

# ENGEL **Liquidmetal**<sup>®</sup>

Efficient injection moulding of metal alloys



## Unique component properties with Liquidmetal®



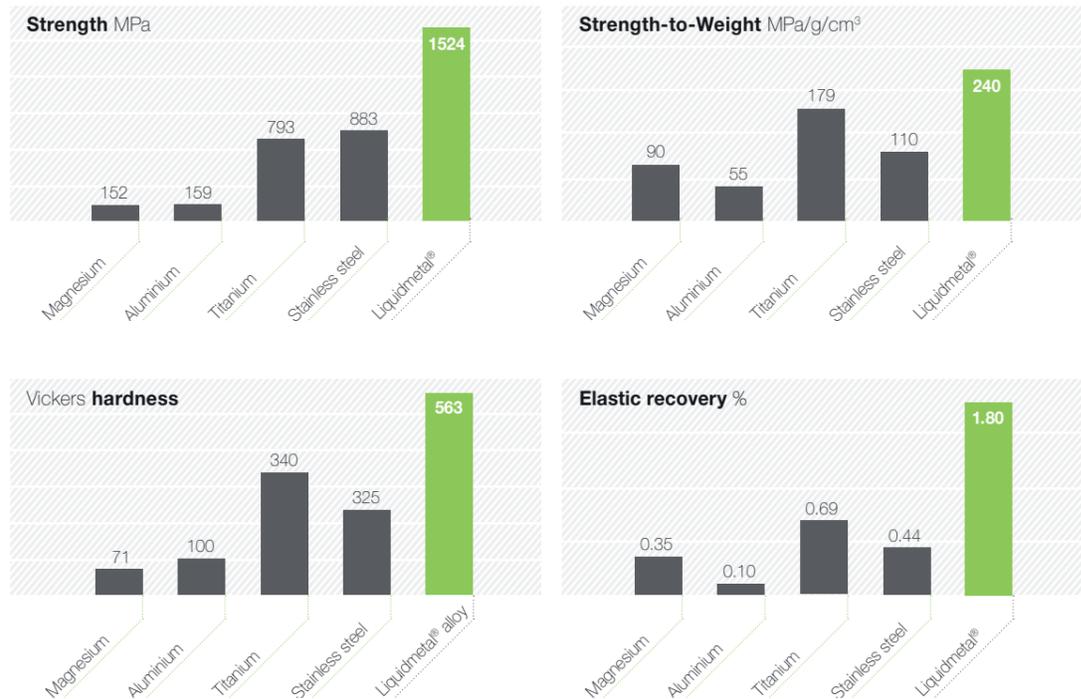
In cooperation with Liquidmetal Technologies, ENGEL is opening up the door to totally new material classes and product properties: the use of novel amorphous zirconium alloys, with the injection moulding process, now makes it possible to manufacture extremely high-quality metal components.

### Elastic, virtually indestructible & extremely corrosion-resistant



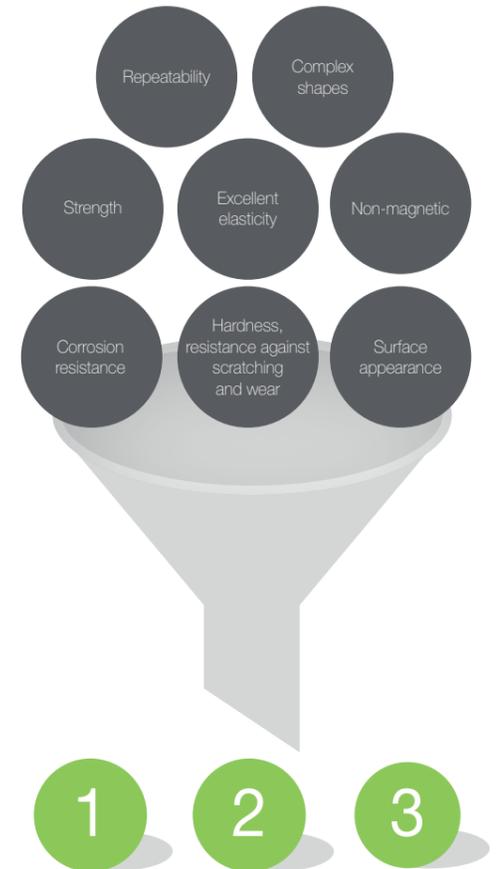
The non-crystal structure of the Liquidmetal® alloys provides extremely hard, but also highly-elastic parts with excellent elastic recovery. Whether for air transport and space travel, military or medicinal uses, or the sports equipment sector: the alloys' low specific weight, corrosion resistance and anti-magnetic quality make it possible for products to be developed with a completely new quality profile. Plus, the parts can be injection moulded with high economic efficiency and an outstanding surface quality.

