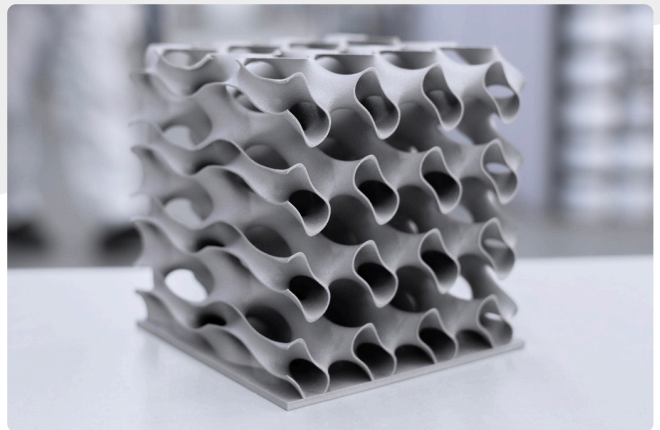


3D printing as a complement to zinc die casting

(A technical article from 2023, author: Mona Ohms, PROTIQ GmbH, Blomberg)

Producing prototypes from zinc has until now required a great deal of time and money. With the help of additive manufacturing, however, this problem can now be solved: thanks to a process developed by PROTIQ, components made of Zamak 5 can now be 3D printed.



Components made of the zinc alloy Zamak 5 are widely used in industry. The applications of this standard material range from connectors to fittings in the window and furniture industries. Zinc die casting allows such components to be produced economically in large quantities. In this process, molten metal is forced under high pressure into a previously manufactured steel mold. This master form, the tool, defines the geometry of the components and at the same time represents the largest financial outlay in production. Tooling costs are normally allocated across the planned quantity; for high quantities, the share usually amounts to only a few cents – but for small batches, the tool becomes a problematic cost factor.

Even minimal changes to the geometry require an adaptation or even the manufacture of a new tool. For this reason, prototype tools are only used in component development once the final component geometry has largely been fixed. As a result, however, functional prototypes made of Zamak 5 only become available so late that changes can hardly be made anymore. In times of ever shorter product life cycles and shorter development times, this poses a major challenge for companies in a competitive market. Additive manufacturing can provide a remedy here.

3D printing as an innovative manufacturing process

Since the invention of 3D printing in the 1980s, the technology has developed rapidly. The first 3D printers worked with a UV laser and a photopolymer resin that cured under the UV radiation. The resulting components were mainly suitable as display models and prototypes.

Meanwhile, a large number of new 3D printing processes have become established, for example selective laser melting or laser sintering, which also enable the production of series components. Then as now, the components are built up layer by layer across all processes. These processes can even produce highly complex geometries, such as elaborate freeform surfaces or internal structures, efficiently.

The wealth of 3D printing processes now available also allows an ever-growing range of materials to be processed.

Zinc components without expensive tooling

In order to increase freedom in the product development of zinc components, PROTIQ GmbH became the world's first 3D printing service provider to develop a process for the additive processing of the series mate-



rial Zamak 5. Selective laser melting is used for this purpose: in the first step of this process, a thin layer of metal powder is applied to a build platform. A laser melts the metal powder at the coordinates specified by a CAD file, after which the build platform is lowered and another layer of powder is applied. In this way, a metal object is created layer by layer which, after the manufacturing process, only needs to be freed from excess powder and support structures and detached from the build platform.

With the help of this additive manufacturing process, the high time and cost expenditure that is typical of zinc die casting for the production of small quantities can be overcome. Prototypes and small series can now be manufactured at the lowest possible component price. This type of production is a world first, but the material remains the proven one. The material Zamak 5 has an elongation at break of 1.5 ± 0.5 percent. The accuracy is ± 0.1 millimeters and the minimum wall thickness is 0.6 millimeters. The tensile strength is 218 ± 40 MPa, while the component density is greater than 95 percent.

