Description

Image

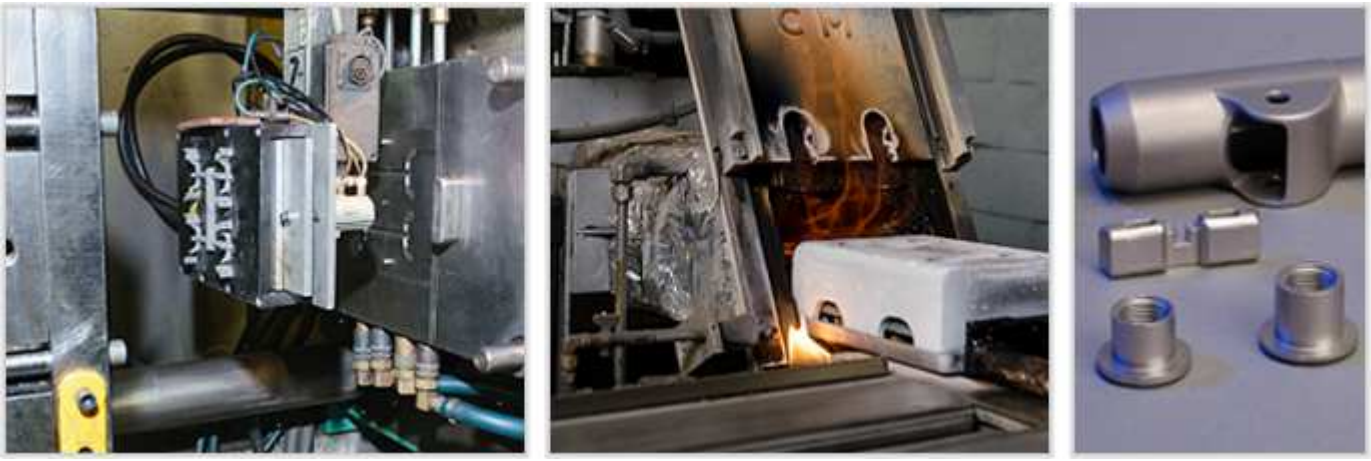


Image caption

(1) Molding phase © NetShape Technologies Inc (2) Sintering phase © NetShape Technologies Inc (3) Medical pieces made by powder Metal Injection Molding Manufacturing © NetShape Technologies Inc

The process

In POWDER INJECTION MOLDING and POWDER EXTRUSION, metal or ceramic powder is mixed with a thermoplastic binder (up to 50%) and injected under pressure into heated molds on standard injection molding machines. Most of the binder is removed from the molded components by thermal baking or solvent processing. The green parts are then sintered to near full density. The mechanical properties are generally better than those of traditional P/M parts and can approach those of wrought metal of the same composition.

Process schematic

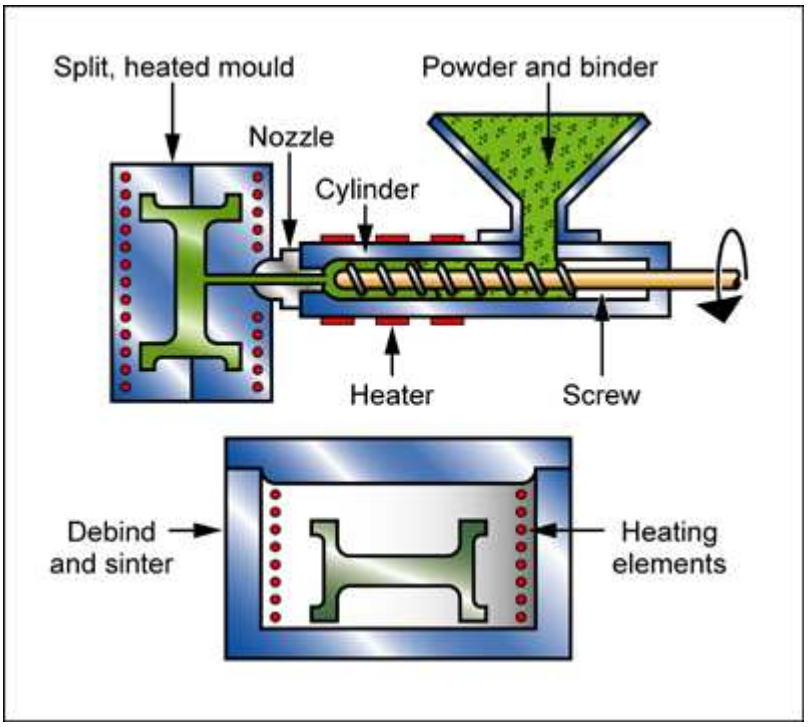


Figure caption

Powder injection molding.

