Metal Injection Molding vs. Machining and Casting

About Metal Injection Molding

Similar to plastic injection molding Metal Injection Molding, or MIM as it is commonly referred, which typically uses retrofitted injection molding machines to mold metals, and or metal alloy blends into complex parts, which typically have a hard to machine geometry. There are many advantages to the MIM process, including a decreased production time, repeatability, and decreased need for secondary operations.

MIM Benefits

In contrast to mechanical manufacturing, an added benefit to the MIM process is that it allows you the ability to manufacture components of additional complexity without additional cost(s). Therefore, highly integrated castings and assemblies are made possible when using the MIM process, which contributes to the reduction in the overall cost(s).

Another advantage to the MIM process is its repeatability and cycle time. High quality products can be made more efficiently, and lead-time is reduced as secondary operations are virtually eliminated. This reduction in manufacturing time allows manufacturers to meet the JIT, or "Just in Time" requirements of the customers in today's lean economic environment.

MIM Technology

MIM technology has met the increased demand for repeatable quality products capable of being manufactured at more efficient and effective rate. Custom resin compounders have also developed and refined this technology, and have the capability to meet the anticipated future demand for custom metal, or metal alloy blends.

MIM Questions and Answers

What makes a good candidate for MIM?

A good candidate for the MIM process is typically one that is a relatively small part with a complex, or hard to machine geometry.

Why choose MIM?

First, for some applications, it is a low cost alternative to traditional machining, casting, or lost wax manufacturing processes. Second, MIM produces net shape parts that require little, or no secondary machining requirements.

One potential marketplace for MIM, outside of automotive components, is the Jewelry industry. In the right application, MIM can decrease costly secondary overhead and increase production rates, and allow the manufacturer the versatility that they require.

What alloys are available for MIM?

Copper, Gold, Gold-Copper alloys, Silver, Silver-Copper alloys, and some Active Braze Alloys (ABA). As well as 17-4 PH SST, 316L SST, 304 L SST, and F-15 alloys.

What are some typical properties that can be expected from a MIM part?

Densities of MIM parts are typically 95 - 99+%, Size Range: .0005 lbs. to .22 lbs., Tolerances: ± .003"/in., Surface Finish: 45RMS, Minimum Draft Requirements: 1/4°, Normal Minimum Section Thickness .015" (Small Areas).

MIM Process Requirements

Five basic steps are required in the Metal Injection Molding (MIM) process: tooling, mixing, molding, stripping and sintering. Conventional secondary operations can be added if required.

Tooling

Tooling provides a mold cavity that compliments the finished part and is similar to that used in plastic injection molding including slides for three-dimensional features and multiple cavities for higher production quantities.

Mixing

Mixing at selected temperatures combines micron sized metal powders with a multiple component thermoplastic binder system that enables the powders to flow into the tool cavity. When the mixture is cooled to room temperature, it is granulated into small pea-sized particles, which are called feedstock for injection molding.

Molding

Molding occurs in conventional plastic injection molding machines using similar conditions of pressure, temperature, and speeds. Parts in the as-molded condition are more delicate than plastic parts because they typically contain about 40% binder by volume.

Stripping

Stripping or de-binding is the removal of some binder from the part to permit sintering, achieved in a controlled solvent system.

Sintering

Sintering is a process to heat the parts below the melt point of the powders in a controlled atmosphere in order to remove residual binder and cause the whole part to shrink uniformly to virtually full density. The original shape of the molded part is preserved during sintering and final part dimensional tolerances are closely held.

Secondary Operation Considerations

Many sintered parts do not require any secondary operations because they meet all requirements for features, dimensional tolerances, shape and surface finish.

Machining, Grinding, or Lapping

Machining, grinding or lapping may be desirable to produce tighter dimensional tolerances or to add certain features which are not economical or feasible in the tooling. Some examples are threads inside holes, reamed holes or ground surfaces to create tighter tolerances on outside diameters or flat areas. Lapping can produce extremely flat surfaces when the cost is justified.

Finishing

Finishing may be required to remove certain injection molding features such as gate marks, ejector pin marks, or parting lines. It may be possible to remove these features in the as-molded state. If that is not sufficient then more precision material removal may be required. Larger parts that can be hand held can often be finished using soft grinding wheels. A final surface finishing in vibratory vessels using various abrasive media can smooth the surfaces but can not remove projecting features such as parting lines or ejector pin marks which are only flattened.

Welding and Brazing

Welding and brazing can be conducted on the sintered metal parts as readily as on cast and wrought metal parts.

Plating

Plating can be applied to the sintered metal surfaces in essentially the same way as for cast and wrought surfaces. Some common plated surfaces are copper, nickel, chrome and gold.

Heat Treatment

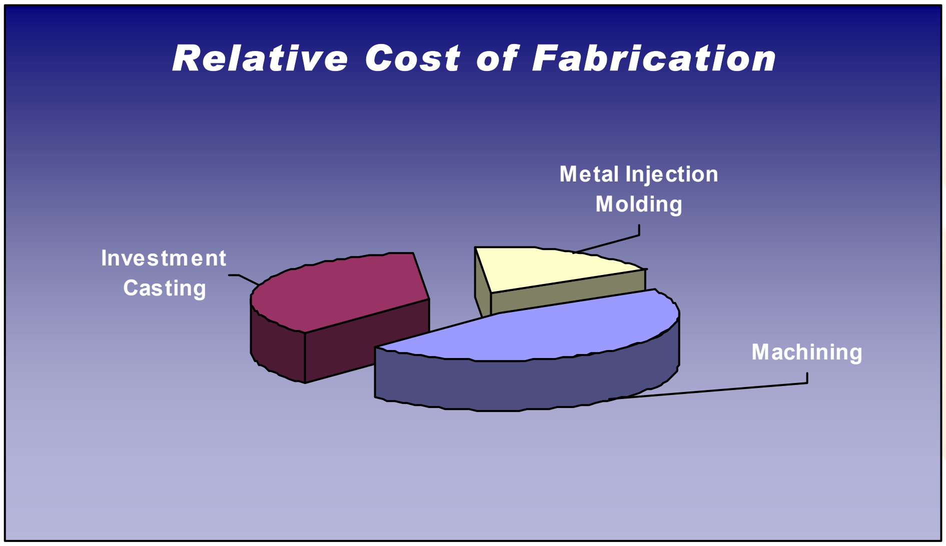
Heat treatment can be done to all conventionally heat treatable metals with essentially the same results.

MIM vs. Conventional Metal Forming Processes

The more complex the part, the better for the metal injection molding process. Compare the MIM advantage to other metal forming operations.

Process	Limitations	The MIM Advantage
Die Casting	Lower strength alloys	Numerous high strength materials
	Rough finishes	RMS 16-32
Investment Casting	Labor intensive process	Highly automated process
	Limited tolerance control	Repeatable tolerances of +/- .001"
	Costly process	Lower costs
	Requires secondary machining	No secondary operations needed
Machining	Complex shapes require numerous machining centers	Mold the part Net Shape
	Significant material waste	Virtually no material waste:
	Design limitations	Ideal for complex shapes
	Difficult to machine hard materials	Wide range of available materials
Powder Metal and Sintered	Low material densities	High densities 97%-99.7%
	Limited part complexity	Ideal for complex shapes
	Secondary machining operations often required	No secondary operations needed
	Impregnation required to weld or plate	Can be welded or plated

Cost Comparison



The more complex the part, the more cost effective metal injection molding (MIM) becomes. The cost savings can be substantial, often as high as 25-70%.