m:MIM (micro MIM)

Precision Metal Powder Injection Moulding Specifications(Optional Product)

- V-LINE® + Newly Designed Injection Structure "Dedicated to m: MIM" -

Newly designed injection structure specifically made for "m: MIM" to maximize V-LINE® injection performance

(optional product)

Metal powder injection moulding (Metal Injection Moulding: MIM), a type of metal processing, is a method that uses fine metal powder and combines resin-moulding with powder metallurgy technology. Features of this technology include: a high degree of freedom in shape and material, high dimensional accuracy and mechanical strength, high mass productivity, and low manufacturing cost. The global average annual growth rate is said to be 11% as new adoptions and applications continue to expand in healthcare, automotive, and mobile device manufacturing.

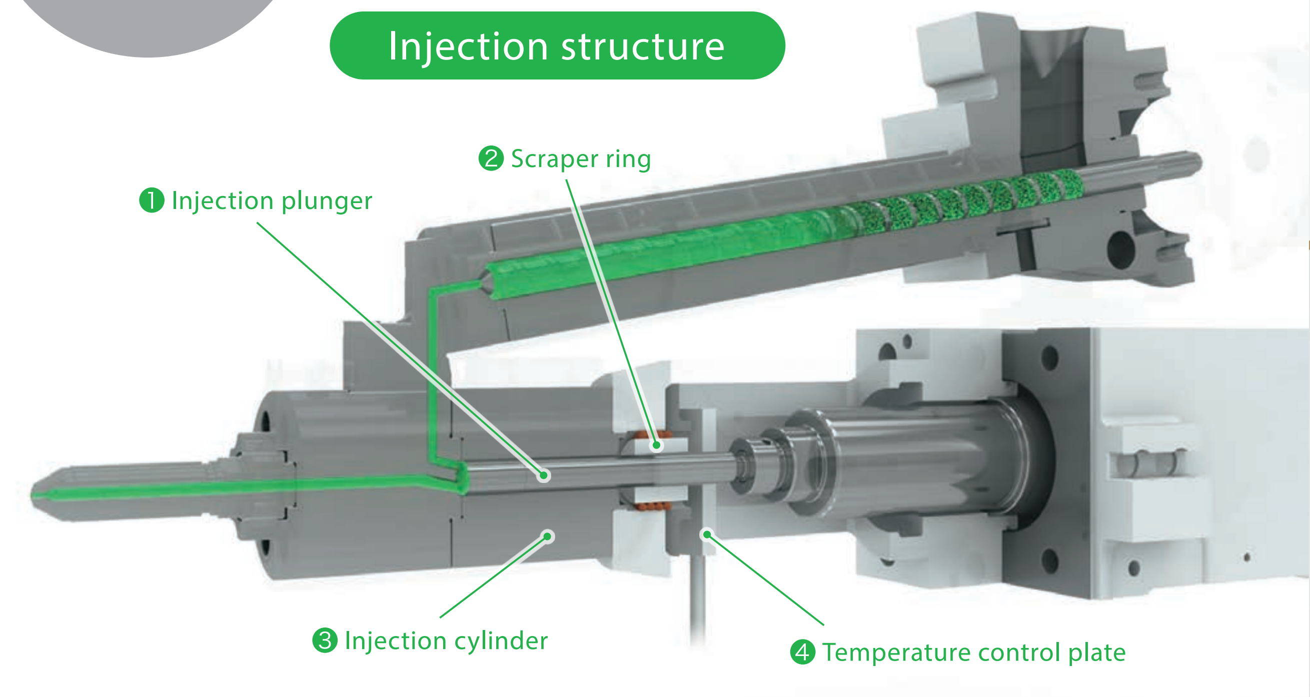
However, metal injection moulding can be temperamental and improper temperature control can cause issues with measurement as well as burring or galling during the moulding process. This would require secondary processing for most products, such as finishing and deburring.