Tradenames

MIM;

Material compatibility

Ceramics	✓
Metals - ferrous	✓
Metals - non-ferrous	✓

Shape

Circular prismatic	✓
Non-circular prismatic	✓
Solid 3-D	✓
Hollow 3-D	✓

Economic compatibility

Relative tooling cost	high			
Relative equipment cost	high			
Labor intensity	low			
Economic batch size (units)	1e5	-	1e7	

Physical and quality attributes

Mass range	0.0022	-	0.441	lb
Range of section thickness	19.7	-	984	mil
Tolerance	3.15	-	19.7	mil
Roughness	0.0315	-	0.126	mil
Surface roughness (A=v. smooth)	B			

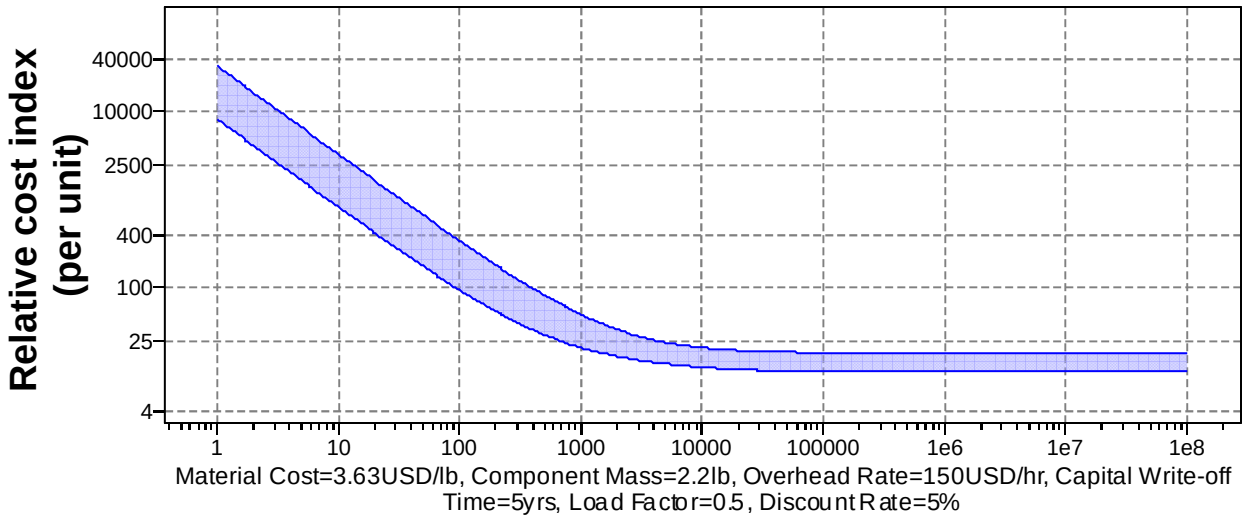
Process characteristics

Primary shaping processes	✓
Discrete	✓

Cost model and defaults

Relative cost index (per unit)	21.2	-	50.3	

Parameters: Material Cost = 3.63USD/lb, Component Mass = 2.2lb, Batch Size = 1e3, Overhead Rate = 150USD/hr, Discount Rate = 5%, Capital Write-off Time = 5yrs, Load Factor = 0.5



Capital cost	1.64e5	-	1.64e6	USD
Material utilization fraction	0.8	-	0.95	
Production rate (units)	40	-	360	/hr
Tooling cost	8.2e3	-	3.28e4	USD
Tool life (units)	3e3	-	3e5	

Supporting information

Design guidelines

Undercuts and projections at right angles to the pressing direction, as well as external and internal threads are possible using split cavity molds, but they add to the die cost. Internal undercuts or recesses are not recommended. Internal closed cavities are not possible

Technical notes

Materials that are commonly powder injection molded are: nickel alloys especially nickel steels, cemented carbides, stainless steels, high speed steels, tungsten, superalloys, intermetallics, cobalt alloys, fiber reinforced metals and ceramics. A uniform wall thickness is critical in order to avoid distortion during sintering. A draft angle of 2 deg recommended for long parts.

Typical uses

PIM generally finds high technology applications, mainly in aerospace, in manufacture of spark plug insulators, heat-engine components, medical and dental devices, office equipment, printed circuit substrates, metal working tools, camera parts, high temp ceramic turbines and firearm components.

The economics

Because of the high die costs PIM is only economic for large production runs. For these, the speed and the precision make it an attractive process route.

The environment

Fine powders can be pyrophoric and easily dispersed in air where they become a health hazard.

Links

MaterialUniverse

Reference