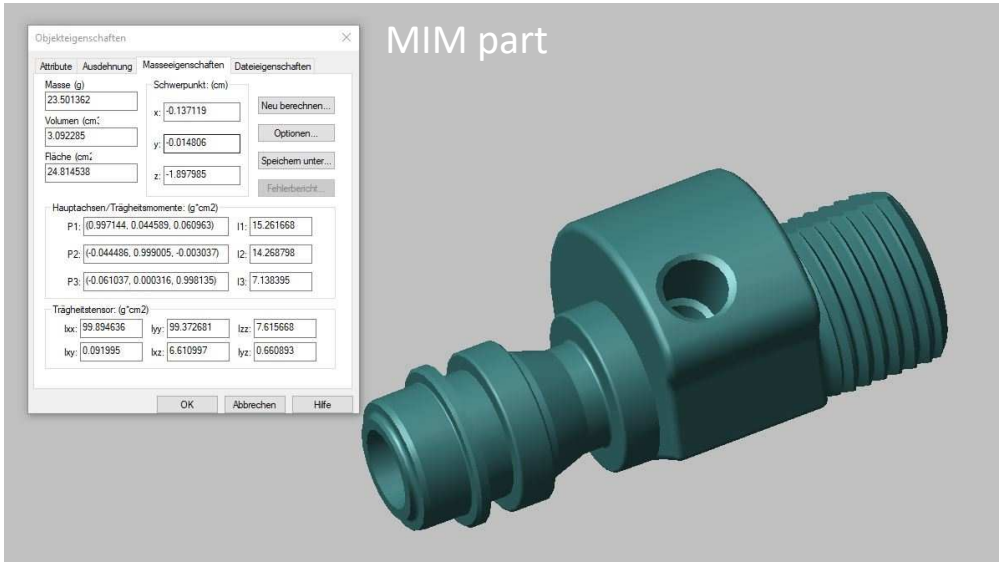
➔ MIMplus supports with our production know-how
➔ 25 years experience

Feel free

use the design possibilities of the injection process

AM	MIM
	
✓	✓





Machining out of round bar

➔ 60% burr

➔ 40% part

MIM / AM

➔ 100% part

AM	MIM
	
✓	✓

Feel free

use the design possibilities of the injection process

- Save material - save resources

  Put your parts on a diet.

  Try to utilize the design freedom of the MIM process to create lightweight parts.

  This will save material, resources and costs!

  Example: Vent valve for a flow analyzer
  original design: turning part

  Weigth Original ➔ 32gr.
  Weight MIM ➔ 23gr.
  ➔ Saving 29%

AM	MIM
	
✓	✓

Feel free

use the possibilities of the MIM process to consolidate parts

- Save assembly cost by making one part out of three

  Integrate different functions into one single part

  Forget the limitations of conventional processes that force you to split a solution in different, easy to produce parts.

  Don't worry about assembly problems

  Just integrate all your functions into one single part

  Open your horizon for new solutions

  Example: Electronics connector
  conventionally made out of 3 parts
  MIM solution integrates all into one part

Conventional solution

MIM/AM solution

AM	MIM
	
✓	✓

Feel free

use the possibilities of the MIM process to consolidate parts

- e.g. for the production of one-piece drilling templates

➔ such as those that are already printed out of plastic today

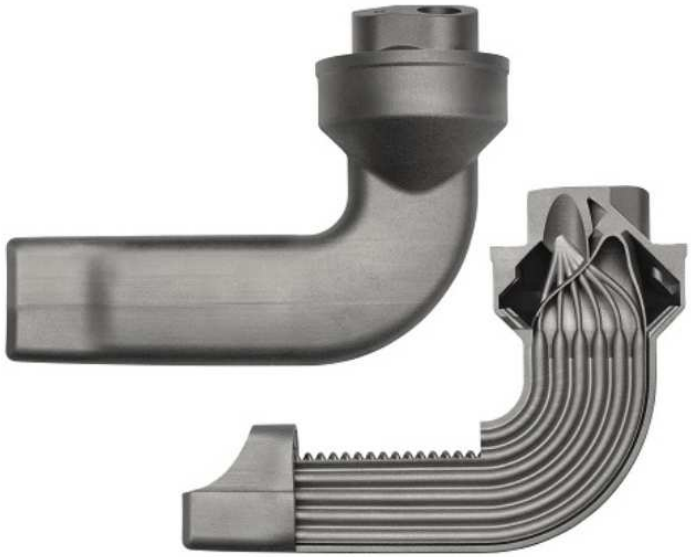
➔ or are assembled from several components