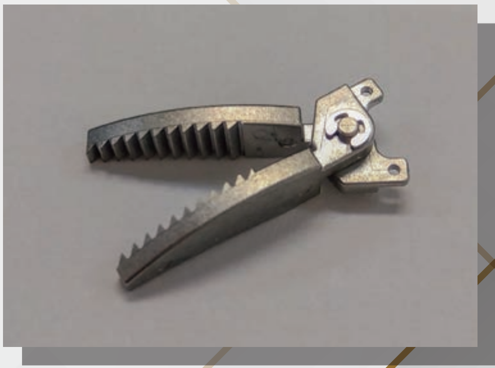
The injection structure "dedicated to m: MIM (micro MIM)" proposed by Sodick maximizes V-LINE® performance with precise fill control and high injection responsiveness, realizing final form-product (net-shape) moulding that does not require secondary processing.

NEW

Injection structure specifically designed for m: MIM

Injection structure





The Full Lineup

V-LINE® High response model

LP20EH3

Plunger diameter 16 mm
Screw diameter 18 mm

eV-LINE® Electric model

MS50G2

Plunger diameter 22 mm
Screw diameter 22 mm

V-LINE® Electric hybrid model

GL30

Plunger diameter 16, 22 mm
Screw diameter 18, 22 mm

V-LINE® Electric hybrid model

GL60

Plunger diameter 22 mm
Screw diameter 22 mm

Newly designed injection structure specifically made for

"m: MIM (micro MIM)" to maximize V-LINE® injection performance and achieve net shape moulding

V-LINE®, a core-technology developed by Sodick, is optimized for m: MIM, contributing to net shape.

The challenges of the previous MIM V-LINE®

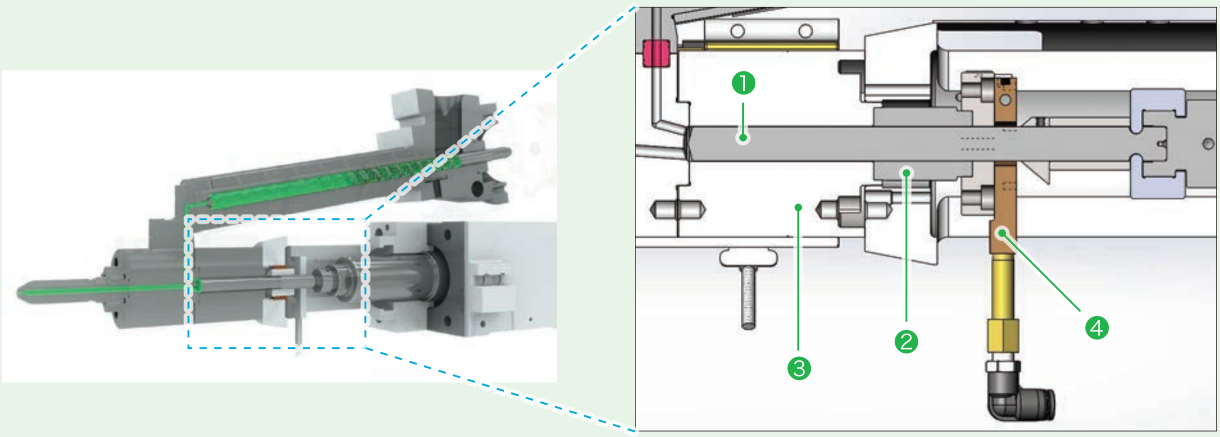
The original MIM specifications, similar to CIM (ceramic powder moulding) specifications, had the following challenges:

- Metal powder entering spaces between the injection plunger and cylinder caused galling and injection malfunction
- With conventional anti-galling measures, only the same level of holding pressure as in-line machines can be applied, and filling density cannot be increased. This caused material waste to be discharged from the rear of the injection plunger

Newly designed injection structure "m: MIM" (patented)

- **Highly lubricated steel material** is adopted for the injection sliding part, thus making structures less susceptible to damage from metal powder
- **The level of high injection holding pressure** expected of our plunger type moulding can be achieved
- Temperature control at the rear of the injection plunger improves **the stability of the injection process** and **reduces the amount of discharged material**

▶▶ These dedicated structures enable **precise MIM that takes advantage of the original injection properties of V-LINE®**



1 Injection plunger	Highly lubricated steel, specifically designed for m: MIM
2 Scraper ring	A resin seal is formed, and a higher pressure than before can be maintained
3 Injection cylinder	General MIM standard product
4 Temperature control plate	Temperature control at the rear of the injection plunger

Example of moulding utilizing injection characteristics of V-LINE®

[Features of V-LINE® injection]

