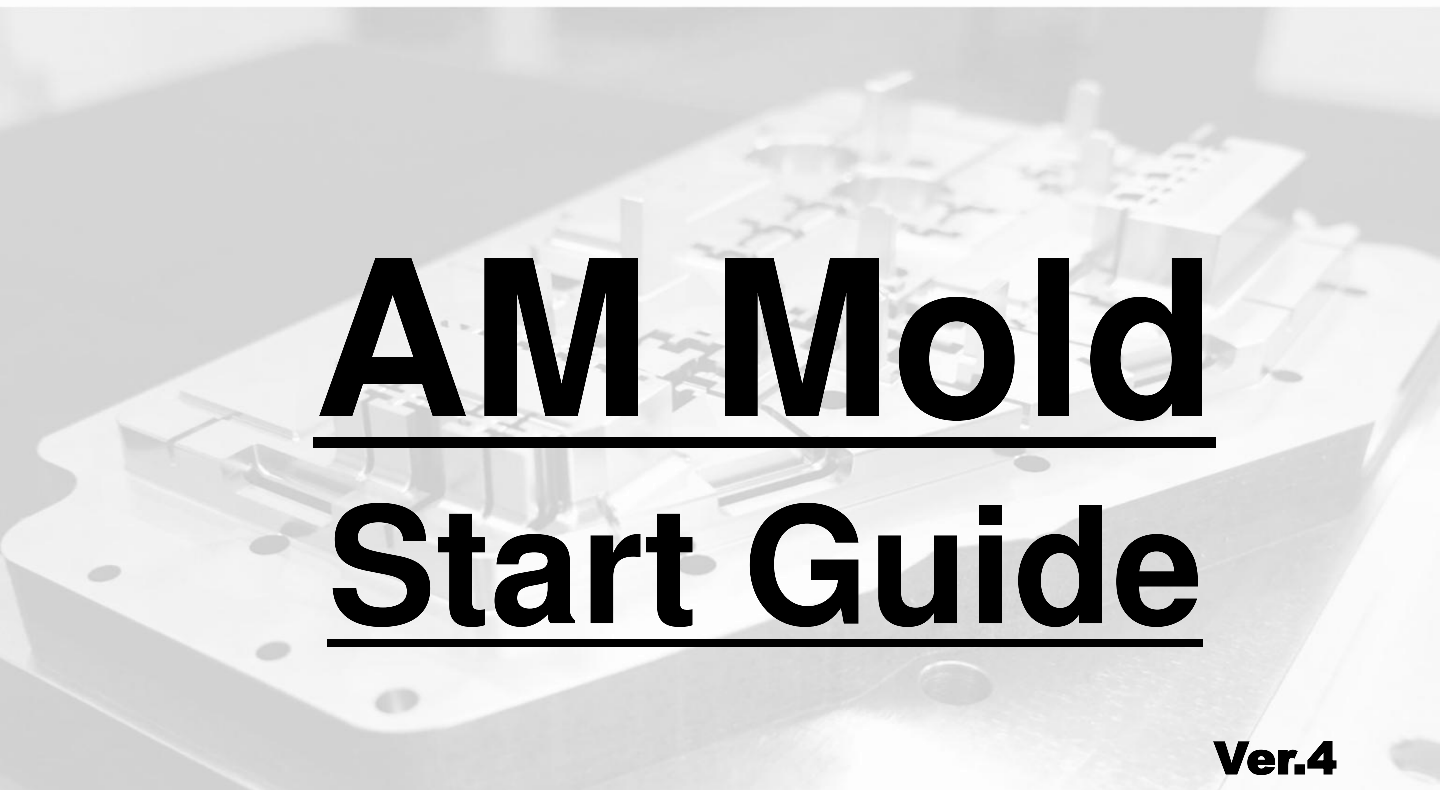


AM Mold Start Guide

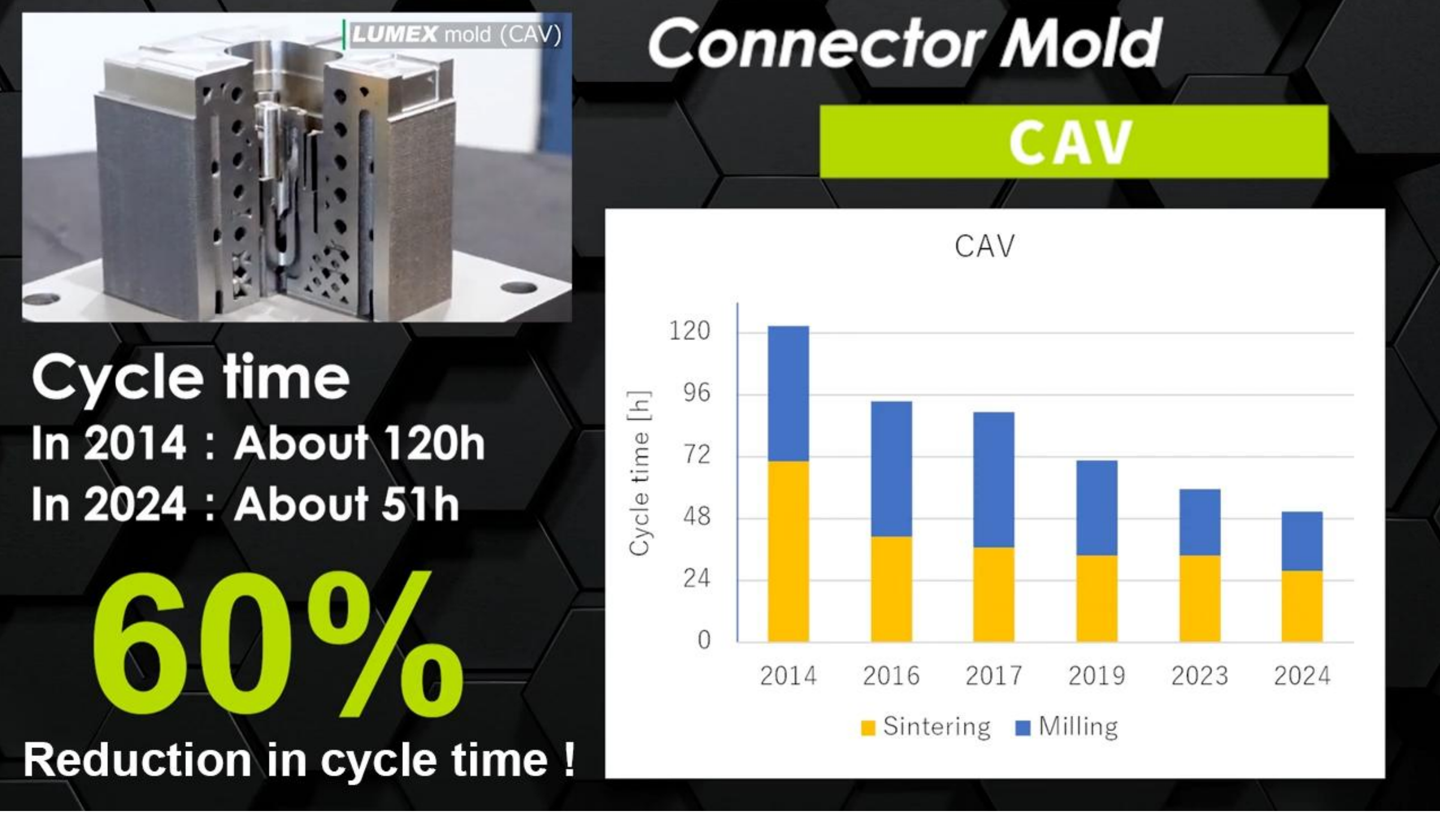
Ver.4

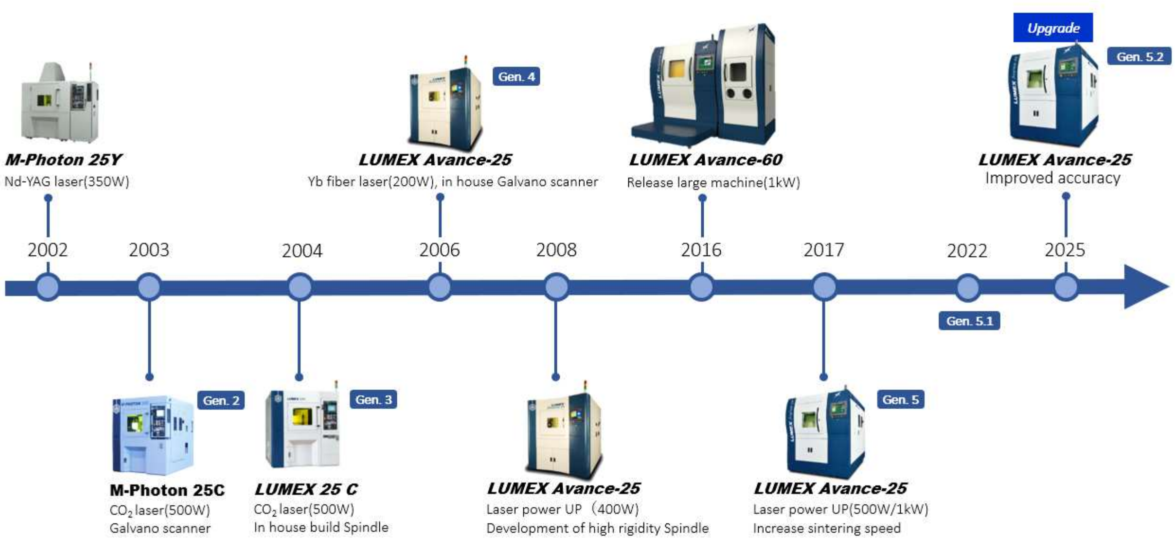
LUMEX Avance-25

What is the *LUMEX*?

Revolutionizing complex **Mold Manufacturing** – at the push of a button with the *LUMEX*

In the 1990s, Matsushita Electric—now known as Panasonic—was at the forefront of metal 3D printing, utilizing German-made technology to produce and test high-performance molds with conformal cooling channels. However, they faced significant challenges in manufacturing complex mold cores with intricate slits and thin walls. Recognizing that the lead time for final products hinged on mold core production, they sought a more efficient solution. This need led to the development of the hybrid manufacturing method—combining additive and subtractive technologies for precision and efficiency. To bring this vision to life, Panasonic turned to Matsuura, a leader in machining center technology. Their collaboration led to the design of custom in-house equipment, ultimately evolving into a groundbreaking new business for Matsuura—one that continues to drive innovation in hybrid manufacturing today.

