PIM Technology

a powder technology for complex small engineering parts

- Powder Injection Moulding (PIM)
  - metals (MIM)
  - ceramics (CIM)
  - cemented carbides (CCIM)

PIM is a new process for material shaping that combines the flexibility and high productivity of thermoplastic injection moulding with the performance of the metallic and ceramics parts.

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Near-net shape powder technology for component shaping

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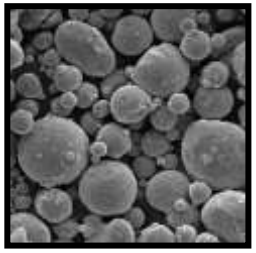

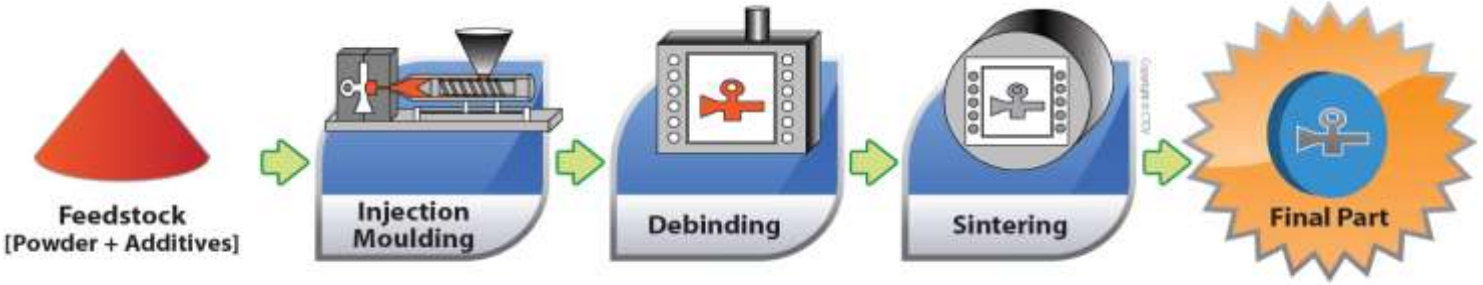

PIM technology allows to the production of high precision small parts without necessary to post-machining, with a significant cost reduction.

Main advantages:

- One-step shaping of very complex part geometries
- A cost-effective production route for difficult machinable materials
- Low to high series production
- Raw material use rate up to 100%

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How to consider a component as a PIM candidate?

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- part selection general criteria

	minimum	maximum	optimum
mass (steel)	0.01g	250g	<50g
wall thickness	0.1mm	8mm	2mm
max. linear dimension	3 mm	100 mm	25 – 50 mm

+

- complex shapes
- 3D-free forming design are not barriers
- Integration of multifunction in one part

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Design can be optimised…

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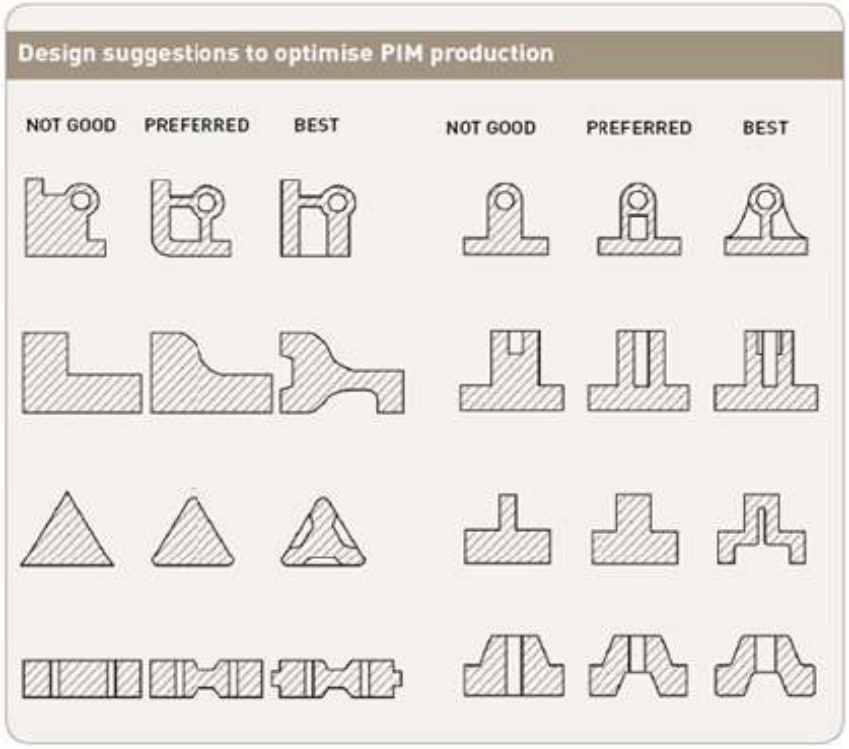
some rules to design a PIM candidate part or to ease the production process/ reduce material consumption



