The Metal Injection Molding (MIM) Manufacturing Process

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ABSTRACT

The processes involved in MIM (metal injection molding) manufacturing.

While research was being conducted regarding fired cartridge cases from multiple firearms with similar firing pin impressions, information was obtained that the firing pins in question were manufactured using metal injection molding (MIM) technology. Of interest was whether the features observed in the firing pin impression were due to a mold characteristic or from the (MIM) manufacturing process itself.

The General Manager of Megamet Solid Metals, Inc. (MSM), Bruce G. Dionne, was contacted. MSM manufactures various firearm parts along with other parts using metal injection molding. Mr. Dionne, who is also the president of the MIMA (Metal Injector Mold Association), graciously gave the examiners from the St. Louis County Police Department Crime Laboratory a tour of the manufacturing facility.

Metal injection molding (MIM) is a multi-step manufacturing process that combines metal powders into a solid metal part through molding, debinding and sintering. The metal powders are mixed with a binder (plastic or paraffin wax) into a homogeneous mixture, similar to the consistency of toothpaste. Approximately 80% of the mixture is metal powder and 20% is the binder material. This mixture is injected into the cavity of a mold or multiple cavities in a multi-cavity mold through a "gate". The molds are similar to those used in the conventional plastic injection molding process. The mold is heated at relatively low temperatures. The molded "green" parts are significantly larger (about 20%) than the finished part.

The "green" parts are then thermally processed in two steps; debinding and sintering.

The debinding process removes most of the polymer or paraffin binder through evaporation in a debinding oven which has a nitric acid fume. Only a small portion of the binder is left in the part (just enough for the part to maintain its' shape). When the parts are removed from the debinding oven they are referred to as "brown" parts. The remaining binder will be removed in the next step, sintering.

Sintering is the process that solidifies "brown" parts into solid metal parts. The 'brown" parts are then heated to a temperature, near the melting point of the alloy, in a dry hydrogen atmosphere, which hardens the part evenly. The shape of the original molded part is retained throughout this process, however is approximately 20% smaller. The exact measurement of shrinkage can be achieved providing exact tolerances.

The sintered metal parts can be further processed in a fashion similar to any other metal. Typical finishing processes include heat treating, passivation, polishing, secondary machining, and coatings. The parts that have further machining processes would have microscopic features on them similar to any part manufactured by machining processes whether it was a MIM part or not.

The advantages of metal injection molding (MIM) allows for small complex shapes to be formed in a single operation which eliminates much of the machining process. There is a significant cost savings over traditional forming methods such as investment casting or production machining. The metal injection molding (MIM) part is just as hard as parts made utilizing other methods.

Reference

"Megamet Metal Injection Molding - (MIM)." Megamet Metal Injection Molding. Web. March 2012. <http://www.megamet.com/>.

Three selector switches from same multicavity mold

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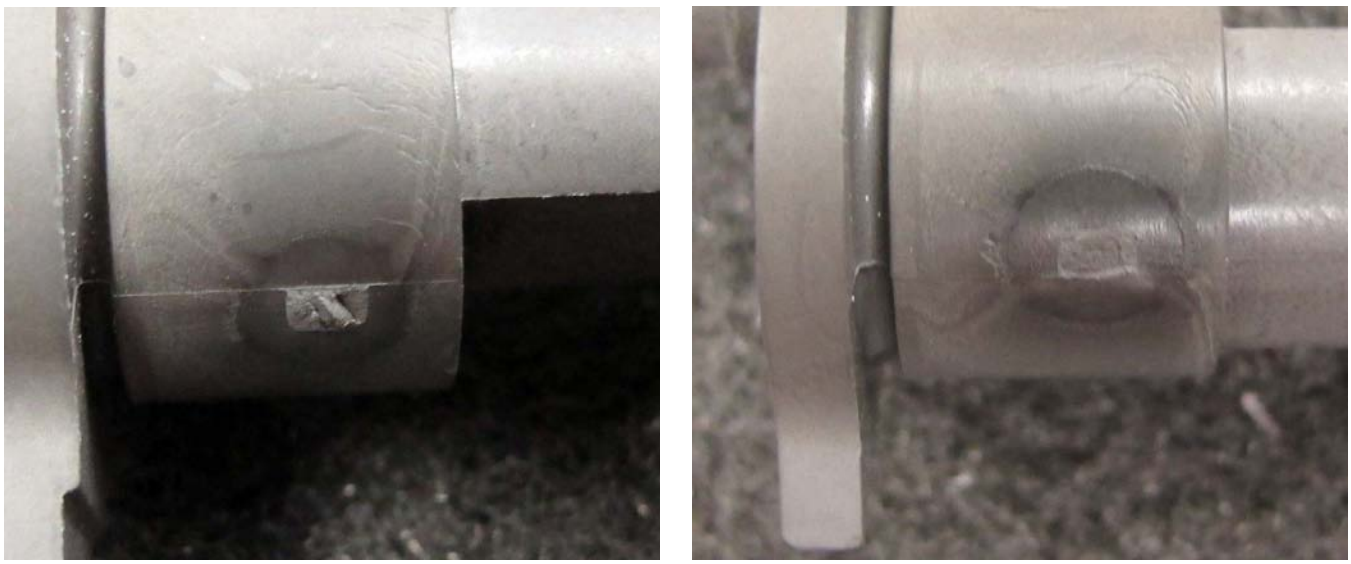
Mold marks from the multicavity mold



Note the "Gate" area of the mold where the material gets inserted into the cavity.