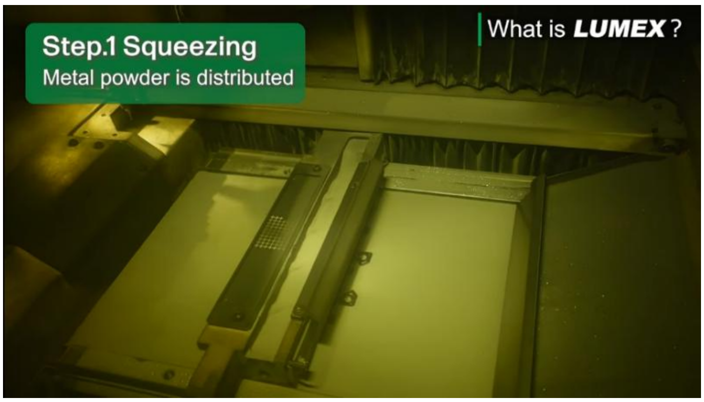




- The target is the **mold industry**
- **20+ years** of R&D history

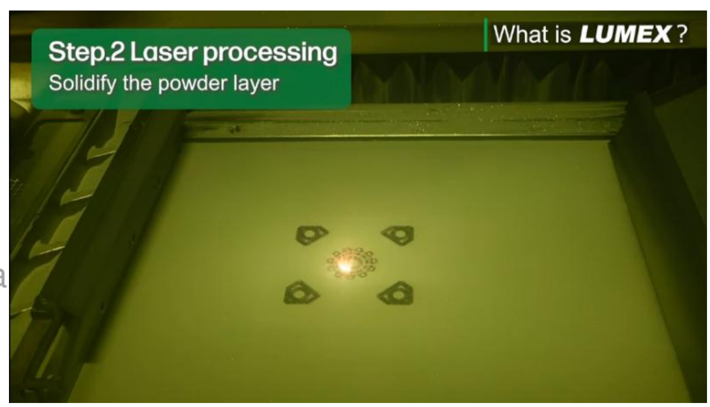
The most notable point

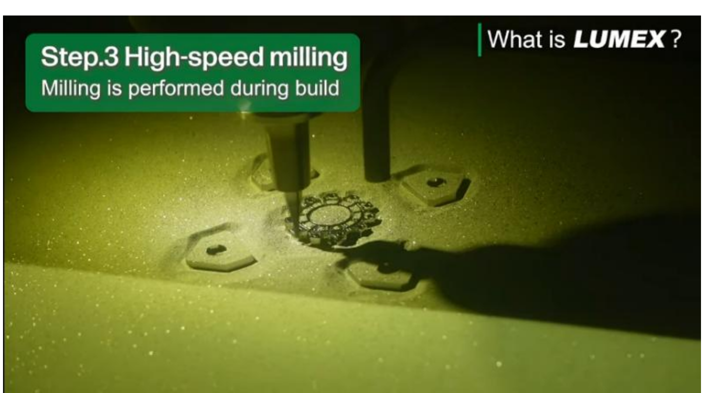
The Hybrid AM



After the table descends downward, the recoater moves across its top. While traversing, powder is supplied onto the surface, and the powder is scraped with a blade mounted on the recoater to form a metal powder layer of uniform thickness.

The machine irradiates the powder layer with a fiber laser installed at the top of the chamber. The powder is melted and solidified. By driving the galvanometer scanner via a program, the cross-sectional shape of the model is formed.





The two processes are repeated several times. When the height reaches a certain level, milling is performed. After collecting the powder around the milling area with the extraction device, high-precision cutting is performed by the spindle.

The Additive
and the Subtractive

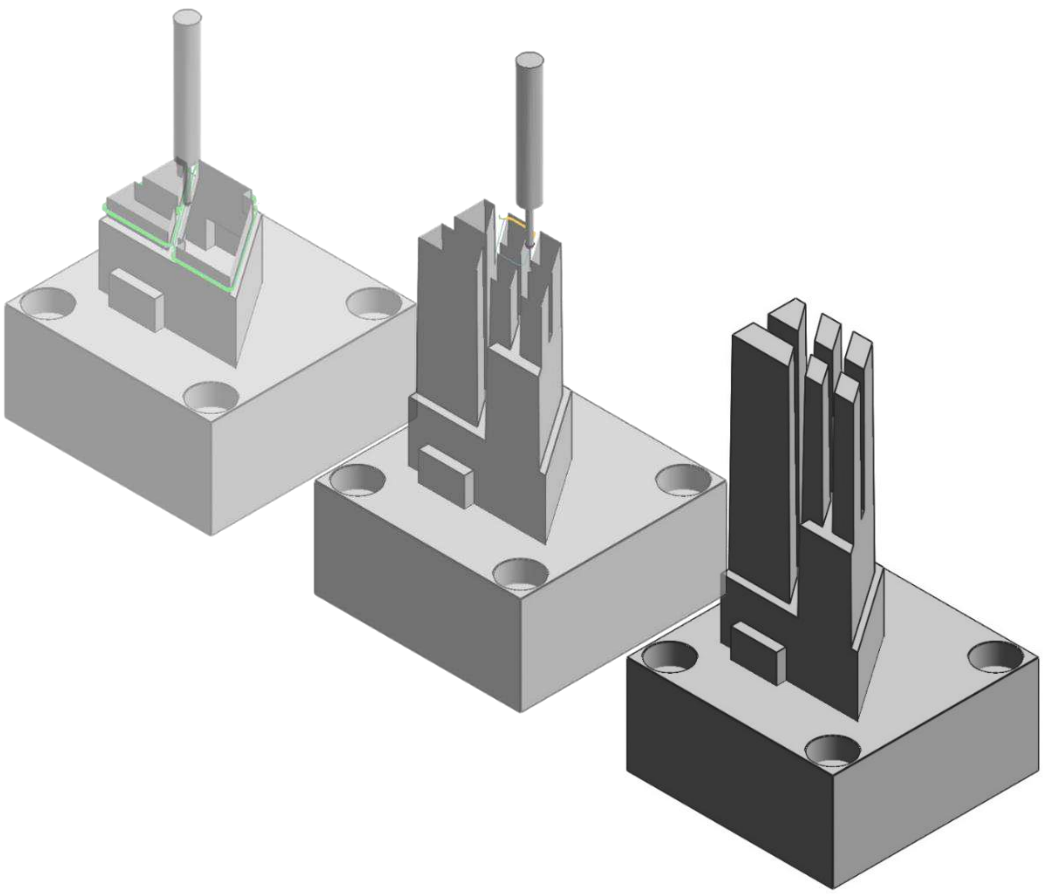
that only a machining center manufacturer can offer.

- The **hybrid** AM
- A machine-tool-oriented **spindle**

What can you do with it ?

Effective Spindle Application

1. Deep slit milling with a short tool



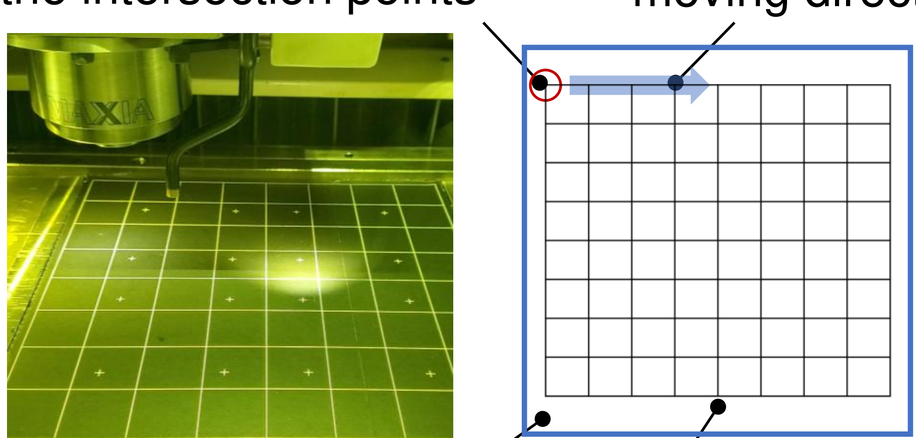
- Capable of milling even in areas inaccessible by post-processing
- **Stable milling** with a short tool

2. Precise printing

By using the CCD camera mounted next to the spindle, the intersection points drawn by the laser are read, and the laser coordinate system is aligned with the machining coordinate system. The laser coordinate system is then precisely calibrated (**pincushion function**). Distortion or misalignment specific to the laser coordinate system can be corrected on the machine, **allowing the system to adapt to aging-related changes over time**.

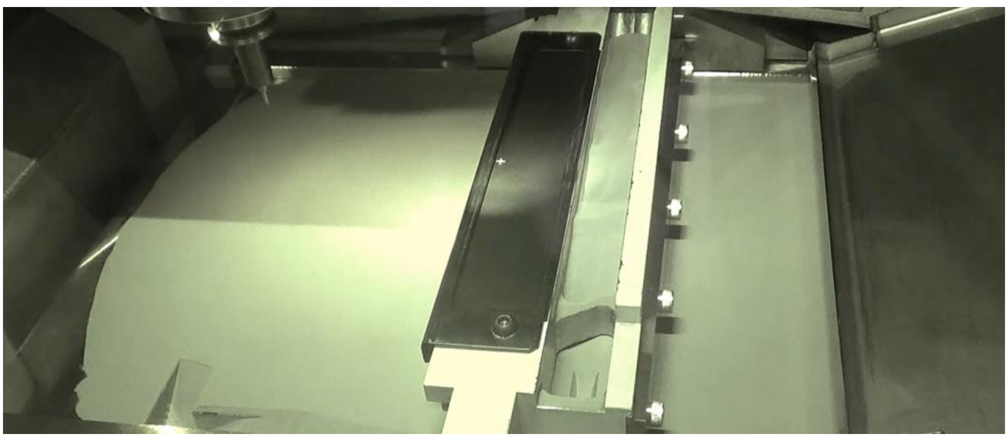
Pincushion function

By verifying whether the laser's trajectory geometrically matches the coordinate system on the table, the laser system's parameters are corrected, and any misalignment is adjusted. The key consideration is that corrections can be made by **referencing the straightness and perpendicularity of the spindle's orthogonal axes**, ensuring precise alignment during machining.



