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Metal Injection Molding (MIM) Technology

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What is MIM

- As a metal forming process, Metal Injection Molding (MIM) combines the material flexibility of powder metallurgy and the design flexibility of plastic molding. With properties comparable, or better than, those of wrought steel, the MIM process is ideally suited to producing small and complex-shaped parts with outstanding mechanical properties. In addition to cost-effective, high-volume production, other MIM benefits include:
  - Complex geometries
  - Close porosity
  - Excellent surface finish
  - High performance
  - High final density (93-99%)
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The Process

- The process involves mixing fine metal powders with polymer binders which allow the metal to be injected into a mold. The binders are then removed by thermal processes and the resultant metal part is then sintered at a controlled temperatures profile to bind the particles but not melt the metal. The products of metal injection molding are up to 99% as dense as wrought metal and used in a broad range of applications.
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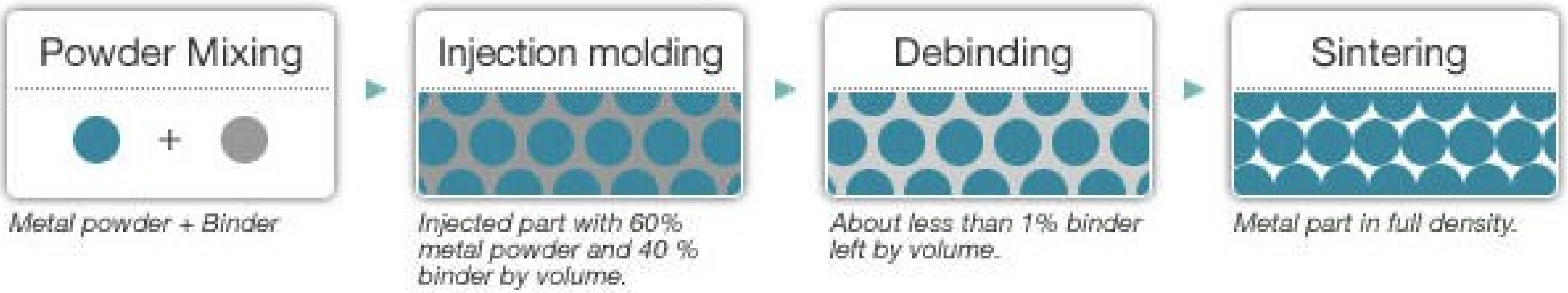

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Part before and after sintering

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Available Material for MIM

Low-alloy steels for heat treatment	
FN02	case hardenable
FN0205	heat-treatable
FN08	heat-treatable or case hardenable
8620	case hardenable
42CrMo4	heat-treatable
100Cr6	heat-treatable, wear resistant

Ceramic Injection Molding (CIM)
Aluminum oxide
Zirconium oxide

Tool steel	
M2	wear resistant

Stainless and heat resistant steels	
316L/317L	nonmagnetic
430	ferromagnetic
17-4PH	hardenable, ferromagnetic
420	hardenable, ferromagnetic
310	heat resistant
440B	hardenable, ferromagnetic

Soft magnetic alloys	
F	Carbonyl iron
FeSi3	Carbonyl iron with 3% of silicon
FN50	Carbonyl iron with 50% of nickel

Special alloys	
Ti	Titanium, commercially pure

Tolerance and Mechanical Property

General tolerance =1% of dimension with minimum of ± 0.05mm. Examples:	
DIMENSION	TOLERANCE
up to 10mm	± 0.05mm
12mm	± 0.06mm
18mm	± 0.09mm
24mm	± 0.12mm
40mm	± 0.20mm

Materials	Density g/cm3	Dimen-sional change %	Porosity %	0,2 yield strength MPa	UTS MPa	Elon-gation %
316L MIM - LA	7,93	16,7	0,8	>180	>510	>50
316L MIM - LC	7,93	16,7	0,8	>180	>510	>50
316L MIM - LG	7,95	16,7	0,6	>180	>510	>50
316L MIM - LW	7,87	16,7	1,1	>180	>510	>50

Notice: MIM UTS is very close to raw Stainless Steel 316 or 316L, which is around 550 MPa

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Benefits and Applications

Design Freedom - MIM offers design flexibility similar to plastic injection molding. Geometrically complex parts that cannot be produced using the conventional powder metal processes without secondary machining are possible using the MIM process.

Enhanced Details - MIM provides intricate features such as dovetails, slots, undercuts, threads, and complex curved surfaces. MIM can produce cylindrical parts with greater length-to-diameter ratios.

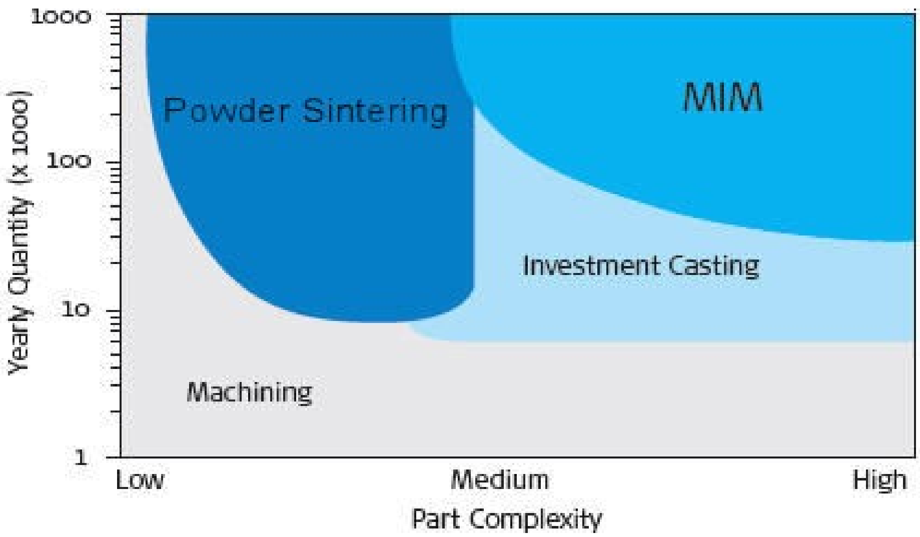
Reduced Assemblies – The MIM process can be used to combine two or more simpler shapes into a single, more complex component to minimize assembly costs.

Reduced Waste/Machining - MIM's capability to provide net shape components eliminates many secondary machining operations.

Improved Properties - MIM parts are typically 95% to 98% dense, approaching wrought material properties. MIM parts achieve greater strength, better corrosion resistance, and improved magnetic properties when compared to conventional powder metallurgy processes.

Limitations of the MIM Process

- **Size** – The economical part size is typically limited to less than 100 grams due to the cost of the fine metal powders used for MIM parts.
- **Section Thickness** – The maximum section thickness is generally kept to less than 0.25 inch to effectively remove the thermoplastic binder from the part without damage, and to control distortion during sintering,
- **Tolerances** – Typically +/- 0.5 percent, down to +/- 0.001 inch (0.025 mm) for very small dimensions. Tighter tolerances require secondary machining or grinding operations.
- **Production Volume** – Tooling costs generally limit the economic annual production volume to greater than 10,000 parts (with exceptions for very expensive parts).



The MIM process is ideal for small, geometrically complex components that are subject to high requirements in terms of mechanical properties and are to be manufactured in large numbers.
The potential applications are even greater than for traditional sintered metal products, thus providing new opportunities within a large number of industrial areas.

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Thanks for Attention

- Please contact us or visit www.novosk.com for more information about MIM or MIM materials.