Non-demouldable cavities

AM	MIM
	
✓	✗

- Use the freedom of design that only AM offers you
- AM can produce internal structures, no other process can achieve due to demoulding restrictions

Example: curved cooling channels



AM	MIM
	
✓	✓

2K AM and MIM

combine materials

- 2K MIM: injecting 2 materials in the tool
- 2K AM: print 2 different materials
  - combine materials with different properties in the same part
  - You need a partially magnetic part? – combine 316L and 17-4PH
  - You need high friction or temperature resistance?
    e.g. combine Inconel for the functional areas and normal steel for the support material. This way you save money without compromising the performance of your part.
  - The only limit is the sintering temperature and atmosphere
    Our development team will help you to find the best combination

AM	MIM
	
✓	✓

Mix it

mix different processes

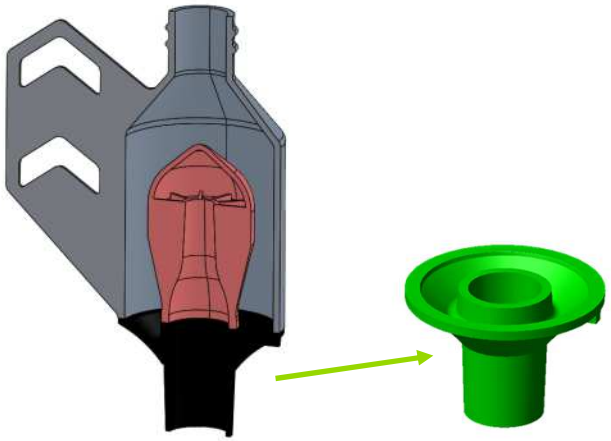
- Combine MIM and AM

You have many part variants, but the base is always the same?

MIM your base and print the variants on the MIM part.

This saves printing time and reduces your costs.

Example: Valve



Co Sintering

same process

AM	MIM
	
✗	✓

- Combine 2 MIM parts

  Geometries that are not possible in MIM but the quantity is too high for AM?

  Create two or more MIM parts, assemble them in green stage. After sintering you will get one part

  Example: Nozzle

Co Sintering

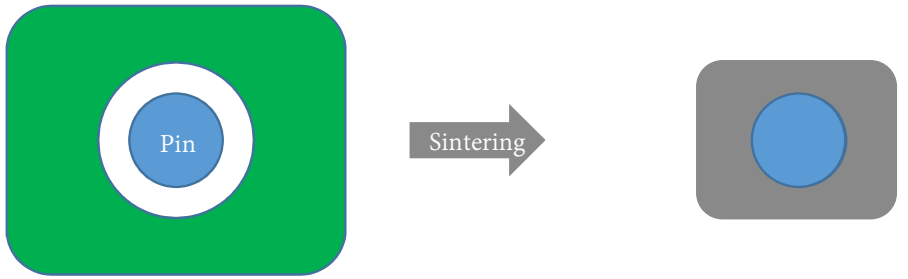
mix different processes

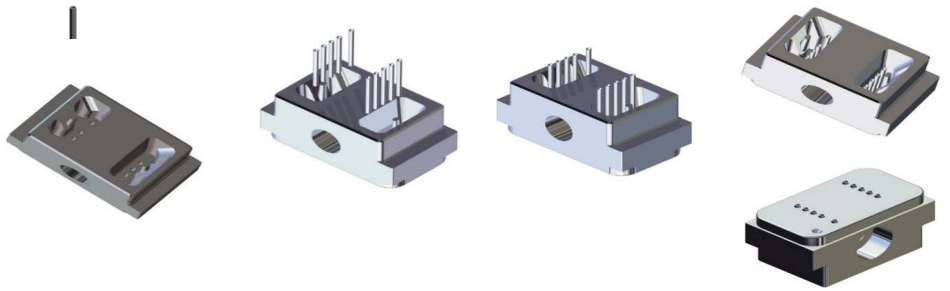
AM	MIM
	
✓	✓

- Combine MIM and conventional manufactured parts

Use the shrinking during sintering to assemble MIM with conventionally produced parts.