3. Minimum allowance

During the printing process, the **compensation function** adjusts the laser coordinate system to match the cutting coordinate system, allowing the laser to be accurately positioned. As a result, the **variation in the built object on the table is minimized**, and the finishing allowance can be kept to a minimum.

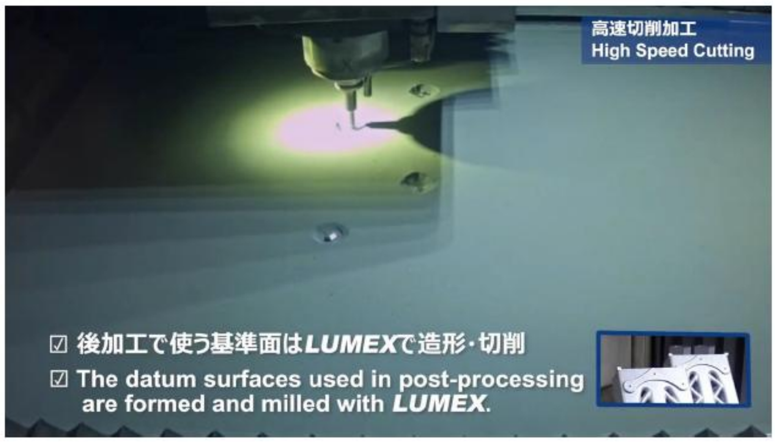


Compensation function

At each layer, a cross mark is drawn on the paper on the recoater using a laser. The position is then read by the CCD camera mounted beside the spindle, and any coordinate misalignment is corrected.

4. Easy post-processing

By machining a **reference surface**, it can be utilized for quality evaluation, precise alignment in subsequent processes, and as a stable chucking surface for secure workholding.



5. Precise additional building

The ***LUMEX*** utilizes the spindle and **probe to capture the coordinate system of existing objects**, making the setup process easier and more accurate.

Particularly effective for injection molds

The Three Major Benefits

Saving Labor/Time

1. **Complex shapes can be fabricated with just one button.**

- Minimization of mold splitting
- Reduction of EDM processes
- Reduction of assembly

Higher Added Value

2. **Freedom of design**

- 3D cooling channels for improved quality/productivity

3. **Porous structures**

- Relaxation of internal stress
- Reduction of low-pressure molding and defects through gas venting

However,

Full of Questions

I heard that powder is expensive.
Are cost benefits truly achievable?

Is it practical for mass production?

Can we modify the AM mold later?

Gas venting?

Where should I start with mold design?

How long is mold life?

What are the material's properties?

Can we achieve high density?

To take the first step

Clear up Doubts

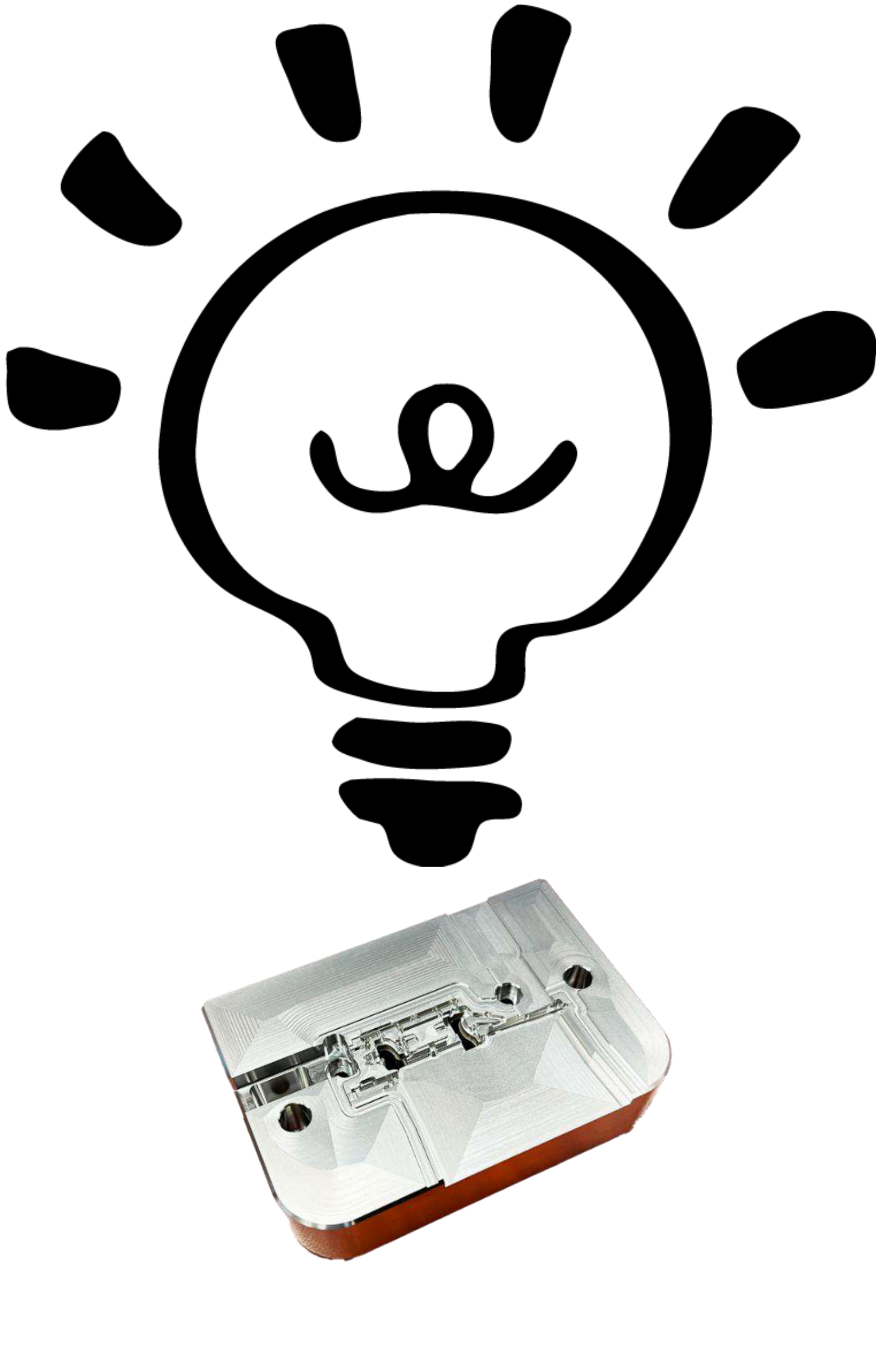
1. Material **Properties**?

2. **Mold lifespan**?

3. How can we achieve **ROI**?

4. How should we deal with **deformation**?

5. How can we **modify** and **fix** defects?



Fundamentals

Material Properties

PBF is a method of melting metal
Very similar to bulk material

Maraging for example is;

the most popular material for PBF tool applications

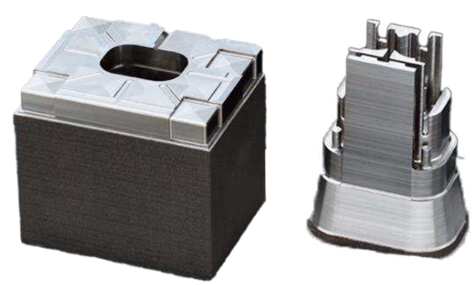
	As built	905℉ for 3h ＋**Aging treatment**	NAK80
Hardness	HRC36±1	HRC53±1	HRC40
Tensile Strength	1,150~1,200MPa	1,900~1,970MPa	1,250MPa
Yield Strength (Rp 0.2%)	1,000~1,100MPa	1,850~1,900MPa	1,000MPa
Elongation	11±1%	2.5±1.5%	
Modulus of elasticity	21±4Mpa (×10^4)	18±2Mpa (×10^4)	
Ductility	38±2 J	8±2 J	
Fatigue strength		300MPa	
Thermal conductivity	15.3 W/(mK)	18 W/(mK)	21.3W/(mk)
Specific heat capacity	0.44 J/(gK)	0.44 J/(gK)	

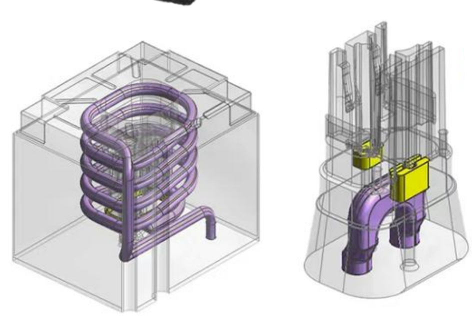
- With aging treatment, hardness can achieve **HRC 53±1** without the need for high-temperature heat treatment.

Primary concerns:
Mold Lifespan & Injection Count

Comparable to a Conventional Mold

Track record: **2M** injections with PP





- Commonly used for **mass production** (ABS, PP, PC, PPS, and GF materials)

Many faced this challenge in the past

Is the density low?

