Use of the zinc die-cast series material Zamak in additive manufacturing

Series production with the highest quality standards

(A technical article from 2022, author: Max Wissing, Technology Manager, Protiq GmbH, Blomberg)

By processing the series material Zamak, which is used in zinc die casting, the manufacturing service provider Protiq is creating new possibilities in 3D printing. Thanks to further developed processes, additive manufacturing, which was previously often limited to the production of prototypes, is also becoming attractive for series production.

Series production of zinc components using 3D printing: As the first service provider for the additive manufacturing of Zamak 5, Protiq's offering not only addresses the prototype business.

The manufacturing process of zinc die casting for the production of metal components is widely used in industry. The zinc alloy Zamak has established itself as one of the standard materials. The components made from Zamak are used in all areas of daily life as well as in industrial environments. Typical applications include interior elements in cars, metal housings for electronic connectors, fittings in the window and furniture industry and bathroom fittings.

In zinc die casting, the molten material is pressed at high pressure into a specially made steel mold. This master mold - the tool - determines the geometry of the component and also represents the greatest financial outlay in production. The zinc die casting process therefore aims to produce the largest possible quantities in order to be able to pass on the high tool costs to the many items produced. If smaller batch sizes are required - for example for special items or prototypes - the high initial costs of the tool quickly make the process very expensive. This is where Protiq's additive processing of Zamak comes to the rescue. A few years ago, the Blomberg-based service provider became the only supplier in the world to successfully process the zinc material with process reliability on additive production systems. The use of the same zinc alloy as in established zinc die casting makes Protiq's 3D-printed components an ideal addition to existing manufacturing processes.

Further development of the laser melting process

The Blomberg production process is based on the well-known selective laser melting process, but has been further developed and modified for processing the zinc material. What both processes have in common is that the components are built up layer by layer from fine metal powder. The powder, which in this case consists of the Zamak alloy, is precisely melted by a powerful laser beam and welded into the desired body. The shape of the component is defined exclusively from the digital 3D CAD data, meaning that no expensive molding tools are required. Thanks to tool-free production, which eliminates the high initial costs of traditional zinc die casting, additive manufacturing proves to be cost-effective even for individual parts and small quantities.

This predestines 3D printing in general for the flexible production of individual prototypes, which is why the process is already widely used in this area of application.

However, this does not mean that the process designed by Protiq is only suitable for small quantities. Since its market launch in 2018, the process has been continuously developed and improved so that the service provider can now also offer direct series production. The possible quantities here are several thousand components per year; for smaller items, even five-digit annual quantities are possible. In this way, Protiq is addressing a critical niche that was previously covered by zinc die casting, but where conventional production is not profitable due to the small quantities involved. A typical example of this so-called low runner is a small special series that is produced alongside the profitable large series of the same product family.

Protiq offers the series production of zinc components where classic zinc die casting is not yet economical. In addition, the advantages of both processes can be optimally exploited through an innovative combination.

Combining the advantages of immediate, fast production with the new freedom of geometry offered by 3D printing creates the opportunity to mass-produce customized components - keyword: complexity for free. In additive manufacturing, for example, inscriptions or an integrated customer logo can be freely defined and implemented directly in the produced component.

Savings in investment and storage costs as well as logistics costs

In addition, the additive use of the series material Zamak 5 allows the transition from one manufacturing process to another in the product lifecycle. In this way, the advantages of both worlds are optimally exploited. Tool-free production enables the cost-effective production of a pre-series, which can be used to test the acceptance of new products on the market before the high investment in an expensive zinc die-casting tool is made. If the product proves successful and demand increases, the user can then switch to a die-cast component.