Examples: Connector
No laser welding necessary





AM	MIM
	
✘	✓

MIM-Clever

two parts out of one tool

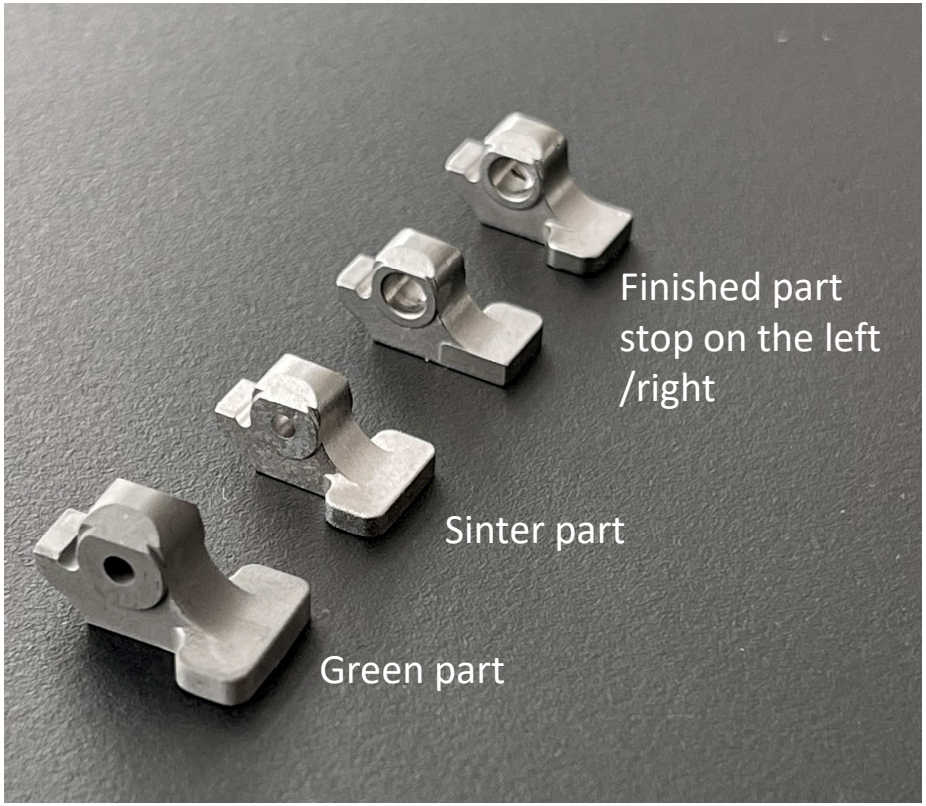
- 2 Variants out of one greenpart / mold

  2 tight fit tolerances (bearing bore diameter and width) that cannot be realized in MIM or AM

  It was clear that this had to be reworked

  If the component is already on the milling machine, the left and right stop can also be machined, saving you tool costs

  Example: Shift Lever / endoscope



MIM-Clever

opportunities of green part processing

AM	MIM
	
✘	✓

- Some materials are really hard to machine

  green part processing is much easier

  Hardened steel, Nickel based alloys, …

  if it is not possible to integrate features in the tool –

  think of green part processing

Example: Finger follower made of hardened tool steel

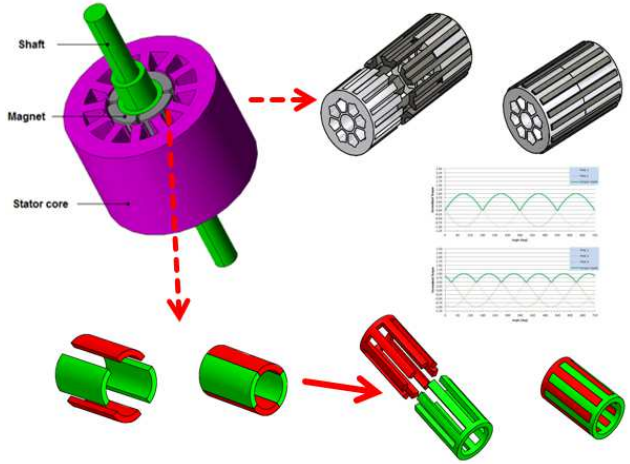
bore with diameter 0.5mm drilled in green stage