Impressions from the past experience

"Metal 3D printers can only produce parts with low density (~98%)"

There are various parameters

High-speed/Low-density

↕

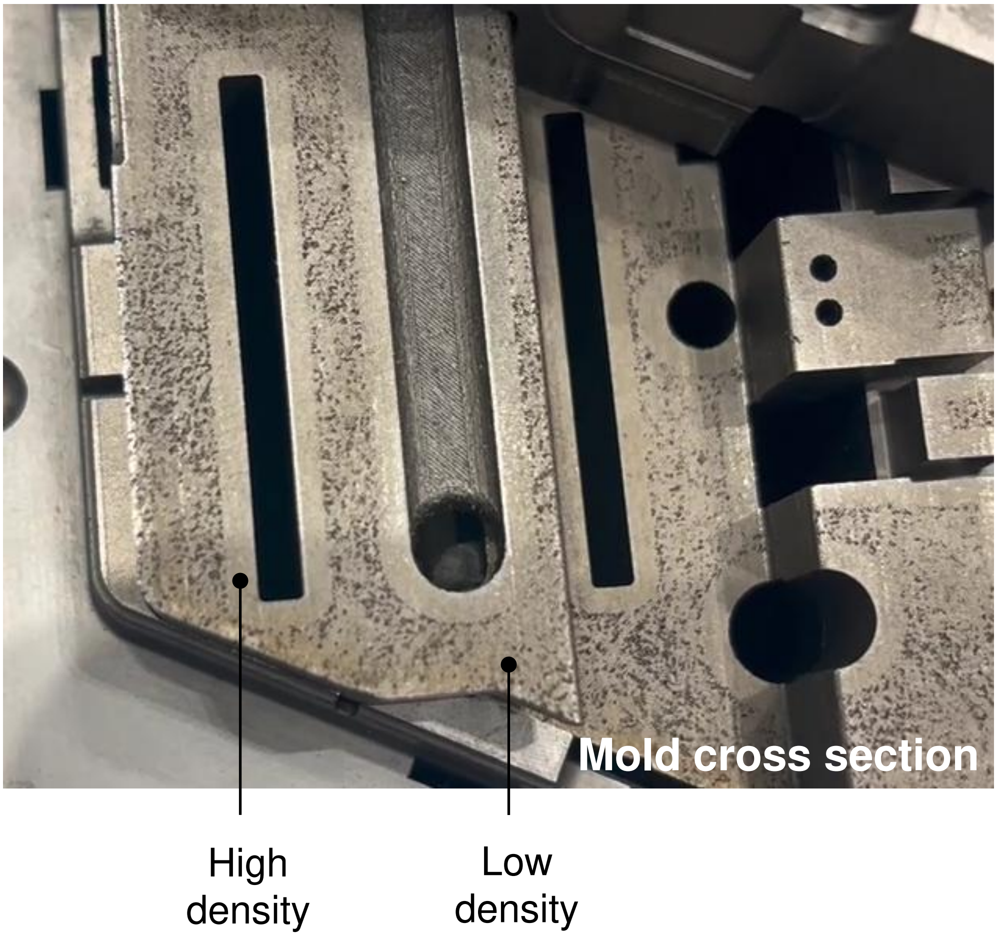
Low-speed/High-density

By using **low-speed**/**high-density** processing parameters, a relative density of over 99.5% can be achieved, enabling builds with a quality level fully suitable for mass-production injection molding.

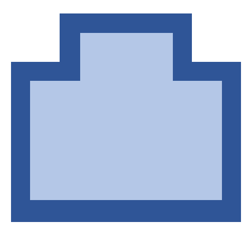
- "Low density because it's metal AM."
  That's a **misconception.**
- By combining post-processing,
  we can meet **demanding specifications.**

So then, is it slow?

We have a solution

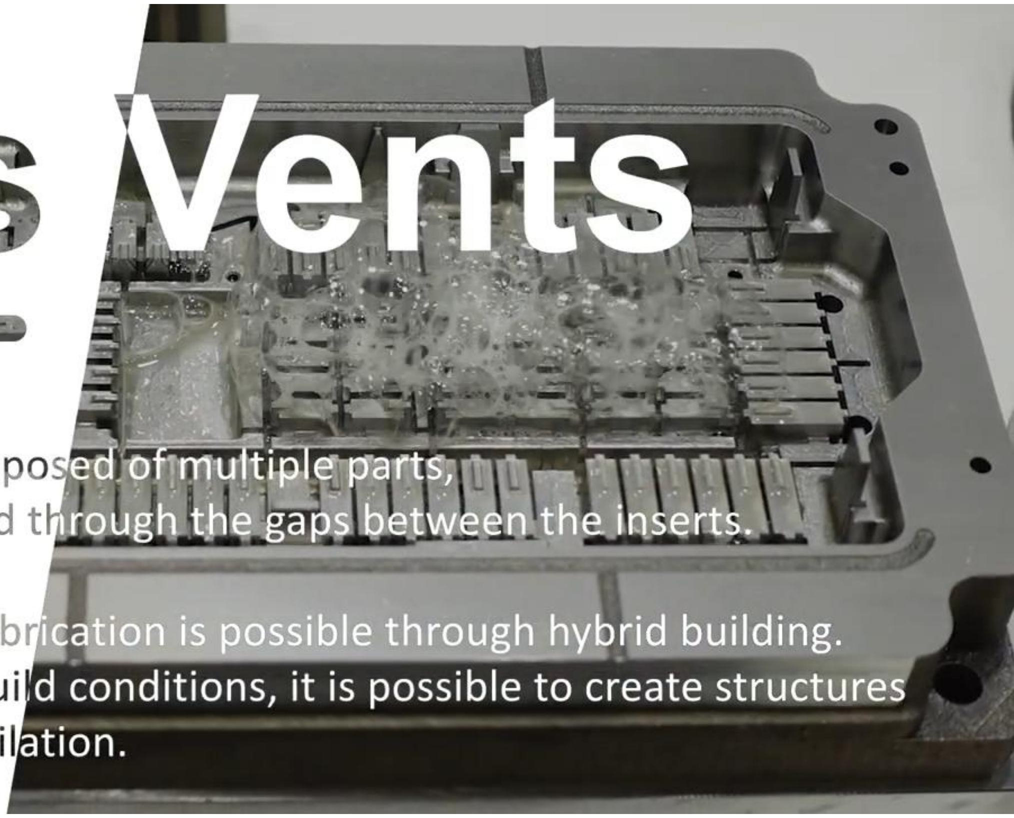


Mold surface: High density
Mold interior: Low density



Reduction of internal stress
Shortening of build time

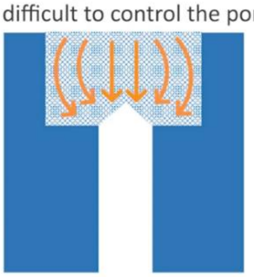
Gas Vents

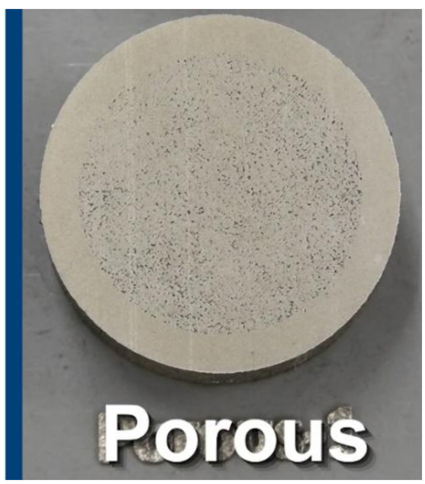


[Conventional]
The mold was composed of multiple parts,
and gas was vented through the gaps between the inserts.
[LUMEX]
Integrated mold fabrication is possible through hybrid building.
By adjusting the build conditions, it is possible to create structures that allow for ventilation.

By adjusting the energy density of the build parameters, it is possible to form sponge-like pores.

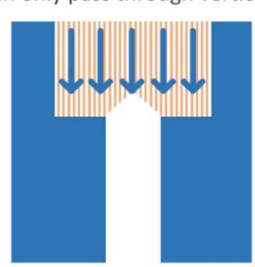
【Advantage】
Enables airflow in all directions
【Disadvantage】
It is difficult to control the pore size.



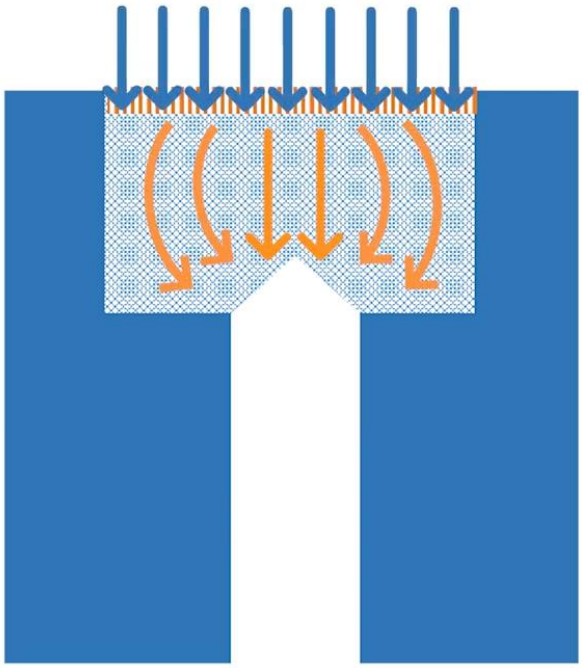


By using a laser to draw a lattice pattern, a grid-like arrangement of pores can be formed.

【Advantage】
The pore size can be freely adjusted.
【Disadvantage】
Air can only pass through vertically.



Transfer prevention
+ Omnidirectional venting



Hybrid vents

Surface: A grid structure is applied,
and the pore size is adjusted.

By minimizing the pore size, transfer to the molded product is prevented.

Inside: A porous structure is applied.

The design flexibility of ventilation paths is improved.

Minimum pore size of porous structure:
80–250 µm
Minimum pore size of grid structure:
70 ± 30 µm

- Doesn't a porous structure **get clogged**?

Super engineering plastics that are prone to gas generation and those with high fluidity like LCP, PBT, and PPS, will require higher maintenance frequency. For resin materials with high fluidity, design methods such as avoiding direct contact of the porous surface, or incorporating gas venting grids to prevent transfer, are effective solutions.

Admittedly,

Powder Costs Remain High

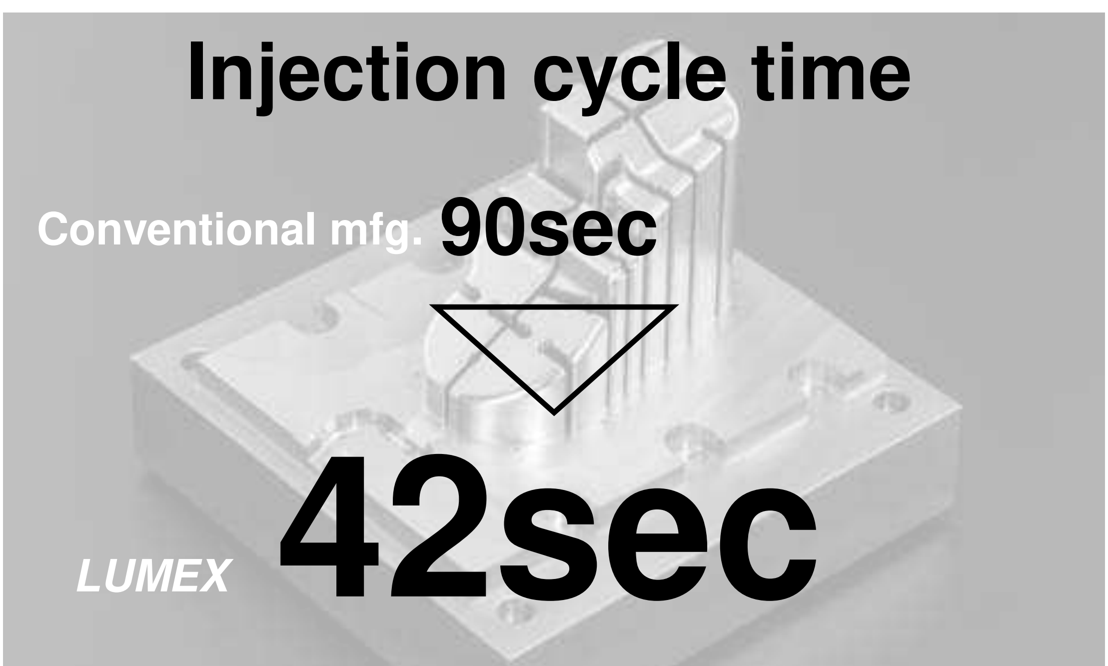
The cost of general AM mold design and manufacturing is said to be **1.1 to 1.5 times** higher compared to conventional methods.