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examples of PIM parts

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Fig. 12 Examples of MIM parts showing the geometric attributes favored in production

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Geometrical tolerances

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- PIM tolerance table

dimension (mm)	tolerance (mm)
< 3	± 0.05
3 – 6	± 0.06
6 – 15	± 0.075
15 – 30	± 0.15
30 - 60	± 0.25
> 60	± 0.5%

- Better than medium class tolerancing - nearly fine – of machining processes (ISO 2768)
- MIM parts can be machined and grinded to tighter tolerances, as in conventional technologies

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Materials

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- metals (MIM)
- ceramics (CIM)
- cemented carbides (CCIM)

carbonyl steels	1010, 1060
low alloy steels	Fe-2Ni (MIM220), Fe-2Ni-0.5C, Fe-8Ni (MIM2700), Fe-8Ni-0.5C, 42CrMo4 (MIM4140), 4340, 100Cr6, 8620, 8740, 16MnCr5
stainless steels	304L, 310, 316L, 420, 430, 440B, 440C, 17-4PH, F75, PANACEA
tool steel	M2
soft magnetic alloys	Fe, Fe-3Si, Fe-50Ni
special alloys	Inconel 718/713, Hastelloy X, Ti, Ti6Al4V, Tungsten heavy alloys
heat transfer materials	Copper alloys
cemented carbides	WC-Co
fine ceramics	Alumina, Zirconia, Alumina-Zirconia

» Material properties according to MIM standards (ASTM B883 and ISO 22068)

» Other material grades under request

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Complementary moulding techniques

2 Moulding techniques for production from prototypes to large series:

- Higher pressure injection moulding
- Lower pressure injection moulding

	Higher pressure PIM	Lower pressure PIM
Mould tooling cost	High	Low
Prototyping capability	Low	**High**
Short production capability	Low	**High**
Large production capability	**High**	Medium

Production schemes

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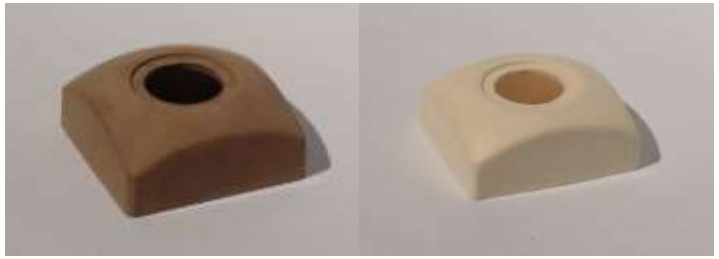
- **Flexible Production**

  - **Type of raw materials:**
    - Ready-to-mould feedstock
    - Customised in-house compounded feedstock

  - **Type of binder systems:**
    - Catalytic debinding
    - Thermal debinding
    - Solvent / Water debinding



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Experience

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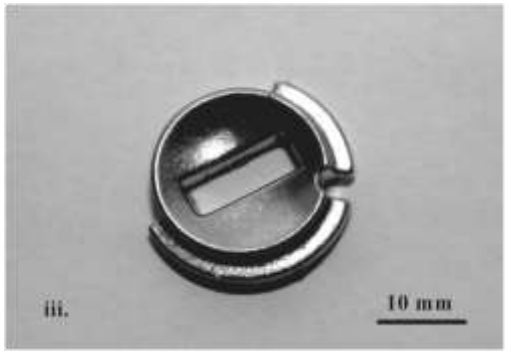
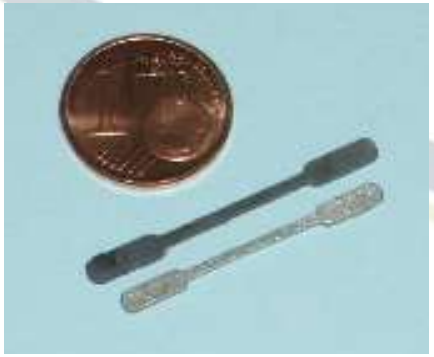
- Household & personal
- Industrial tools
- Automotive components
- Miniaturization
- Hardmetal
- Titanium for medical and mechanical applications





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Best equipment for the best production

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Main equipment for process full chain

- **Compounding**
  - binder and feedstock compounders
- **Moulding**
  - Higher and lower pressure moulders
- **Debinding**
  - Diverse debinding method furnaces
- **Sintering**
  - Sintering of ceramics
  - Sintering of metals in multiple and pure atmospheres

Quality and development lab

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List of Main Equipments

- Rheology: high pressure capillary, Plastograph, Brookfield and rotational rheometers
- Microscopy: optical and scanning electron microscopy
- Metallography and ceramography
- Particle size: Sedigraph, Laser light scatter
- Thermal analysis: TGA, DSC, STA, DIL
- Helium pycnometer
- X-ray difractometer
- X-ray fluorescence
- Hardness and microhardness tester
- Tensile and flexure testing equipments
- Thermal conductivity meter

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