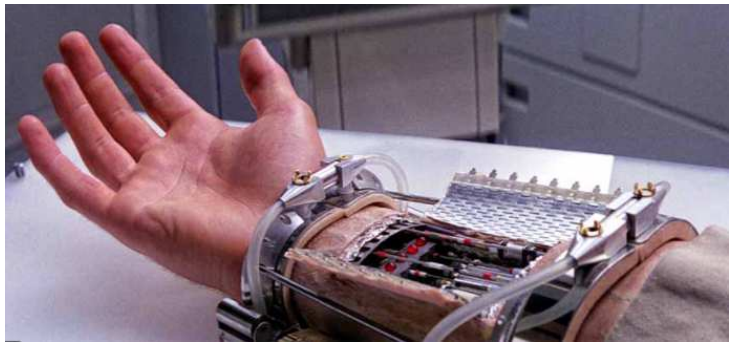
MIM-Magnets in Medical Industry

100% waste-free production of complex-shaped rare earth magnets (Nd-Fe-B) from recycling material in a closed material cycle

- Recycling of NdFeB from end-of-life magnets
- Innovative technologies for using ressources more efficient, e.g. by manufacturing of magnets via MIM
- MIM magnets combine the advantages of sintered magnets (high energy product BHmax) with polymer bonded magnets (complex geometries and magnetization)