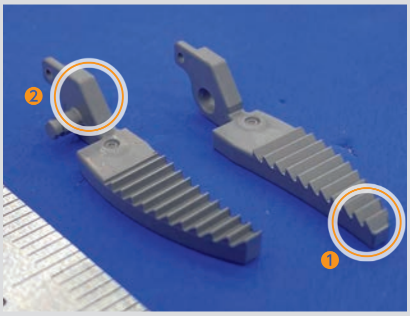
- There is no backflow during injection and the velocity of the injected material matches the movement of the plunger
- Since the injection plunger is short and lightweight, the initial injection speed response is fast and the braking distance is short

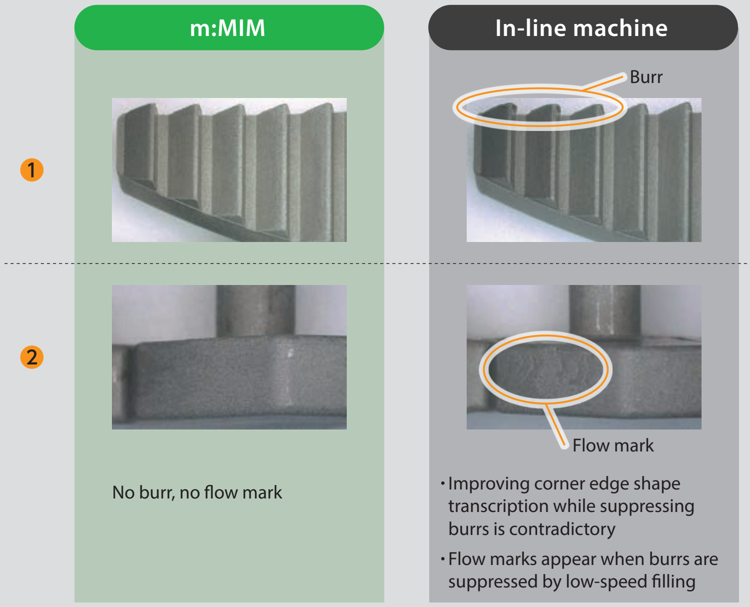
[Characteristics of MIM material]

- The metal powder is heated by shearing during injection, the melt viscosity of the binder (base resin) decreases, and the fluidity increases
- When the flow stops, the mould temperature is transmitted to the metal powder, and the temperature of the binder drops rapidly and solidifies

▶▶▶ It can be said that this is a moulding material that is prone to burrs, but thin-wall moulding is difficult

Sample Product: Medical Clips (material: SUS630)

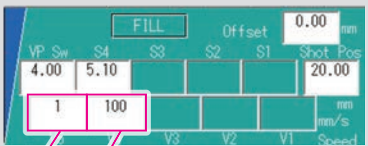


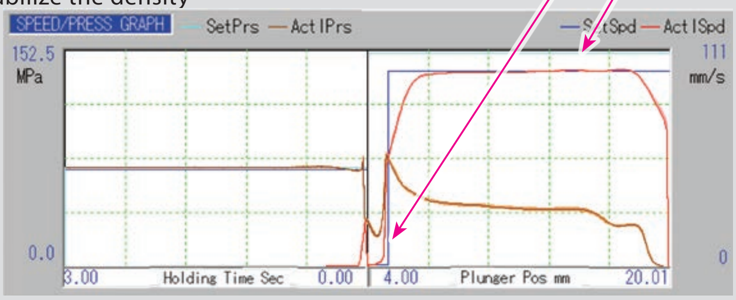


◆Example of an injection speed setting that suppressed vertical burrs on insert and burrs on uneven parting surfaces

*With the in-line machine, the resin discharged from the nozzle cannot be controlled at the speed as shown in the figure below

- Fill up to the part where burrs are likely to occur, and slow down rapidly just before burrs appear (100mm/s ➡ 1mm/s)
- Apply appropriate holding pressure at the timing when the skin layer solidifies to stabilize the density





[Challenges of MIM]

- If burrs are suppressed with mould accuracy, air escape will be worse, causing incomplete filling and poor transfer
- Secondary processing, such as deburring, results in higher costs, uneven quality, and lower yields