Nevertheless,

Huge advantages

when molding parts

- 3D cooling channels for improved quality/productivity
- Reduction of low-pressure molding and defect through gas venting



Only with the hybrid AM,

Cost Reduction and Shorter Lead Time

Basic principle of *LUMEX* utilization
Minimize EDM processes

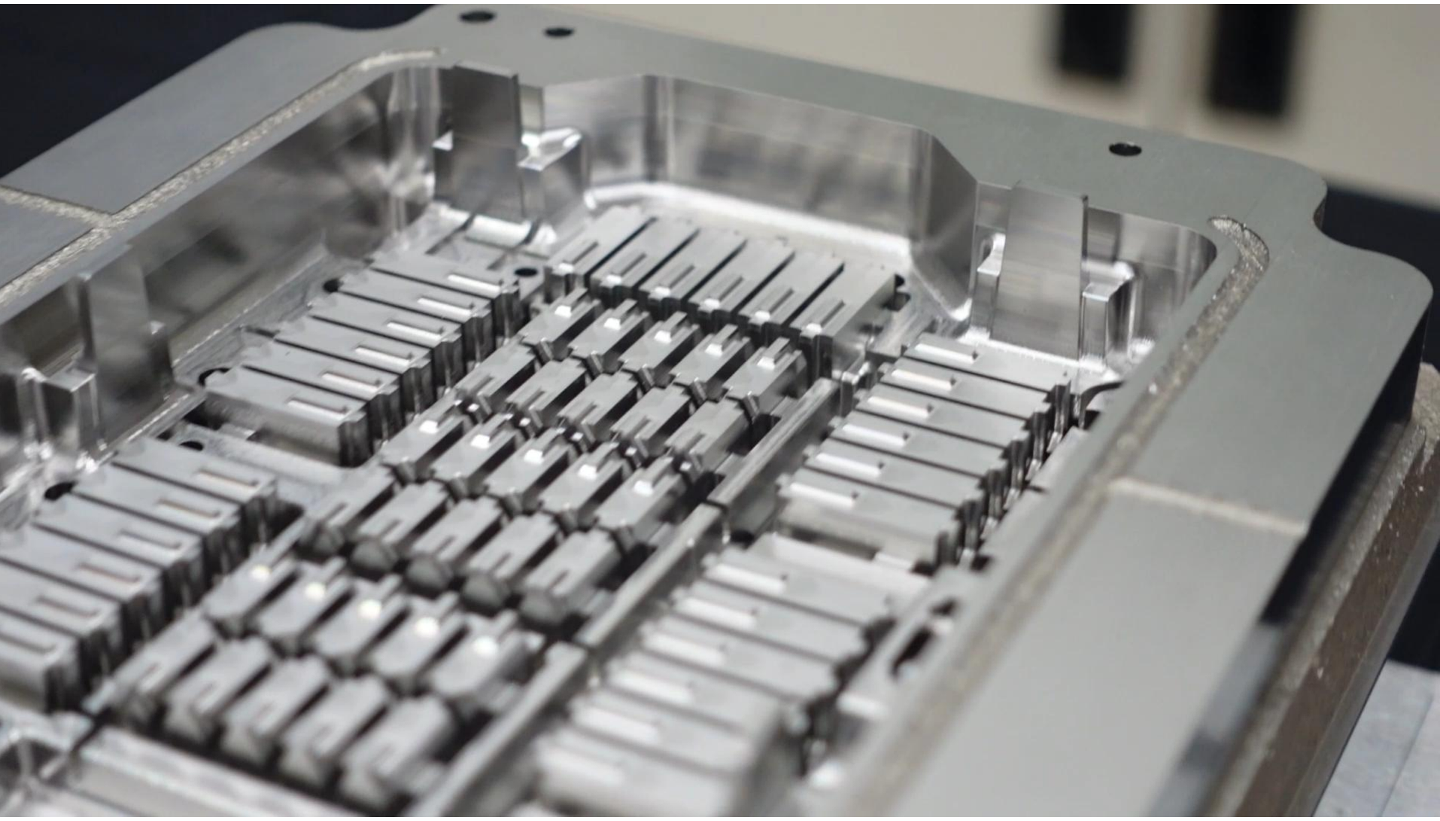
Once implemented into your tool building process, the design of the mold becomes quite simple. Only the mold split is required, eliminating the need to produce inserts exclusively for manufacturing purposes. (EDM, Polishing and Venting).

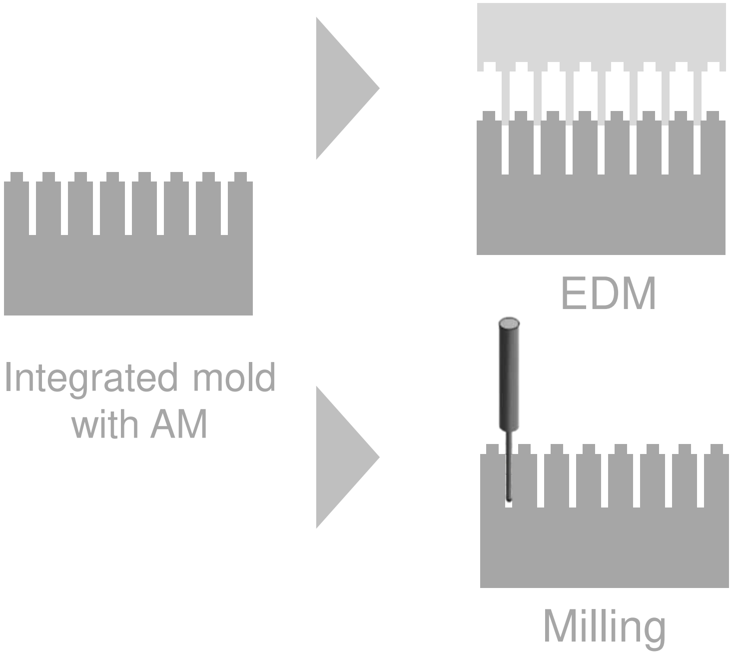
Saving the time for:

- EDM programming
- Multiple setups for EDM process
- EDM operation
- Mold design for creating inserts
- Electrode design
- Electrode machining

YouTube

[AM + Post Processing]
Involve Time and Effort



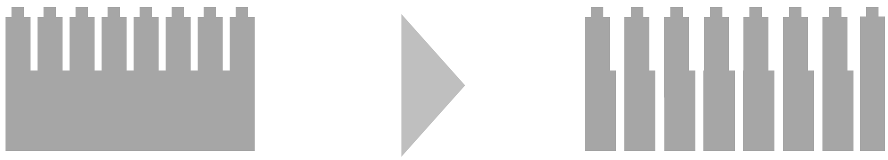


- The electrodes for EDM also have complex designs, so the effort involved doesn't really change.
- Plus, the EDM process itself takes a long time.

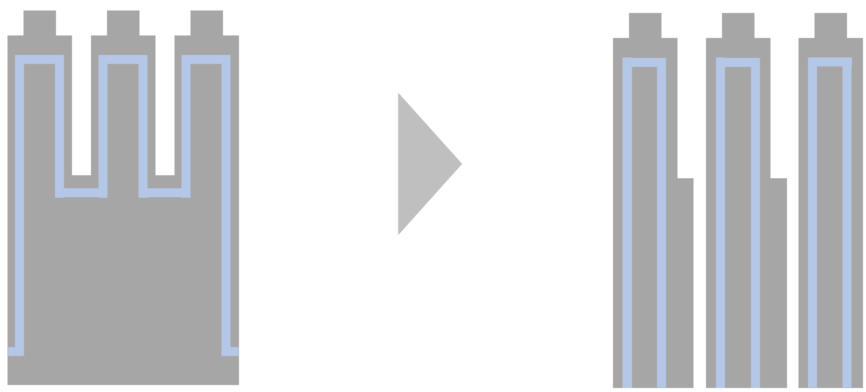
- Milling narrow grooves with long tools while managing chatter is challenging.

It limits your consolidation

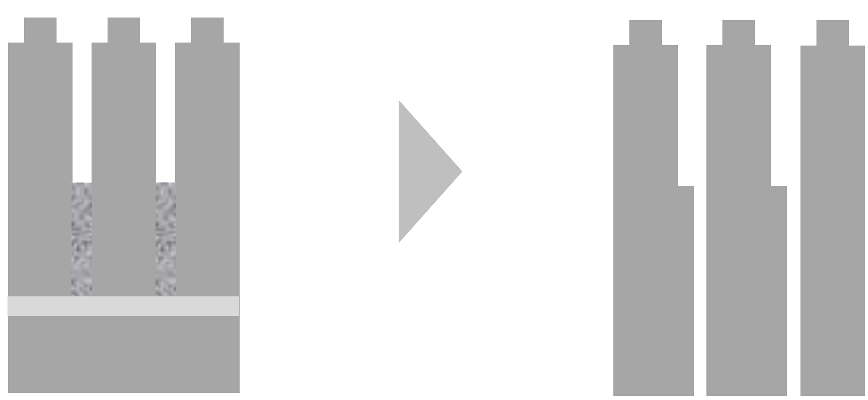
Unutilized AM benefits



Splitting the mold for easier post-processing.

