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## The evolution of MIM at Matrix: From transforming the production of eyewear components to luxury goods and beyond

There are a number of applications where Metal Injection Moulding turned out to be the 'perfect fit'. Whilst some well-known successes are the high-volume, high-precision parts needed for smartphones, dental braces and surgical instruments, a less well-known area of success for MIM is in the eyewear sector. Here, the combination of small, complex components, high-volume production and high strength requirements has seen the technology flourish. As the following article reveals, Italy's Matrix s.r.l. has been a driving force behind this success and is now applying its expertise to an ever-growing range of industries.

The eyewear district of Belluno, in the Veneto region of northern Italy, is home to many of the leading firms in the international eyewear industry. The area accounts for 80% of Italian eyewear production, a staggering 70% of global eyewear production for the luxury sector, and 50% of licensed global production for the major fashion brands. Together, this generates revenues of €1.5 billion. It should, therefore, come as no surprise that the story of Matrix s.r.l., Italy's leading manufacturer of eyewear components by Metal Injection Moulding begins here, in the small town of Rasai in the municipality of Seren del Grappa.

The idea to establish a MIM operation at Matrix was conceived in 2002 following the merger of three small lost wax micro investment casting companies, each specialising in the production of miniature precision components for the eyewear sector. In 2003, the company's new MIM operation was established – one of the first in Italy. To many, MIM was still a relatively new technology and

for the company it looked like a leap in the dark. Nonetheless, MIM also showed great potential, as it enabled the production of more cost-efficient components, minimising waste, and opening up a wider range of markets.

"MIM represented a revolution," stated Alessandro Zatta, General Manager at Matrix, "especially for the transition from commonly used materials like copper, zinc, nickel and Monel [Cu-Zn-Ni alloys] to stainless steels." Today, 90% of



Fig. 1 Industrial-scale sintering furnaces for metal injection moulded part production at Matrix s.r.l.



Fig. 2 MIM eyewear bridge sections after debinding, sintering and finishing at Matrix s.r.l.

MIM production at Matrix is divided between the two main MIM stainless steels: 316L and 17-4 PH. The company uses feedstock manufactured externally; since 2016 it has been one of the largest buyers of MIM feedstock in Italy.

"The move into MIM wasn't an easy sell", stated Zatta. "It took a lot of convincing to venture into a market where other companies had already failed, prematurely betting on MIM in its earliest stages. Matrix seized the moment just as the technology was ripe to thrive in the precision

miniature components market, following the intuition of a few in the company's management who believed it was as a better alternative to the manufacturing technologies out there."

### Meeting the needs of the eyewear sector

Apart from timing, the company's geographic location was also an important supporting factor, as its management team was already

known in the eyewear industry and could benefit from an established network of clients. However, Zatta stated, "Having the technology and a favourable position would have been meaningless without our understanding and expertise in the manufacturing processes for eyewear and an almost obsessive attention to the product and to the service provided." Once the benefits of the technology became apparent, demand came quickly from the eyewear industry, which soon recognised the superiority of MIM over conventional manufacturing processes for the types of components that the eyewear industry required.

The most noticeable advantage of MIM is undoubtedly its cost-effectiveness in relation to the complexity of the design. The process requires far less material than conventional precision metalworking processes and has fewer process steps than required by other routes where, for example, blanking, turning, milling, CNC machining and pressing may be needed at various stages. "With MIM it becomes possible to manufacture components of high geometrical complexity in a simplified production process, with the positive effect of drastically increasing overall production capacity. Large quantities of small precision components can be produced, saving time, material and, as a result, cost," stated Zatta. MIM eyewear applications include bridges, shown in Fig. 2, and arm components, shown in Fig. 3 in the green state following automated removal from a mould, and in Fig. 4 on ceramic plates after sintering.

Zatta believes that this combination of fortuitous timing for the adoption of the technology, an advantageous geographical position and high-quality customer support during product development and manufacturing were the key factors that won over clients and pushed Matrix to its strong position in the precision components market.

"What we are most proud of is the way the company deals with clients and the services offered. Our experienced technicians and engineers

sit together to interpret their needs and intentions; a crucial part of the service is a high level of flexibility when it comes to joint product development and the move towards production."