Verification and evaluation of moulded body (green body) to degreased sintered product (SUS630)

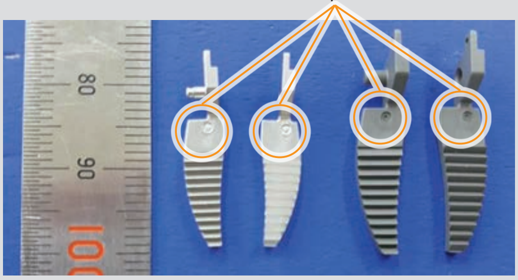
◆**Appearance and mass variation were compared, verified, and evaluated with degreased sintered products of moulded body (green body)** (hereinafter referred to as "moulded body") **made by m: MIM and in-line machine (standard specifications).**

Poor appearance (flow marks, hot water wrinkles) of the moulded body is more apparent after sintering. Since the burr remains in its shape, it must be removed after sintering.

The moulded body by m: MIM maintained its properties, with no burrs or flow marks identified. Even under rapid deceleration conditions with reduced burrs, the amount of filling resin is accurately controlled, and there is no distortion. In particular, the pin gate and surrounding conditions are smooth, without leaving excess pressure or flow.

On the other hand, the in-line machine cannot control the movement of the filling resin quickly resulting in dents on the moulded body.

Gate position



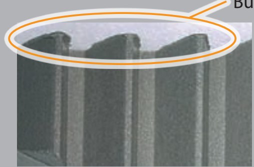
Sintered product (SUS630) Moulded body
(Shrinkage rate: about 13.8%)

m:MIM

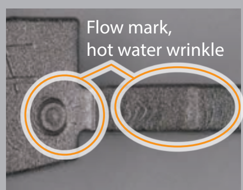
Burr, flow mark
No dents in the gate

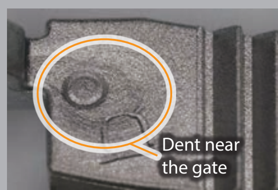
In-line machine

Burr



Weld line





The burrs remained as they were, and the flow marks that were confirmed on the green body were more clearly visible

Hot water wrinkles and dents were also found near the gate

・Mass variation (n=30)

The amount of variation is more pronounced in the sintered product compared to the moulded body

The rapid deceleration conditions that suppress burrs do not affect the filling state between shots

	Product status	Average mass	Coefficient of variation
m:MIM	Green body	0.9352	0.00025
	Sintered product	**0.8730**	**0.00038**
In-line machine	Green body	0.9402	0.00049
	Sintered product	**0.8776**	**0.00068**

m: MIM realizes a net shape by taking advantage of the injection characteristics of V-LINE®

With its high injection responsiveness, control, and accurate injection-filling, **V-LINE®** can also suppress appearance defects that are contrary to burrs. Contributing to **ultra-precision and high yield** from conventional precision MIM in **a wide range of machining conditions**.

●The machining data in this catalogue is based on conditions, machining environment, and measurement standards that have been specified by Sodick.