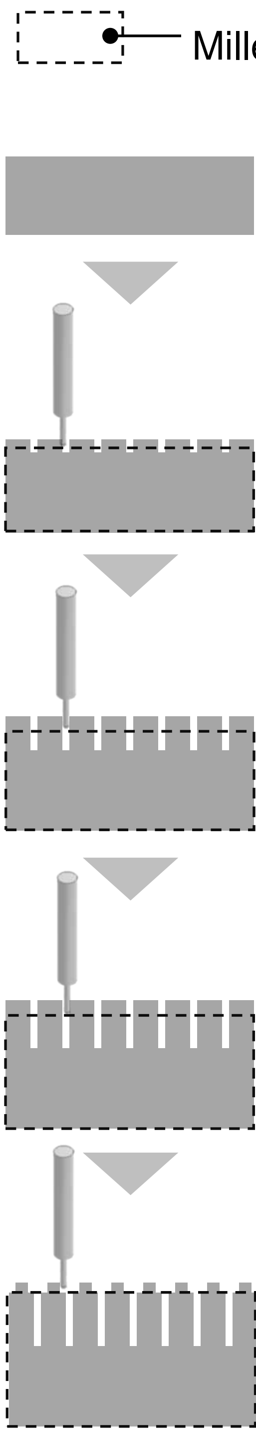


Internal cooling channels that cross split mold components carry a risk of leakage, which limits where the channels can be placed.



In compression molds or molding processes using materials like elastomers or FRP, splitting the mold often leads to flash issues. An integrated AM mold can address gas burn problems with porous gas venting structures.

The hybrid is **not the same** as [AM + Post Processing]



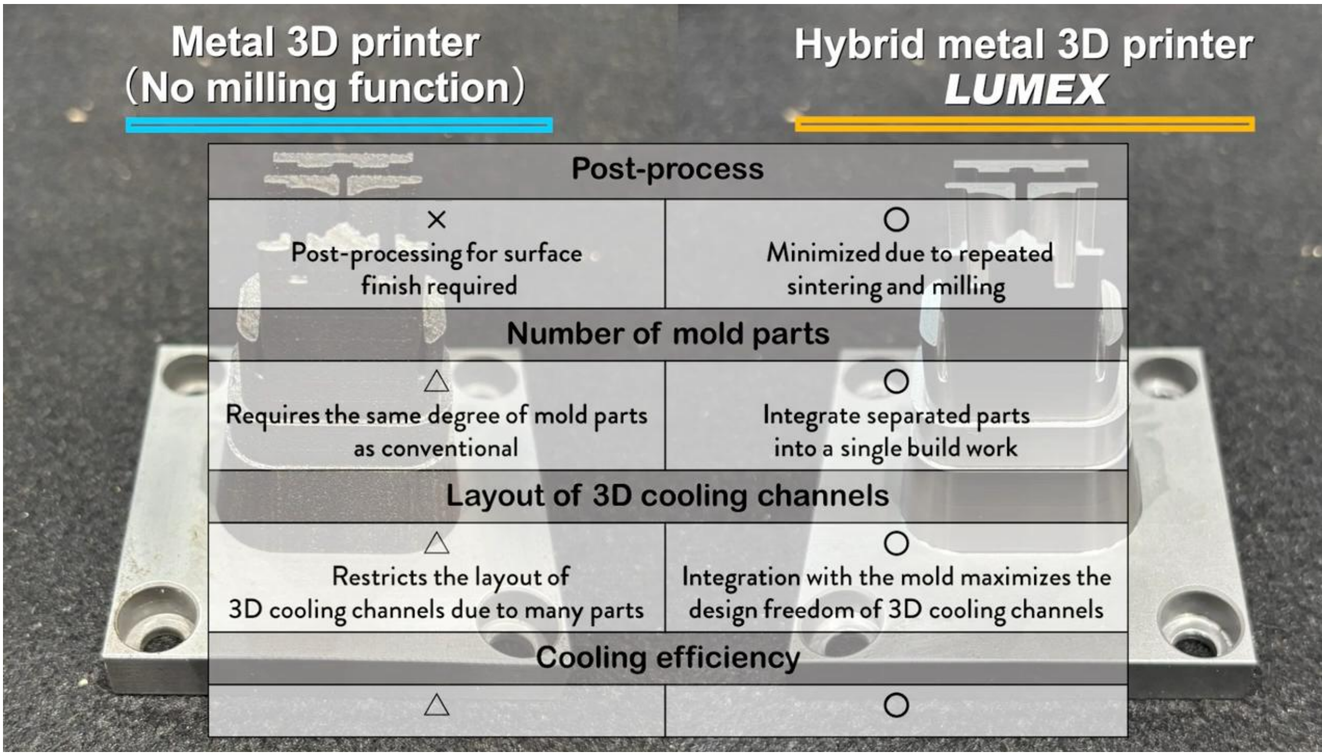
Milling
While building

Stable cutting
With short tools
On every layer

Milling
No longer
Becomes
A bottleneck
In mold design

Not constrained by post-processing

Enables Greater Mold Integration

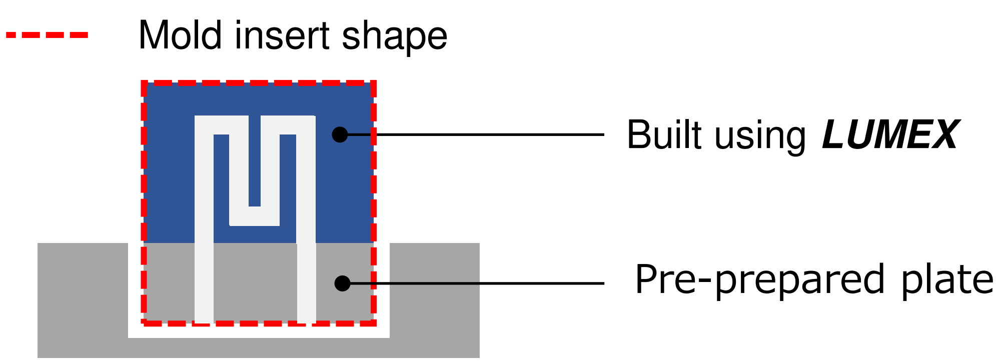


It's not "All or Nothing"
Utilize Other Methods Wisely

There is **no need to replace everything with the *LUMEX***. Apply the hybrid AM to areas where high added value can be achieved, while utilizing conventional methods where applicable. **AM molds do not lose the capabilities of conventional methods, such as EDM, welding, and plating**, allowing for flexibility in mold manufacturing.

A hybrid mold

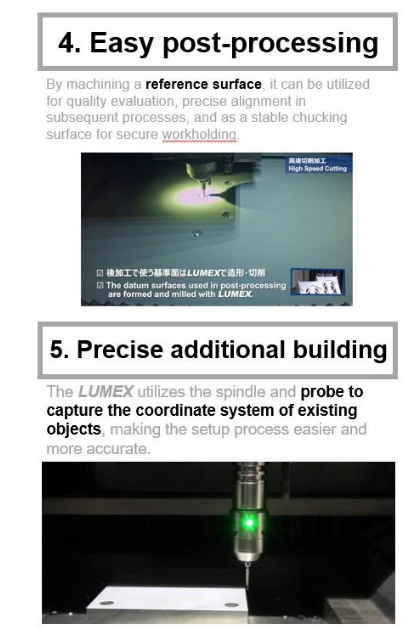
The **base plate**, which functions as the foundation for building parts, is **used as a part of the mold**.



- Reduction in lead time
- Minimized warpage

Since the process involves rapid heating and cooling by melting and solidifying metal powder with a laser, residual stress accumulates in the formed part. When the part is detached from the base plate, deformation inevitably occurs. The hybrid mold application is also aimed at avoiding the need for detachment.

P8



4. Easy post-processing

By machining a **reference surface**, it can be utilized for quality evaluation, precise alignment in subsequent processes, and as a stable chucking surface for secure workholding.

5. Precise additional building

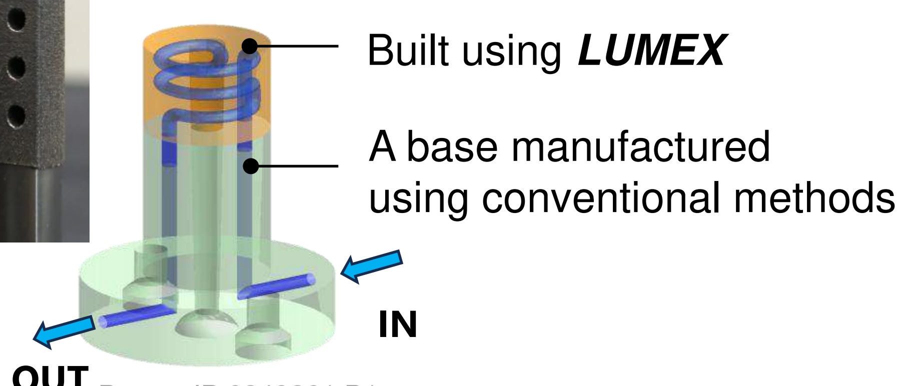
The *LUMEX* utilizes the spindle and **probe to capture the coordinate system of existing objects**, making the setup process easier and more accurate.

Easier to **combine with post-processing** from conventional manufacturing methods.

Easier to **leverage the geometry of existing parts.**

What else?