This is achieved in part through three distinct services: rapid product development and prototyping, thorough testing, and a close attention to the specific finishing requirements of the eyewear sector. For the rapid prototyping of precision parts, the company uses lost wax casting technology. A 3D Systems ProJet MJP 2500W machine, designed for the jewellery industry, is used to make the required precision patterns and through this route metal sample parts can be available in as little as 72 hours. Whilst the samples do not have the same mechanical properties as sintered components, and the materials are generally limited to brass and bronze, the company believes that they are an effective way to evaluate form and function of components used in the eyewear industry.

Application development is supported by Matrix's R&D laboratory, whose facilities include hardness and density testing and metallographic analysis as well as a focus on finishing operations. Here the specifications for finishing parts with certain aesthetic requirements, via manual or mechanical processes, are established. Post-processing options include lapping, tumbling, manual polishing, sanding, and welding – including laser welding.

The significant reduction in waste that MIM offers when compared with conventional production methods represents a significant step forward towards an ethical and environmentally friendly approach to production. Zatta stated, "MIM is proven to be highly effective and convenient when it comes to the processing of expensive materials and special alloys such as copper, gold, silver, cobalt-chrome, titanium alloys and tungsten carbides. Part of this is the minimisation of waste, which makes of MIM and CIM truly green technologies."



Fig. 3 MIM eyewear 'side arm' components as moulded and with the sprue still attached. The parts are removed from the mould by a robotic arm and, prior to debinding and sintering, the sprues are removed and re-ground for re-use



Fig. 4 The parts shown in Fig. 3 after debinding and sintering

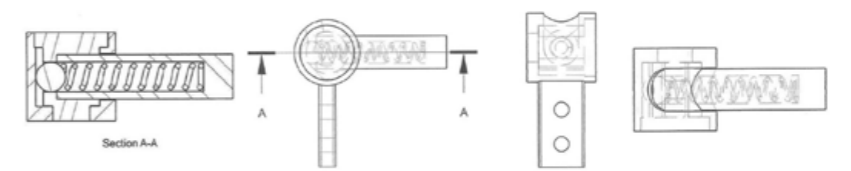


Fig. 5 Matrix s.r.l.'s Easyflex patented screwless hinge was developed in-house and maximises the benefits and capabilities of the MIM process whilst also offering a new degree of customisation to eyewear designers