Specifications

<table>
<tr><th colspan="2"></th><th>
LP20EH3</th><th colspan="2">
GL30</th><th>
GL60</th><th>
MS50G2</th></tr>
<tr><td colspan="2">Moulding machine type</td><td colspan="4">Hybrid</td><td>Electric</td></tr>
<tr><th colspan="7">Clamping Unit</th></tr>
<tr><td colspan="2">Mould Open / Close System</td><td colspan="5">AC Servo Motor Control</td></tr>
<tr><td colspan="2">Clamping System</td><td>Direct Pressure Type</td><td colspan="3">Direct Pressure Locking Type</td><td>Double Toggle</td></tr>
<tr><td>Max. Clamping Force</td><td>kN</td><td>196</td><td colspan="2">294</td><td>588</td><td>490</td></tr>
<tr><td>Tie Bar Distance (W × L)</td><td>mm</td><td>310 × 260</td><td colspan="2">310 × 310</td><td>360 × 320</td><td>360 × 360</td></tr>
<tr><td>Platen Dimension (W × L)</td><td>mm</td><td>430 × 360</td><td colspan="2">440 × 440</td><td>520 × 460</td><td>500 × 500</td></tr>
<tr><td>Open Daylight</td><td>mm</td><td>400[*1]</td><td colspan="2">550[*1]</td><td>650[*1]</td><td>600[*2]</td></tr>
<tr><td>Min. / Max. Mould Thickness</td><td>mm</td><td>150 (Min.)</td><td colspan="2">150 / 360</td><td>200 / 390</td><td>150 / 350</td></tr>
<tr><td>Mould Opening / Closing Stroke</td><td>mm</td><td colspan="4">(Open Daylight) - (Mould Thickness)</td><td>250</td></tr>
<tr><td>Mould Open / Close Force</td><td>kN</td><td>6.6 / 13.2[*3]</td><td colspan="2">6.8 / 13.6[*3]</td><td>9.9 / 19.8[*3]</td><td>—</td></tr>
<tr><td colspan="2">Ejecting System</td><td colspan="5">AC Servo Motor Control</td></tr>
<tr><td>Ejecting Force / Ejection Retention Force</td><td>kN</td><td>7.3 / 4.3</td><td colspan="2">9.8 / 5.8</td><td>13.7 / 7.8</td><td>14.6 / 7.8</td></tr>
<tr><td>Ejector Stroke</td><td>mm</td><td colspan="3">50</td><td colspan="2">80</td></tr>
<tr><th colspan="7">Plasticization & Injection Unit</th></tr>
<tr><td colspan="2">Plasticization & Injection System</td><td colspan="5">Screw Pre-plasticizing</td></tr>
<tr><td>Screw diameter</td><td>mm</td><td colspan="2">18</td><td colspan="3">22</td></tr>
<tr><td>Plunger diameter</td><td>mm</td><td colspan="2">16</td><td colspan="3">22</td></tr>
<tr><td>Max. Injection Pressure</td><td>MPa</td><td colspan="2">262</td><td colspan="2">260</td><td>285</td></tr>
<tr><td>Max. Holding Pressure</td><td>MPa</td><td colspan="5">150</td></tr>
<tr><td>Theoretical Injection Volume</td><td>cm^3</td><td colspan="2">14</td><td colspan="2">27</td><td>53.2</td></tr>
<tr><td>Injection Rate</td><td>cm^3/s</td><td>160</td><td>101</td><td colspan="2">190</td><td>152</td></tr>
<tr><td>Plunger Stroke</td><td>mm</td><td colspan="4">70</td><td>140</td></tr>
<tr><td>Max. Injection Speed</td><td>mm/s</td><td>800</td><td colspan="3">500</td><td>400</td></tr>
<tr><td>Plasticizing Capacity GP-PS</td><td>kg/h</td><td>6.5</td><td>7</td><td colspan="2">14</td><td>16</td></tr>
<tr><td>Max. Screw Revolution</td><td>rpm</td><td>370</td><td colspan="4">400</td></tr>
<tr><td>Rated Screw Torque</td><td>N•m</td><td colspan="2">98</td><td colspan="3">147</td></tr>
<tr><td colspan="2">Number of Temperature Control Zone</td><td colspan="5">7</td></tr>
<tr><td>Heater Capacity</td><td>kW</td><td colspan="2">5.0</td><td colspan="2">6.6</td><td>6.2</td></tr>
<tr><td>Nozzle Pressing Force</td><td>kN</td><td colspan="2">4.9</td><td colspan="3">6.8</td></tr>
<tr><td>Unit Traveling Stroke</td><td>mm</td><td>230</td><td colspan="2">280</td><td>320</td><td>280</td></tr>
<tr><th colspan="7">Machine Dimension・Weight</th></tr>
<tr><td>Machine Dimension (L × W × H)</td><td>mm</td><td>2629 × 925 × 1681</td><td colspan="2">3150 × 1030 × 1679</td><td>3685 × 1094 × 1679</td><td>3725 × 1155 × 1729</td></tr>
<tr><td>Machine Weight</td><td>kg</td><td>2100</td><td colspan="2">2000</td><td>2700</td><td>3000</td></tr>
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*1: Daylight in direct pressure machine (min. die thickness + max. stroke) *2: Daylight in toggle machine (max. die thickness + die opening/closing stroke) *3 : Rated / Instantaneous

Precision Metal Powder Injection Moulding Specifications (Optional Product)

m:MIM

Sodick's official website

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