AM	MIM
	
✗	✓



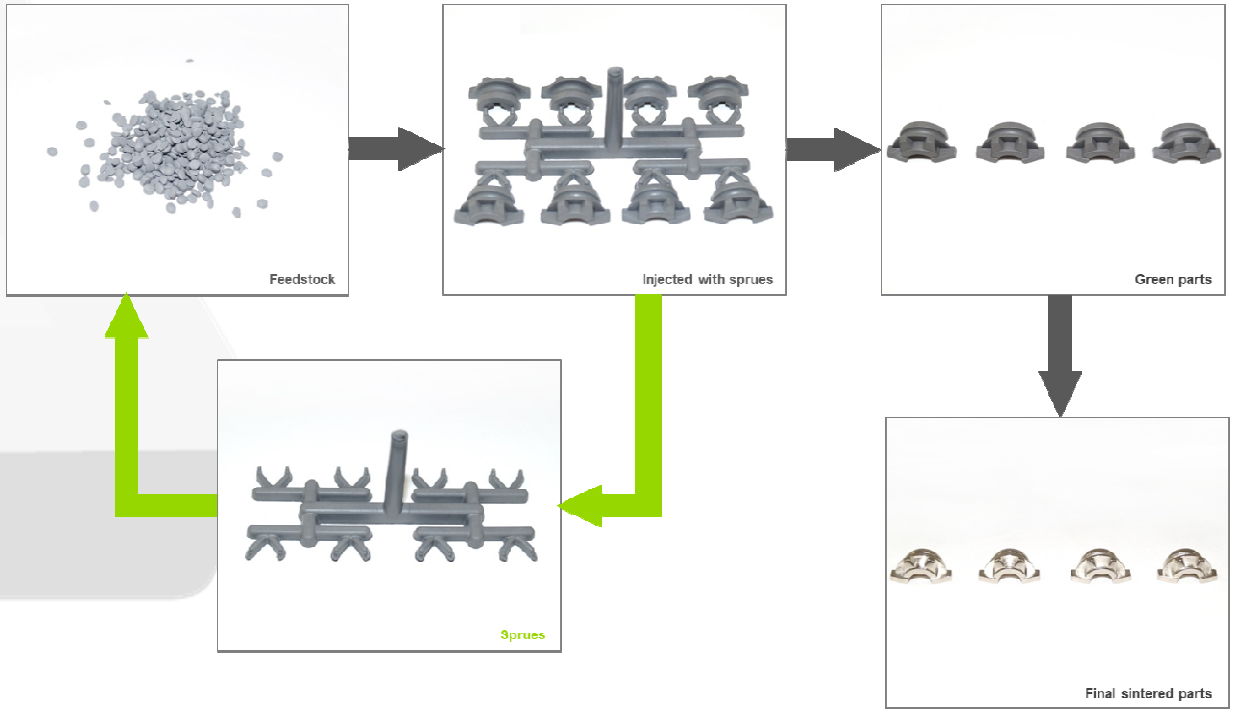


Think green: MIM and AM – a green technology

AM	MIM
	
✓	✓

- Application of only necessary resources
- Recycling thinking implemented in process
- 100% waste free technology
- Lightweight construction