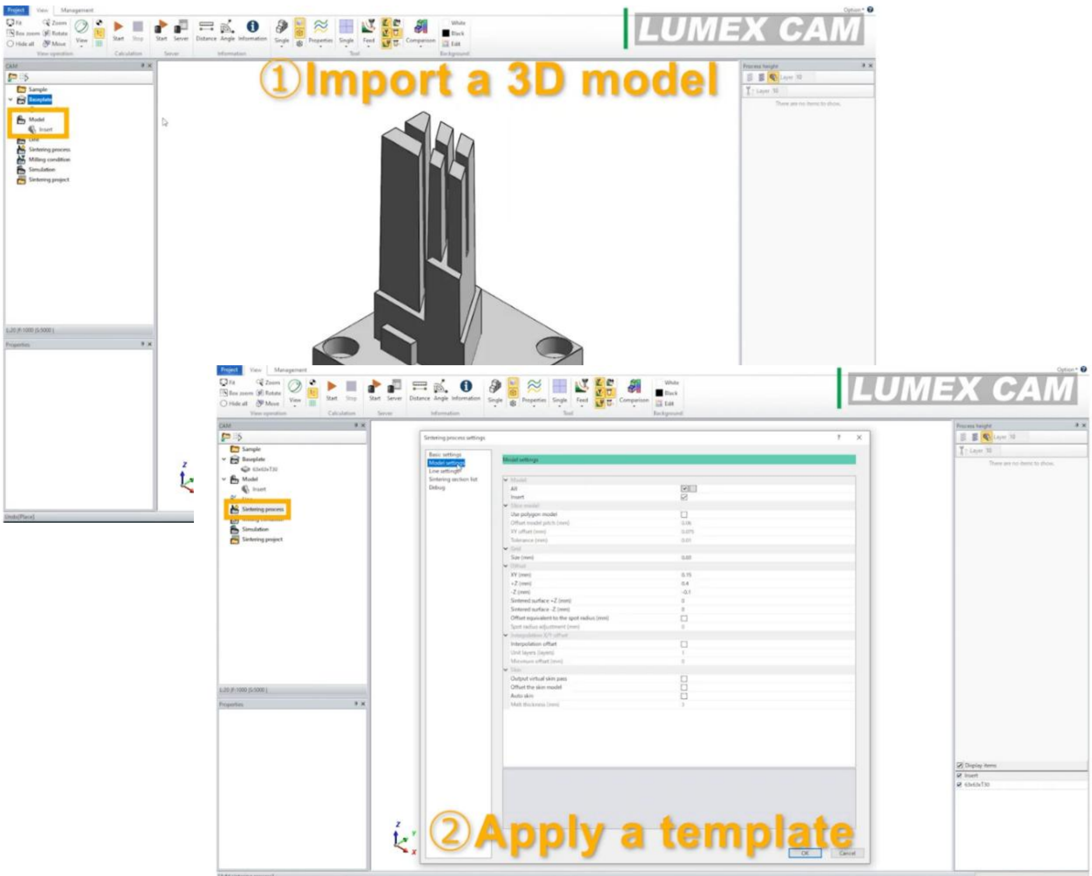
- Only **the deep and narrow slits** are milled on the LUMEX, while exposed surfaces are milled afterward.
- Only **the parts that are difficult to produce without splitting them** using conventional methods are integrated.



Patent JP 6249261 B1
This patent is licensed by Panasonic

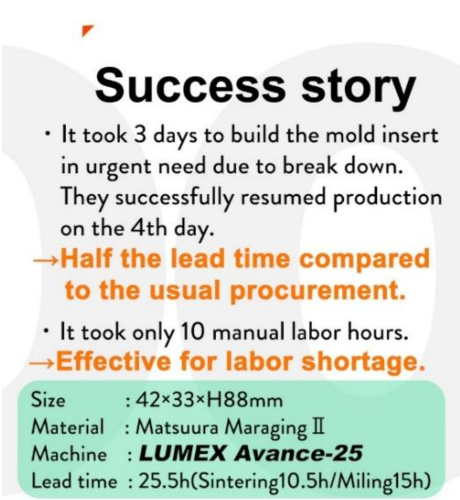
3D model & powder

The fundamental process



Program generation with ***LUMEX CAM*** is incredibly simple and straightforward.
Just load the 3D model, assign a template, set the conditions, and start the calculation — that's it. **Compared to the electrode design and process planning required for EDM, this approach saves a significant amount of time and cost.**

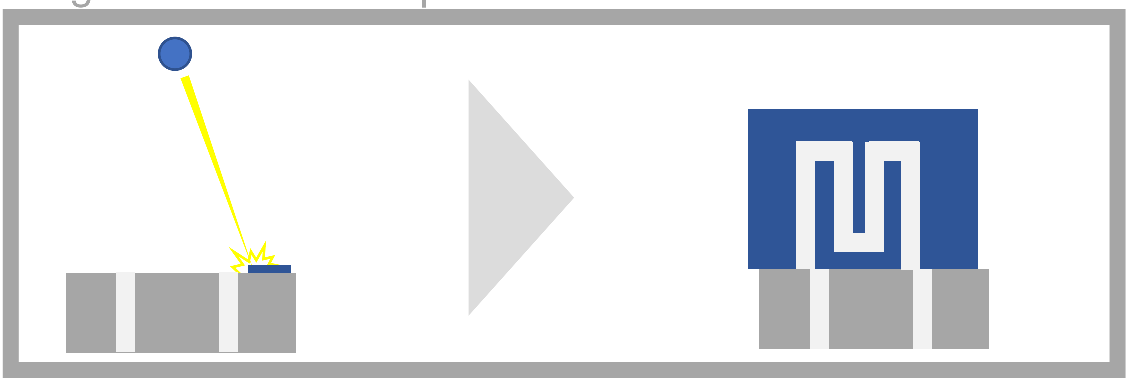
No matter the mold, the essentials are simple: a base plate (common steel material) and metal powder. By **skipping the conventional material procurement process**, You can start production within **just a few days** - especially for mold inserts.



Only with probing,

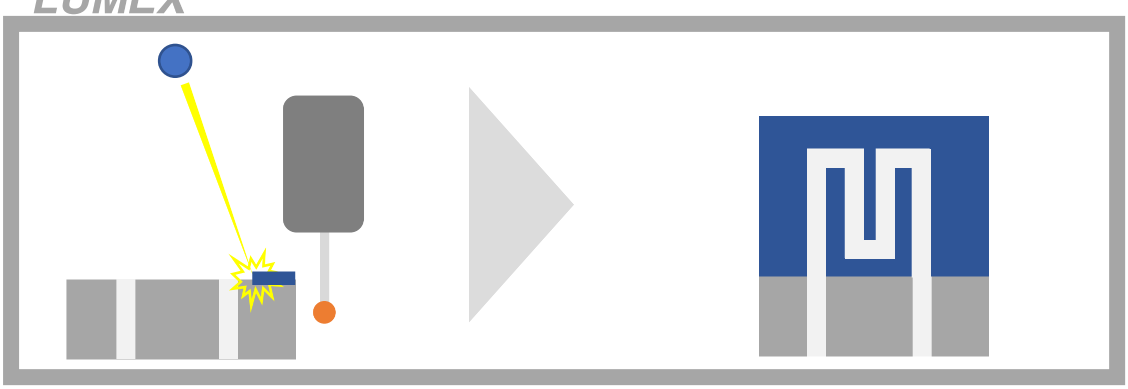
Precise Setup

A general metal 3D printer



Maintaining the absolute coordinates of the laser system on the table is difficult. Additionally, due to aging changes, **accurately performing additional building on top of existing objects requires trial and error.**

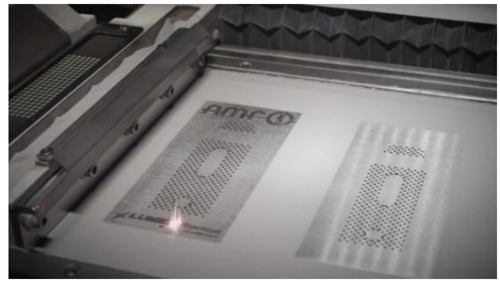
LUMEX



- Creating a coordinate system with **a probe**, ensuring that **additional building** on existing objects **does not shift**

Even easier

Zero Clamp Systems



YouTube

- Easy clamping with air supply
- Repeatable positioning
- Automatic powder recovery
- Multi-part builds

Not that difficult

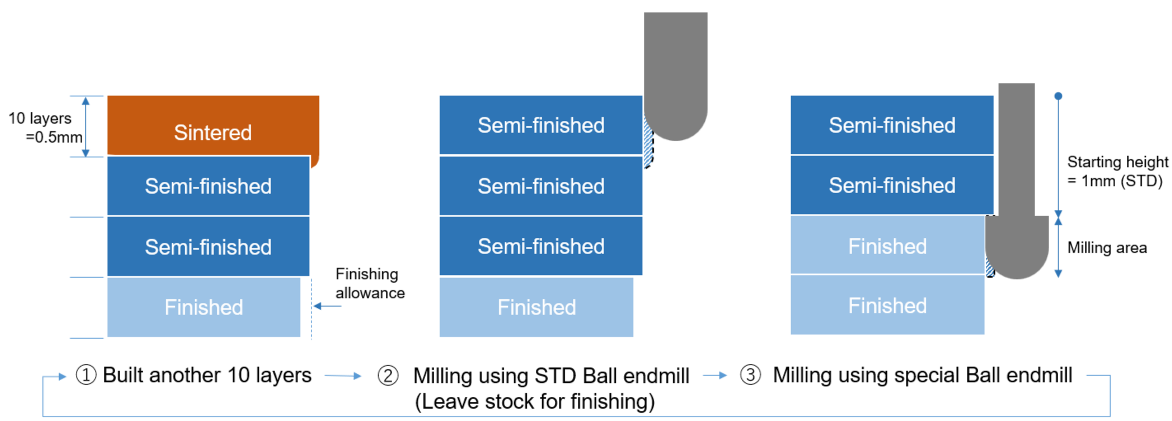
How to Handle Deformation

Warping and **distortion** during the build process inevitably occur to some extent

Intra Layer Milling

Patent
JP 4452692

Finish milling while avoiding the upper areas affected by thermal shrinkage. Minimize step differences to achieve a high-quality surface.