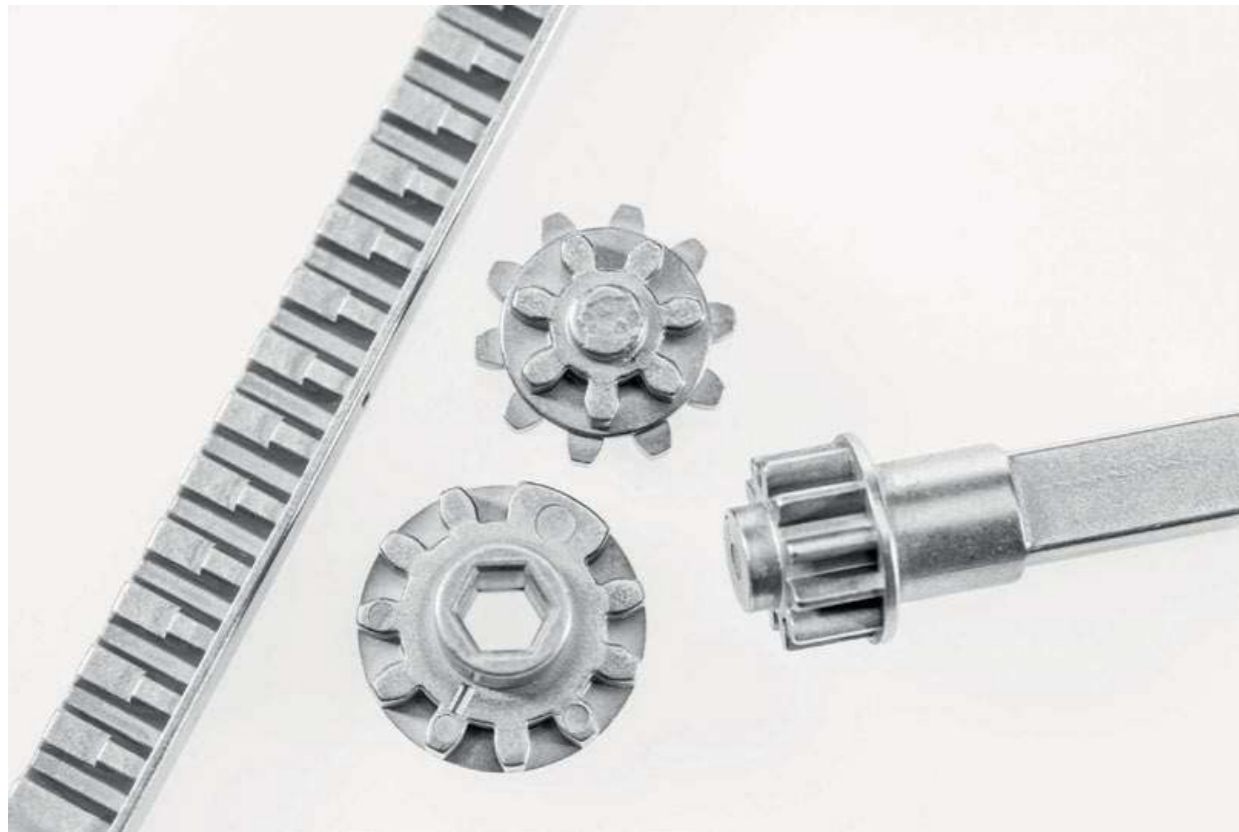


Fig. 6 Component used in automation devices for domestic doors and windows. The largest gear has a diameter of 20 mm and the parts are produced from MIM 17-4 PH stainless steel

Matrix also develops technology for sale to the eyewear sector, with its Easyflex screwless hinge being one example (Fig. 5). This patented hinge design maximises the benefits and capabilities of the MIM process

customer. In the example shown, the hinge is adapted to plastic glasses. However, thanks to the flexibility of the operating principle, nothing prevents it from being used on any other front for glasses. In fact, being

**“Matrix also develops technology for sale to the eyewear sector, with its Easyflex screwless hinge being one example. This patented hinge design maximises the benefits and capabilities of the MIM process...”**

whilst offering a new degree of customisation to eyewear designers. “Easyflex can be defined as an ‘elastic’ hinge. It has no screws, it can be made of steel, bronze, ceramic or many other materials, but above all it can be customised by the

able to adjust the size of the Easyflex hinge’s cylinder means that it can be easily adapted to the customer’s specific needs, thus being able to be used to create countless new models of glasses, with more types of materials,” explained Zatta.

### The power of ‘Made in Italy’ and market diversification

At the turn of the millennium, suppliers to the eyewear industry in Belluno faced an uncertain future. Many eyewear manufacturers decided to relocate to China to reduce manufacturing costs and, as a consequence, orders placed with local third-party suppliers suffered a dramatic decrease. Despite the challenges of the years that followed, the company was able to reorganise itself and to survive the eyewear industry’s relocation through a process of diversification.

Recent years, however, have seen a reshoring of a number of brands and product lines. “Many important brands now recognise that to be able to state that their products are completely ‘Made in Italy’ carries certain associations such as quality and design flair, and, as such, is a great marketing tool,” explained Zatta.

Even though the eyewear sector remains to this day the company’s biggest market, accounting for 60–70% of all part production, Matrix has been able to explore and develop other markets, including fashion, medical devices, food production and electronics. “Today MIM and CIM technologies have applications that span sectors from eyewear to biomedical and automotive, from the fashion luxury market to aerospace, expanding the production of components to virtually every industry sector. We expect that MIM and CIM will be ever more and more present in an increasingly wide range of markets.”

Matrix reports particular interest from the fashion and luxury market. “The fashion industry constantly demands sophisticated metal accessories to be featured on clothing, handbags, purses, shoes and more. MIM is perfect for manufacturing highly-precise renderings of, among others, logos, buckles, zips, components for shoulder straps, and parts for high-end shoe heels. We are already collaborating with the biggest brands of the fashion market and predict an expansion in the volume of such products where MIM can find application.”