### Liquidmetal® in comparison with other metals



## Ready for the revolution in metal processing?

If three of these requirements apply your application is suitable for Liquidmetal®:



### Liquidmetal® impresses thanks to:

- absolute process repeatability and manufacturing precision even for mass production
- excellent resistance to corrosion and external influences
- brilliant surfaces without rework
- excellent elasticity
- light weight and constant part weight
- complex injection-mouldable shapes

Comparison of technologies	Liquidmetal®	Die casting	MIM	Precision casting	Machining
Low costs despite highly complex parts					
Perfect surfaces without rework					
High degree of elasticity					
Production in a single step					
No heat treatment required for tempering					
No heat treatment required to reinforce the material					
Minimizes rejects					
Deviations in % of the required measurement tolerances	+/- 0.075	+/- 0.4	+/- 0.3	+/- 0.5	+/- 0.075

### Is your application suitable for Liquidmetal®?

- Part weight:** max. 80 g
- Maximum size:** 100 mm
- Maximum exterior draft angle:** 0.5° to 3°
- Maximum interior draft angle:** 1° to 5°
- Wall thickness:** 0.6 mm to 4.0 mm
- Size tolerances:** +/- 0.025 mm

## ENGEL e-motion 110 Liquidmetal® Edition

### The innovative machine solution for injection moulding of high-quality metal components

As an exclusive machine manufacturing partner to Liquidmetal® Technologies Inc., Rancho Santa Margarita CA, USA, we have developed an innovative solution for this sensitive process: the new, all-electric ENGEL e-motion 110 Liquidmetal® injection moulding machine. An integrated ENGEL viper linear robot is used to insert the blanks and to remove the moulded parts.



- Modified injection unit
- Melting chamber
- Integrated vacuum system
- Induction heating
- Integrated automation

### The efficient, fully-automated production process

The Liquidmetal® ingots, in the form of pre-cut rods, are fed into a melting chamber by the ENGEL viper linear robot. Here the material is melted inductively under high vacuum conditions. Instead of a screw, the machine has a piston, with which the molten metal alloy is injected into a temperature-controlled mould. Rapid cooling under vacuum conditions leads to the forming of the amorphous structure that is responsible for the outstanding properties.

## Technical moulding applications

- Precision within the specified tolerances
- Resilient to difficult ambient conditions
- Cost efficiency and premium quality

No matter whether in aerospace applications, for sports equipment, or many other technical parts, Liquidmetal is suitable for a large number of applications of that previously required compromises due to the material or production process.

### Aerospace: lowest tolerances for optimal flight characteristics

As flight characteristics are mainly determined by weight, surface quality and shape, the parts need to be produced with absolute precision and within the strictest tolerances despite the large numbers of parts. Liquidmetal® and the injection moulding process offer major benefits here.

### Sports industry: difficult ambient conditions and exacting design requirements

Various parts in the sports and leisure industry, such as valves, handles, caps and closures or levers, are frequently exposed to the toughest ambient conditions through their lifecycle (for example, salt water, extreme temperatures or sand and dirt). Despite this, customers have exacting design requirements and expect maximum functionality with the lightest possible weight. Although some of the problems can be solved by materials such as titanium or carbon, only Liquidmetal® can meet all of these requirements without compromise thanks to its excellent characteristics.



Resilient even when faced with tough ambient conditions: technical parts made of Liquidmetal®



Absolute precision and repeatability even in mass production

## Automotive applications

Premium surface appearance without rework  
Ideal for cyclical loads and the toughest ambient conditions  
Very little scrape, even with the tightest production tolerances

### Decorative elements with a metal look

Liquidmetal® is perfectly suited for producing elements such as handles, instrument trims or logos, with a premium appearance and tactile experience, using the injection moulding method. Thanks to their excellent hardness, these parts do not scratch or wear, even when exposed to intensive load.

### Absolute precision in production and measurement: pressure sensors

Pressure sensors in the automotive industry are manufactured under strict requirements for process repeatability and precision. Injection moulding with Liquidmetal® easily meets them. Because the material is extremely flexible, the sensors do not deform, even under tough, cyclically recurring conditions. And if the flexibility limit is exceeded, the part breaks, thus avoiding incorrect measurements by non-functional sensors. Reductions in the number of individual parts, and the light weight of Liquidmetal®, drive a reduction of the sensor weight.



Precise measurements under any circumstances



Brilliant surfaces without rework

## Medical applications

Absolute flexibility in the design of medical instruments  
Cost reduction in the production of complex parts  
Verified corrosion resistance and bio-compatibility

Various series of tests, as per ISO 10993, demonstrated that parts injection moulded on the ENGEL e-motion 110 Liquidmetal® edition

- do not cause irritation
- are not systemically toxic
- are haemocompatible
- are not cytotoxic

and can thus be classified as bio-compatible.

Traditional materials and production methods often posed the issue of whether a part can be produced with an efficient design and good repeatability, while still at an attractive price. Liquidmetal® can now close these gaps. Injection moulding enables functional shapes that could not be implemented economically using legacy methods – and thus offers absolute design flexibility. Costs are reduced by the single step production process, the virtual lack of scrap, and the fact that no rework is needed.

### The challenge of minimally-invasive treatment methods

Minimally-invasive surgery requires instruments that are durable, but still flexible enough to adapt to the anatomy. Thanks to its unique combination of strength and flexibility, Liquidmetal® is the perfect material for this, and prolongs the life of the instruments. The injection moulding process drives continual reductions in the size of instruments that are gentle on the patient, thus supporting new methods of treatment.



Break-proof and still flexible: instruments made of Liquidmetal®

Liquidmetal® Partner



**Your Liquidmetal® License**

To purchase a license for Liquidmetal® processing,  
please contact Liquidmetal Technologies [www.liquidmetal.com](http://www.liquidmetal.com)

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