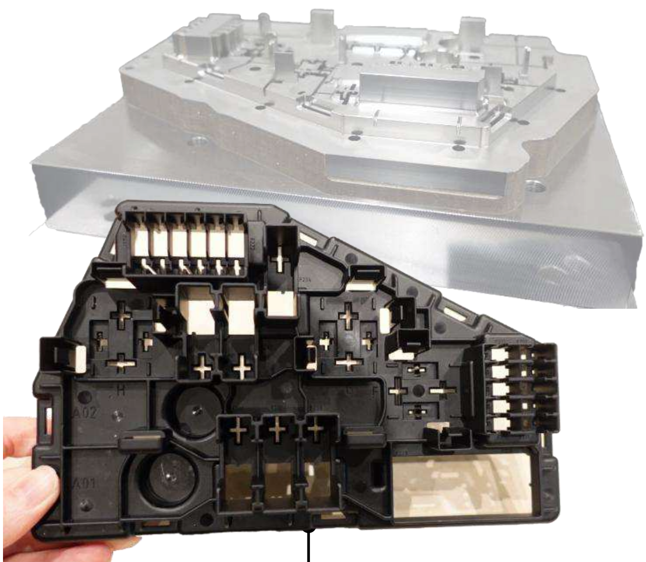


- Dimensional changes (linear expansion) are adjusted by **scaling the 3D model**
- Depending on the target dimensions, **post-processing** may also be required

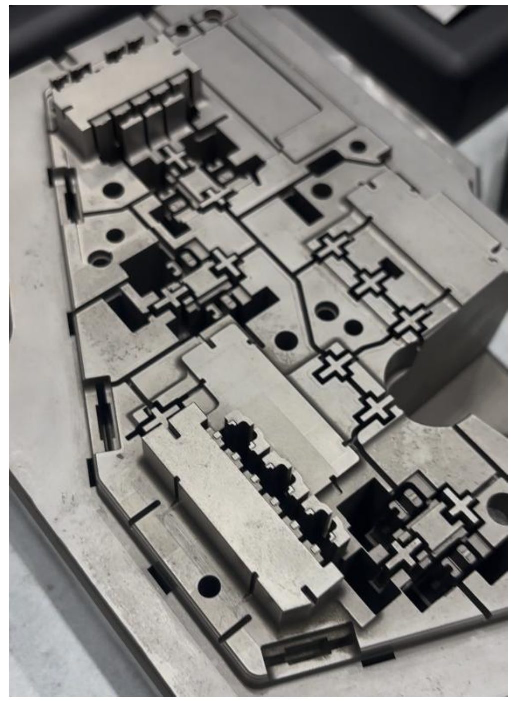
\- Intra layer milling is easily programmed with the ***LUMEX CAM***

How they make

Mass Production Molds



PA6-GF30
(30% glass fiver)



After 400,000 shots

An automobile fuse box mold

1. ***LUMEX*** sintering and milling(234h)
2. **Aging Treatment** to increase hardness
3. **Finishing process** for areas which require high-precision fitting.
4. **Light Sandblasting** to adjust surface roughness

- Dimensional changes are minimized since only an **aging treatment** (low temp) is required

Remaking it from scratch?
How you Modify AM Molds

Repairs can be made by **buildup welding** or by cutting out the damaged area and using an insert

It is better to design the following parts as **separate or insert components** from the beginning

- Easier **maintenance**
- **Design changes** may be a factor
- Expected severe **wear**

Recap

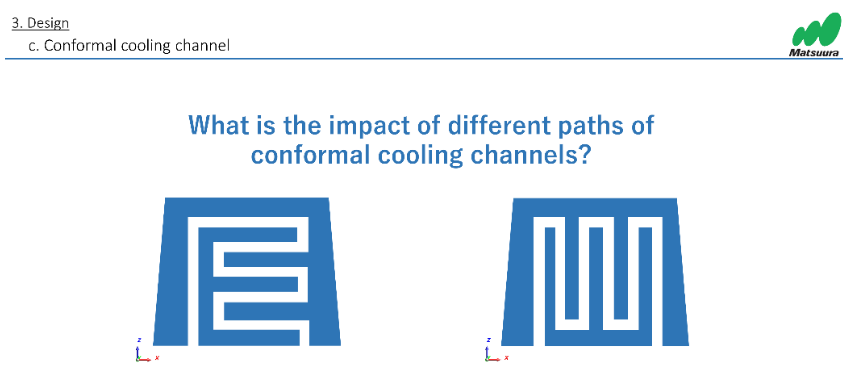
➢ Only **the parts that are difficult to produce without splitting them** using conventional methods are integrated

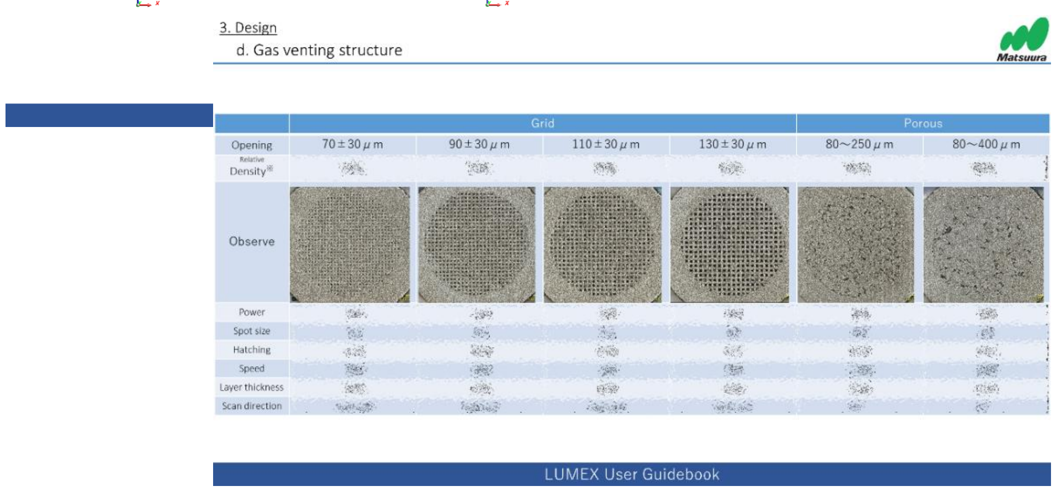
- Maraging steel has good **weldability**, so partial buildup welding is possible.

Other Questions

- What should I start with?

We offer another guidebook (Exclusive for ***LUMEX*** users)
for **effective AM mold design**

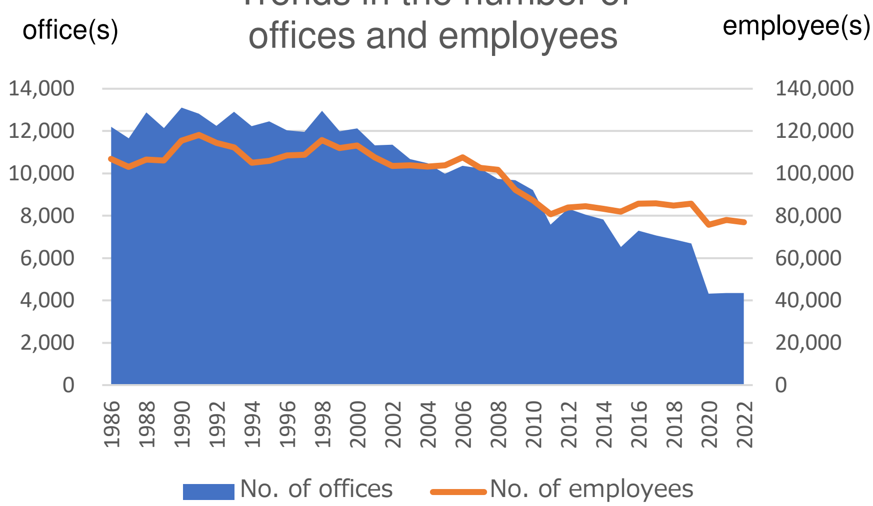




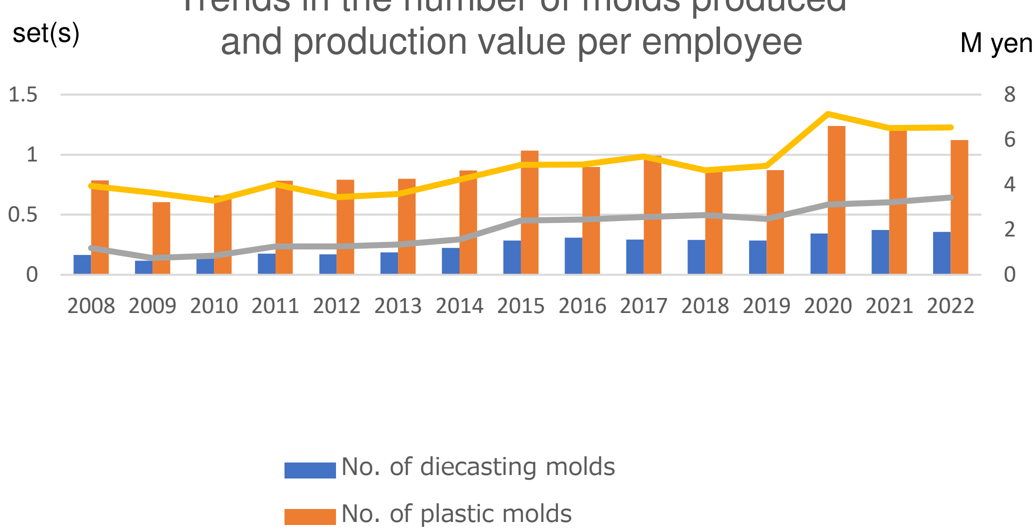
Japanese mold industry

How is Your Country?

Trends in the number of offices and employees



Trends in the number of molds produced and production value per employee



*The graph is created based on statistical data from the Japan Die & Mold Industry Association.

- The No. of employees decline
- The **burden** per employee has been **increasing year by year**.

There used to this major premise

If you use a M3DP,

It is **pointless** unless you make **high-performance molds** with internal water channels or gas venting structures.

However,

Started seeing changes since 2022

Even with molds that can be made using conventional methods, we want to **reduce dependence on machinery and manual labor**.

Please put us to the test

Production Service

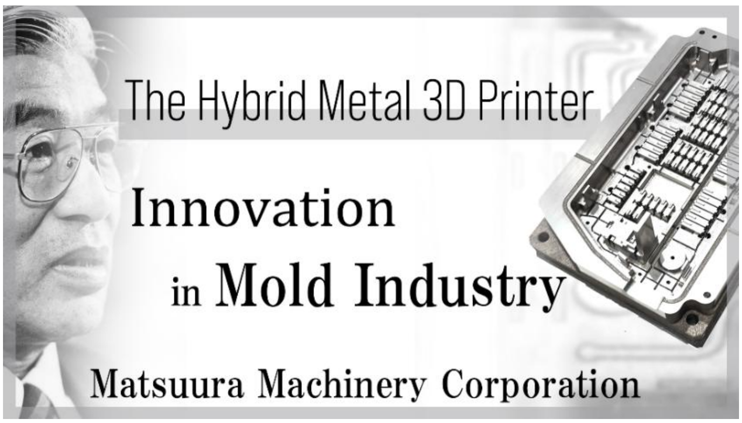
"Come to us.
Let us show you, not explain it to you.
Let us make a part.
Let you take that part.
Use it in your own process.
Evaluate it yourself.
And then, **I don't think there's any further explanation needed.**"

Simon Chappell
Managing Director
at Matsuura Europe GmbH

- We propose solutions for molds based on **20+ years of experience**

In this article, you can learn

All the History



- The development history
- Why are we so confident now?
- User case studies

Thank you for taking the time to read this !

We look forward to your feedback