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USING THE ZINC DIE-CASTING SERIES MATERIAL ZAMAK IN ADDITIVE MANUFACTURING

Series production
to the highest quality standards

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

By processing Zamak, the series material 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 has often been limited to producing prototypes, is now becoming attractive for series production as well.

Series production of zinc components by 3D printing: As the first service provider for the additive manufacturing of Zamak 5, Protiq targets more than just the prototyping business with its offering.

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

In zinc die casting, the molten material is forced at high pressure into a specially made steel mold. This master mold – the tool – defines the geometry of the component and at the same time represents the largest financial outlay in production. The zinc die-casting process is therefore geared towards producing the largest possible quantities so that the high tooling costs can be spread across as many manufactured parts as possible. If smaller batch sizes are required – for special items or prototypes, for example –, the high initial cost of the tool quickly makes the process very expensive. This is where Protiq provides a solution with the additive processing of Zamak. As the first provider worldwide, the Blomberg-based service provider succeeded a few years ago in processing the zinc material reliably on additive production systems. Using the same zinc alloy as in established zinc die casting makes Protiq's 3D-printed components an ideal complement to existing manufacturing processes.

Further development of the laser melting process

Protiq offers series production of zinc components in quantities for which conventional zinc die casting is not yet economical. In addition, an innovative combination makes it possible to exploit the advantages of both processes to the full.

The Blomberg company's manufacturing 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 fused into the desired body.

The shape of the component is defined solely by the digital 3D CAD data, so no expensive molds are required. Thanks to tool-free production, which eliminates the high initial costs of conventional zinc die casting, additive manufacturing proves economical even for single parts and small quantities. This generally makes 3D printing ideal for the flexible production of individual prototypes, which is why the process is already widespread in this field 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. Possible quantities amount to several thousand components per year; for smaller items, even five-digit annual volumes are possible. In this way, Protiq addresses a critical niche that has so far been covered by zinc die casting, but in which conventional production does not pay off due to the low quantities. A typical example of these so-called low runners is a small special series that is produced alongside the profitable large series of the same product family.

Combining the advantages of immediate, fast production with the new geometric freedom of 3D printing creates the opportunity to manufacture customized components in series – keyword: complexity for free. In additive manufacturing, for example, lettering 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 effort

In addition, the additive use of the series material Zamak 5 allows a transition from one manufacturing process to the other within the product life cycle. This makes the most of the advantages of both worlds. Tool-free production enables the cost-effective manufacture of a pilot series that can be used to test market acceptance of new products 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.

Similar potential arises from rarely needed spare parts for which long-term supplier obligations exist. Here, the zinc die-casting tools generate high storage costs. At the latest when they are worn and require costly reworking, it pays to produce the spare parts by 3D printing – true

Bathroom fittings and hardware for furniture and windows are often produced by zinc die casting. The additional design freedom of additive manufacturing makes it possible to realize new, highly complex designs that could not be produced before.

to the motto print on demand. This saves storage costs and reduces logistics effort to a minimum. Business models of this kind are already established in paper printing: the customer orders a book and thereby automatically triggers its printing. The copy is then sent to them fresh from the press within the next few days. The new additive manufacturing technology for zinc components now opens up this business field for the production of industrial components as well.

Protiq delivers additively manufactured functional prototypes within a few days. Using the series material Zamak 5 enables fast product testing and offers optimal comparability with the later series part produced by zinc die casting.

Finishing of the printed components

Naturally, the additive production of die-cast components must maintain the familiar quality of conventional processes. Against this background, using 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 and an elongation at break of 1.5±0.5 percent. The accuracy of the 3D printing process is ±0.1 mm, with a minimum wall thickness or detail resolution of 0.6 mm. The component density is more than 95 percent.

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 surface quality. While die-cast components are usually very smooth because they replicate the inner wall of the tool, the surface of parts produced additively using the SLM process is matte and slightly rough. Additive series production of zinc components at Protiq is therefore understood as a chain of processes in which the actual 3D printing is only one of several links. Downstream processing steps can include, for example, re-cutting tightly toleranced functional surfaces or adding threads by automated CNC milling. In addition, the additively manufactured components are very easy to grind, polish and electroplate. This brings the surface quality into line with that of die casting or creates an elegant high-gloss finish.

Additively manufactured paddle shifters: As is usual with Zamak, the material is very easy to grind and polish – automatically or by hand.

Protiq thus offers the best conditions for implementing series production to the highest quality standards as well. Certification according to DIN ISO 9001 ensures these high quality standards.

Further information:
www.protiq.com

Processing materials that could not be used before

Thanks to its many years of experience in additive manufacturing, Protiq has built up an in-depth understanding of the processes involved. Since its beginnings in 3D printing in 2010, the service provider has focused not only on standard materials but also on materials that previously could not be processed additively. For this purpose, two in-house developed additive production systems have been set up, among other things, which make it possible to process a number of new materials in the first place, Zamak 5 for example.

Driven by this ambition, Protiq is also a pioneer in processing highly electrically conductive copper. This material was long considered unsuitable for 3D printing, yet thanks to its good thermal and electrical conductivity it offers great potential in many industrial applications. Following the introduction of its RS copper – an alloy with a copper content of 99 percent – Protiq is now making these possibilities fully usable, as a process for processing pure copper has also been developed. In doing so, the service provider dispenses with alloying elements entirely and thus ensures an electrical conductivity of 58 MS/m: 100 percent IACS (International Annealed Copper Standard).