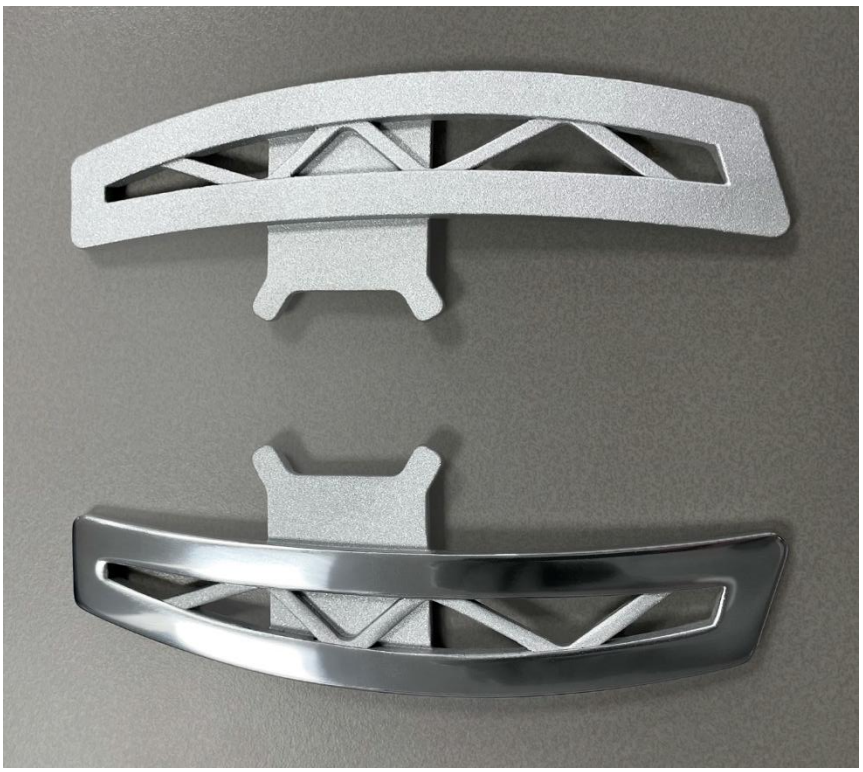
Bathroom fittings or fittings for furniture and windows are often manufactured using zinc die casting. The additional design freedom of additive manufacturing means that new, highly complex designs can be implemented that were previously impossible to produce.

A similar potential arises from rarely required spare parts for which there are long-term supplier obligations. Here, zinc die-cast tools generate high storage costs. At the latest when they are worn out and need to be extensively overhauled, it is worth producing the spare parts using 3D printing - in line with the print on demand motto. In this way, storage costs can be saved and logistics costs reduced to a minimum. Such business models have already become established in the paper printing sector: The customer orders their book and automatically triggers the printing process. Their copy is then sent to them hot off the press in the next few days. The new additive manufacturing technology for zinc components is now also opening up this business area for the production of industrial components.

Protiq delivers additively manufactured functional prototypes within a few days. The use of the series material Zamak 5 enables rapid product testing and offers optimum comparability with the subsequent series article produced by zinc die casting.

Finishing of the printed components

It goes without saying that the usual quality of conventional processes must be maintained in the additive production of die-cast components. Against this background, the use of the same series material as in zinc die casting is crucial. The additively processed material Zamak 5 has a tensile strength of 218±40 MPa, an elongation at break of 2±0.5 percent and a modulus of elasticity of 70±10 GPa. The accuracy of the 3D printing process is ±0.1 mm with a minimum wall thickness or detailed image of 0.4 mm. The component density is more than 95 percent.



Additively manufactured gearshift paddles in cars: As is usual with Zamak, the material can be ground and polished very well - automatically or by hand.

At this point, it becomes clear that the usual accuracy of zinc die casting of up to ±0.02 mm cannot be achieved by the purely additive manufacturing process. The same applies when comparing the surface quality. While die-cast components are usually very smooth due to the molded inner wall of the tool, the surface of parts produced additively using the SLM process is matt and slightly rough. The additive series production of zinc components at Protiq is therefore a chain of processes in which the actual 3D printing is only one of several links. The downstream processing steps of the components can involve, for example, the re-cutting of functional surfaces with tight tolerances or the insertion of threads using automated CNC milling. The additively manufactured components can also be easily ground, polished and electroplated. In this way, the surface quality can be matched to that of the die-cast or an elegant high-gloss look can be created.

Protiq therefore offers the best prerequisites for mapping series production under the highest quality standards. Certification in accordance with DIN ISO 9001 and as an additive manufacturer in accordance with the PPP 11001:2018 standards by TÜV Süd ensures high quality standards.

Further information:

www.protiq.com

Processing of previously unusable materials

Thanks to its many years of experience in the field of additive manufacturing, Protiq has succeeded in building up an in-depth understanding of the process. Since its beginnings in 3D printing in 2010, the service provider has focused not only on standard materials but also on materials that could not previously be processed additively. To this end, two additive production systems developed in-house have been set up, among other things, which make it possible to process some new materials, such as Zamak 5.

With this in mind, Protiq is also playing a pioneering role in the processing of highly electrically conductive copper. This material was long considered unsuitable for 3D printing, but offers great potential in many industrial applications thanks to its good thermal and electrical conductivity. Following the introduction of its RS copper - an alloy with a copper content of 99 percent - Protiq is now making full use of these possibilities, as it has also developed a process for processing pure copper. In this context, the service provider completely dispenses with alloying elements and thus ensures an electrical conductivity of 58 MS/m: 100 percent IACS (International Annealed Copper Standard).