PM™ A recognized green technology



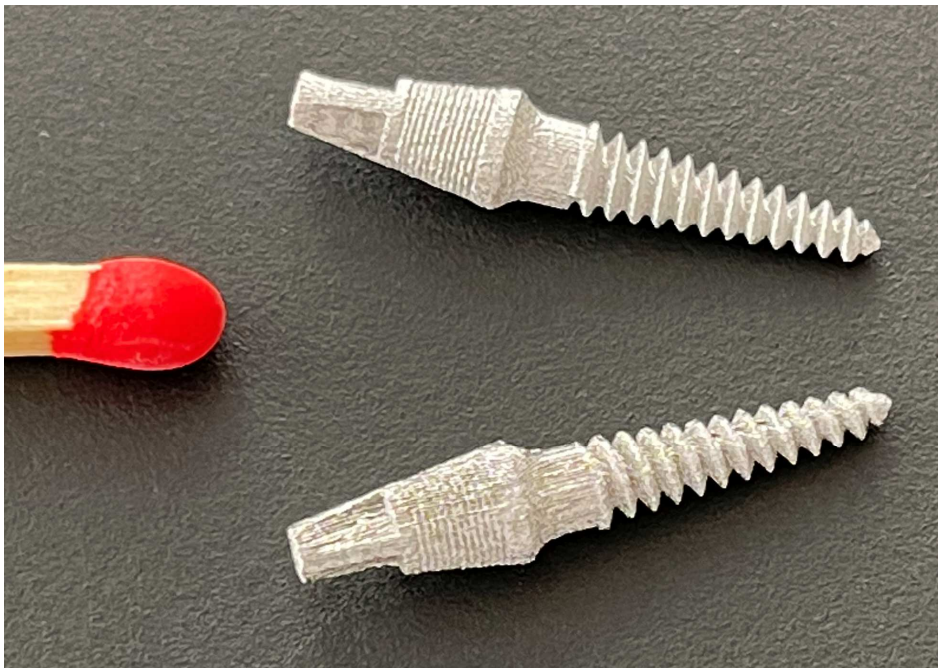
AM Sampels - Implants Discs

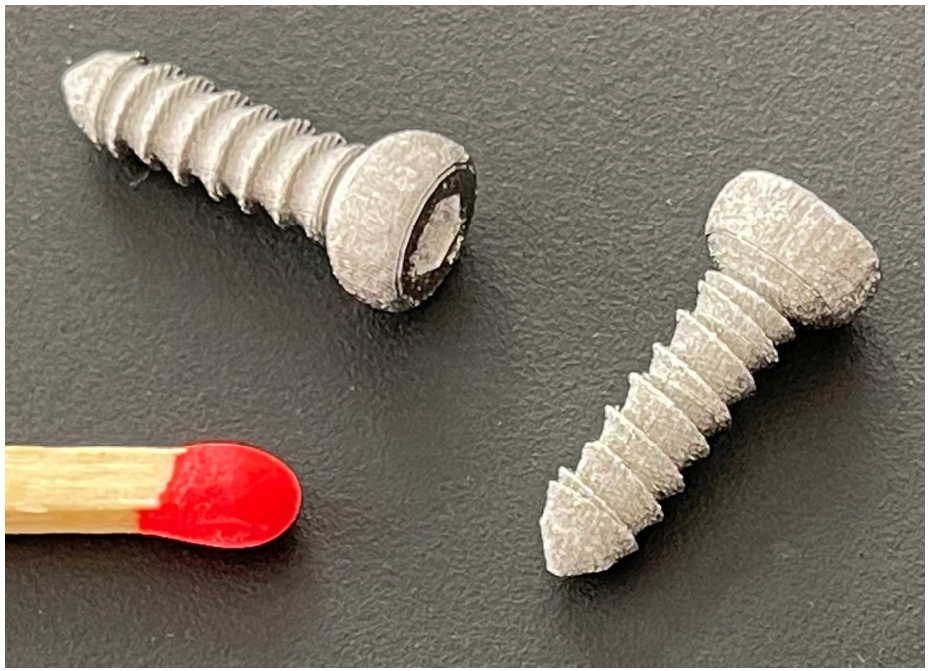
MoldJet

Cold Metal Fusion

AM Sampels - Bone Screws Dental and Surgical

MoldJet

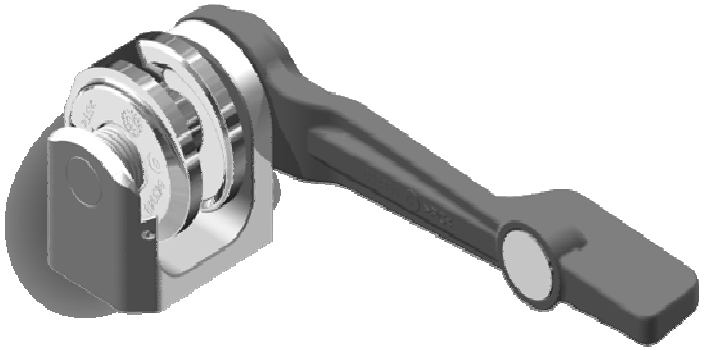




Example AM vs MIM

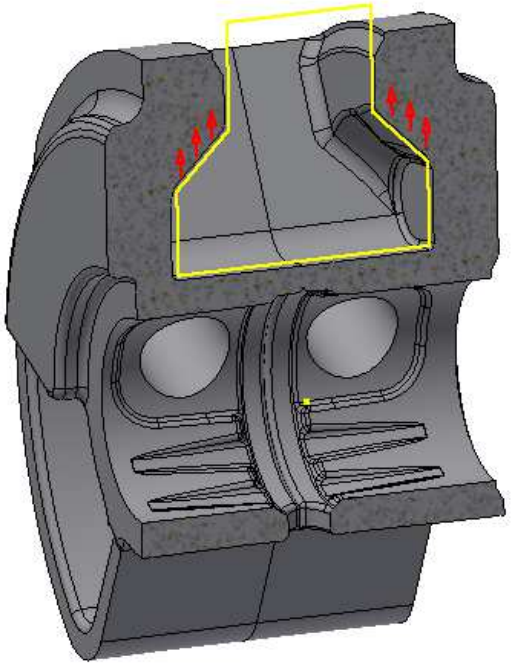
Locking Assembly:

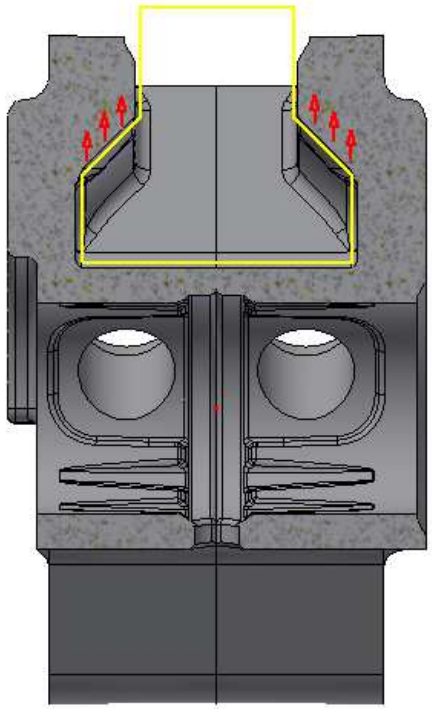
- 2 x MIM parts 440C (hardening and coating)
- 2 x Machined parts (coating)
- 1 x Plastic Parts
- 1 x Magnet
- 1 x Spring
- 3 x Screws
- 2 x Washer
- 11 Sub-Suppliers involved
- In-house assembly

