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# Metal Injection Moulding –Technological Trends and European Business Situation

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**Abstract**

*The global metal injection moulding industry is getting mature. The technology is on its way to grow from a niche technology to a widely accepted manufacturing process. This paper addresses the latest technological trends in MIM. Challenges in materials development as well as the current limits of the technology are discussed. Trends in processing like 2-component injection moulding and micro injection moulding are presented. The European MIM market situation is described and some key factors for business success are addressed. In the discussion of future business opportunities best practice examples are included.*

**Keywords: metal injection moulding, 2-component MIM, micro MIM, market situation**

## 1. Introduction

During the last 10 years, the MIM technology became a mature manufacturing process for complex shaped metallic components. MIM is winning more and more market shares from other production technologies like e. g. investment casting. The MIM manufacturing process is widely established in the industry. Technological developments are concentrating on simulation of mould filling, new materials and miniaturization.

## 2. Market situation in Europe

The European market for MIM parts is growing constantly with an estimated 10% growth rate per year. Key sectors being attracted by the potential of MIM are automotive manufacturers and medical companies. Automotive industry adopts MIM since it could show its potential for continuous production of high quality components. Although the character of the industry is still dominated by regional actors there is a clear need for international standards to further improve the credibility of MIM technology in the global supply chain. Ready-to-mould feedstock is earning a high market share in Europe. Other key factors for business success are making designers feel more comfortable with MIM and powder cost reduction.

## 3. Trends

The limits for an economical MIM production are shifting. The smallest parts have a weight of less than 0.001g and the heaviest parts are weighing more than 200g. A prerequisite for production of micro parts is the availability of fine powders with particle sizes of $d_{50}<3\mu m$. On the other hand, the powder producers pursue a cost reduction initiative to meet the requirements of heavy MIM parts. This means a trend towards coarser powders - 38 micron sieved.

To manufacture a metallic part with two different materials, e. g. magnetic / nonmagnetic, gives new design opportunities. The co-sintering of the different materials is the key stage in this manufacturing route.

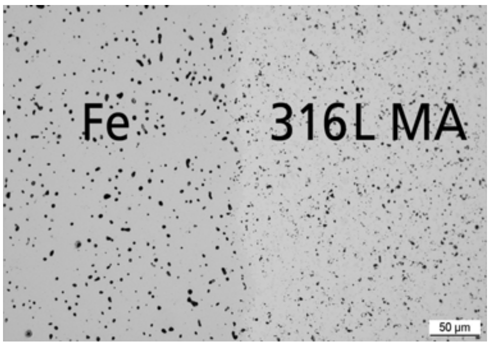


**Fig. 1. 2-component MIM**

With µ-MIM it is possible to produce structures with minimal sizes in the range of 10µm and aspect ratios (height to width) up to 16. Applications are in micro-reactors and microfluidic systems. Smallest isolated parts produced by µ-MIM are in the size range of 350µm to 900µm after sintering, Fig. 2.

Simulation of mould filling is a strong tool for further improvement of part quality and the acceptance of MIM as a mainstream production technology. The 3D-SIGMA simulation software is based on a FEM control volume method. The quality of simulation is strongly related to the physical characterization of the feedstock. Fig. 3 shows the temperature distribution after mould filling of a micro part.

**Fig. 2. Stainless steel μ-MIM parts (Scholz GmbH)**

**Fig. 3. 3D-simulation of temperature distribution after mould filling**

Another trend is the use of a wider range of materials. Ti alloys, W/Cu, superalloys and also noble metals are gaining more and more importance for high value MIM components.

## 4. Best practice example

MIM parts made from titanium and Ti - alloys are of great interest for numerous medical applications and consumer goods. A novel heart valve prosthesis as a medical long-term implant has been commercially manufactured from a Ti-alloy by means of MIM, Fig. 4. Complex shape, thin walls, tight tolerances as well as good mechanical and chemical properties are the characteristics of this MIM-component.

**Fig. 4. Artificial heart valve ring (Tricumed GmbH)**

## 5. Summary

MIM in Europe graduated from a niche technology to mainstream large volume applications like e. g. automotive parts. The structure of MIM companies in Europe is mainly governed by regional niche production but also some global actors handling massive orders. Handbook properties can be expected for standardized MIM materials. On the other hand there is a tendency to find customized solutions with a wide range of new MIM materials. The limits for MIM parts are being shifted towards miniaturization and also towards parts with a weight of more than 200g. The integration of functions by applying two-component MIM technology is an ongoing development.

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