“The end-product has to be flawless and of great visual impact. No matter the complexity of the design, step-by-step monitoring alongside an attentive, detailed care for finishes result in parts of exemplary aesthetic quality. The precision in the smallest details, the impeccable finish and the constant quality of the products, obtained with expertise acquired over the years of continuous development, contribute to increasing the perceived value of the final item and improving the emotional experience of the purchase.”

Another promising sector is that of medical devices. Matrix believes that MIM will continue to have a fundamental impact on the medical sector and declares itself ready for new challenges in this area. “Dealing with hospitals and medical companies usually means a high degree of bureaucracy is involved in



Fig. 7 A jewellery carabiner manufactured from 316L stainless steel



Fig. 8 A case for a diving watch. The original was made of bronze, but the change was made to MIM 316L for improved salt water corrosion resistance



Fig. 9 Fashion bracelet components made by MIM



Fig. 10 A dentistry device made from 316L stainless steel. The application is 130 mm in length and 30 mm wide

the process. To be able to fulfil their requests demands a high degree of flexibility and a capability to adjust to the demands of the client, a skill that Matrix's employees have honed throughout years of practising the technology and tending of relationships with clients," added Zatta.

"Relying on ongoing research and careful material selection, we are able to supply MIM and CIM solutions to the highest quality standards while allowing room for the creativity of the client. Combining this with expertise in the finishing processes associated with conventional production methods, overall production speed is increased, and delivery times optimised," he explained.

### The opportunities for CIM in the luxury sector

Ceramic Injection Moulding finds application in a diverse range of markets, from dentistry to industrial manufacturing to luxury watches.

Matrix reports increasing interest in the process for certain types of jewellery and fashion accessories. "In the fashion market, ceramic is now often preferred to metal. While metal decorative parts may well receive some form of surface finishing to create a desired colour, there is a trend towards the purity and simplicity of naturally coloured ceramics. Whilst many companies still use pigments for colouring ceramics, many like to leave their designs with a 'natural' polished appearance," stated Zatta.

### New ownership brings further opportunities

In 2017, Matrix became part of a larger family of businesses when Ookii, a leading Italian company in the micromechanics sector, founded by Michele De Biasi, acquired a majority stake. Earlier in the same year Visottica

Comotec, a global leader in metal components for the optical sector, acquired a 50% share in Ookii.

For over thirty years, Ookii specialised in cold forging technologies applied to materials such as titanium, steel, aluminium and nickel silver, as well as milling from bar stock, turning, the die casting of zamak, aluminium and magnesium, and the injection moulding of plastics.

Visottica Comotec has been a worldwide leader in metal components for the optical sector since 1947. Established in Conegliano in the 1980s, it has since expanded its operation in the Far East. Today the company has two plants, one in Italy and one in China, with a thousand employees, a production of over one billion components a year, forty international patents and over a thousand customers in fifty countries.

Together, the businesses now benefit from a workforce with a far more diverse range of expertise in the production of precision metal

components. For Visottica Comotec, the benefit of in-house MIM expertise is regarded as a major advantage, while Matrix and Ookii are benefitting from the opportunity to reach a wider market.

"The partnership recognises the seemingly limitless application potential for MIM and CIM technology and it is ready to undertake future challenges. We recently developed and produced components for industrial and commercial oxygenation and ventilation systems [Fig. 11] and are now ready to supply these types of metal components for respirators and ventilation systems in the fight against COVID-19. We are open to new requests and opportunities in this area and are making our skills and knowledge available to contribute to the fight against the pandemic. So far we have only produced plastic components for masks, but we remain eager to do more in the area of hospital equipment and machinery," stated Zatta.



Fig. 11 MIM ventilator components produced by Matrix. The part diameters are 10, 15 and 20 mm

### Conclusion

"It is clear to me that MIM and CIM technologies are going to take an increasingly substantial slice of the precision components market. The opportunities are certainly there," says Zatta. "The challenge is to acquire the means to enter in as many sectors as possible while maintaining the highest standard of product and service quality. It is fundamental to keep in mind that production capacity, expertise, cost-effectiveness and responsiveness of the service are at the core of the business. Further steps will then need to be taken to keep our curiosity alive, so as to keep learning and acquiring skills and capabilities. MIM manufacturers have to remain up-to-date to be able to identify

each sector's specific requirements and meet them. A challenge that is massive in scope, but ever more reachable for us now that Matrix is not alone."

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