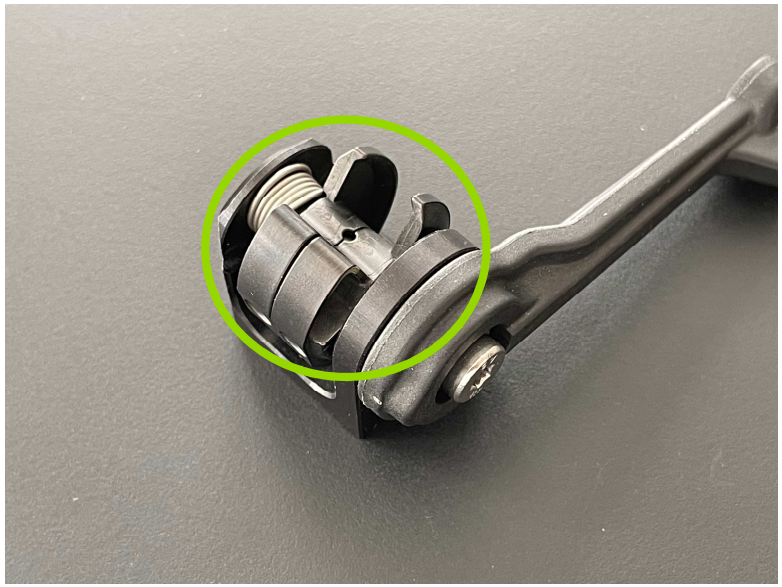


Example AM vs MIM

Undercut







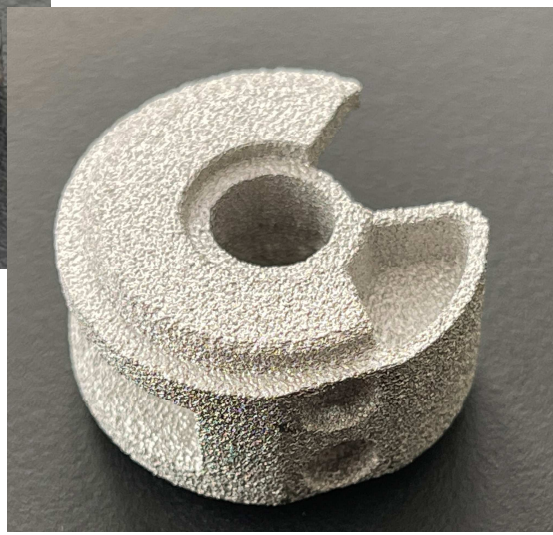
Example AM vs MIM

AM	MIM
	
✓ ✓	✓

MIM:

AM Moldjet:

AM Cold Metal Fusion:



Example AM vs MIM

AM	MIM
	
✓	✓

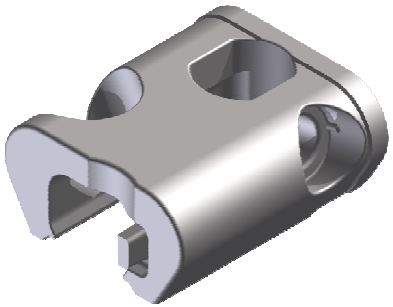
Those two parts are small 4mm*2,5mm*5mm and have a highly complex internal shapes. The requested volumes were 200k per year.

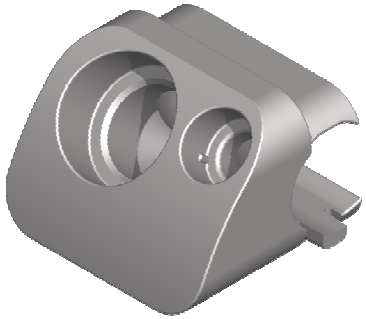
Due to the complex internal form, the MIM injection tool would have been expensive and limited to max 2 cavities.

Thus we took the AM approach and could reduce the costs by:

Part 1 -20,4%

Part 2 -16,3%





The good news at last…

… MIMplus Technologies is your “car dealer” who selects the best vehicle for you.

Thank you !

www.mimplus.com