By using additive manufacturing, functional prototypes made of Zamak 5 with the properties of the later series component can be produced even in the early stages of product development. No further tools are required for

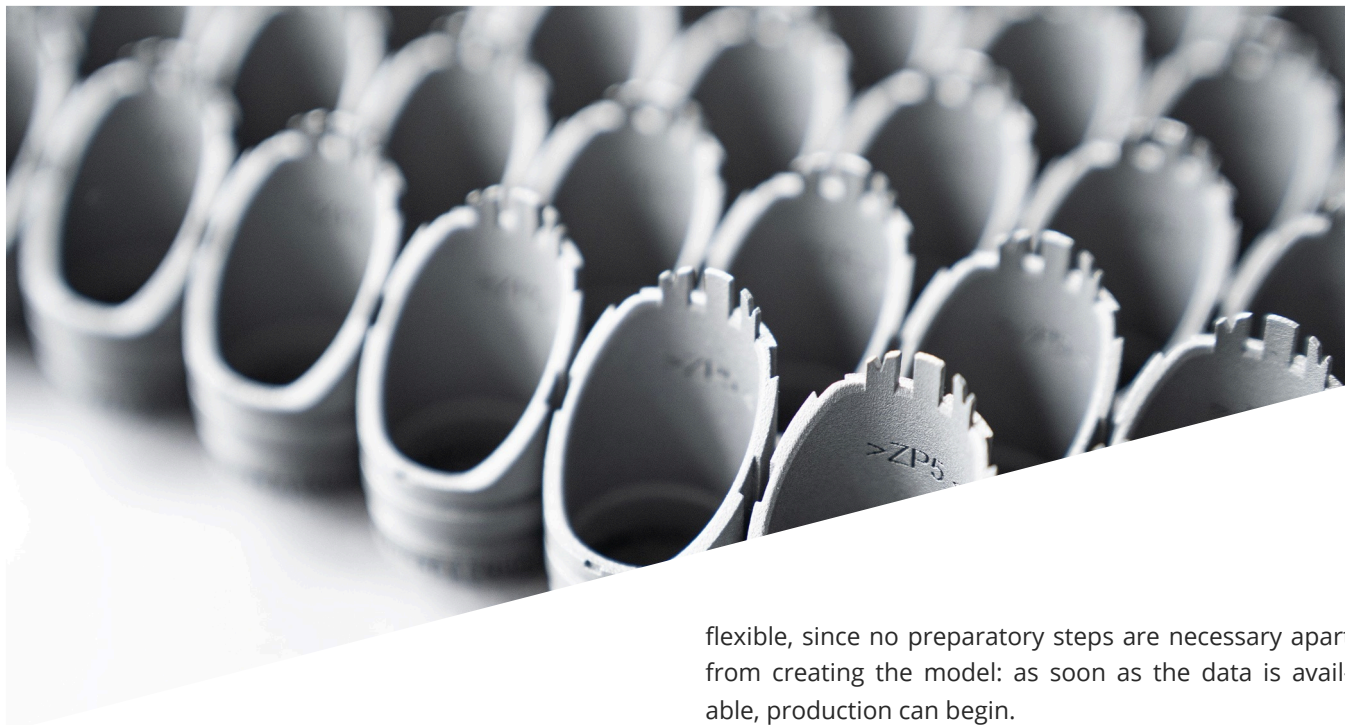
this, as production takes place directly from the CAD data. After polishing, the additively manufactured workpieces can be electroplated as usual to obtain an elegant, high-gloss chrome finish.

Unlike zinc die casting, which only pays off at very large quantities, 3D printing enables the economical production of one-off parts and small series, so-called low runners. Thanks to additive manufacturing, product development, series ramp-up and spare parts supply consequently pay off even for small quantities.

New design possibilities

Unlike zinc die casting, the layer-by-layer build-up in additive manufacturing makes it possible to produce almost any conceivable geometry. Restrictions caused by material accumulations, parting planes or ejectors are no longer relevant. Small and filigree components in particular can be brought to market within a day or produced in series by means of selective laser melting. Another interesting aspect is the possibility of manufacturing any number of different geometries simultaneously on one machine.

So-called print-on-demand allows products to be produced directly, immediately after the order is received. In this way, the customer saves on storage costs and the



logistics effort is reduced to a minimum. In the field of paper printing, such business models are already established: the customer orders a book online and automatically triggers the printing. The product is then sent to them freshly printed the next day. The new additive manufacturing technology for zinc components now opens up this business field for the production of industrial components as well. If the advantage of immediate, fast production is also combined with the new geometric freedom, the result is the opportunity to produce customized components in series: "Complexity for free" is the key phrase. With additive manufacturing technology, for example, product variants or inscriptions can thus be freely defined and implemented without great effort.

Key differences between zinc die casting and additive manufacturing

One of the most fundamental differences between zinc die casting and the additive manufacturing of zinc components has already been mentioned several times: while casting requires a tool, a 3D file is sufficient for printing. This also means that additive manufacturing can generally start faster and is also considerably more

flexible, since no preparatory steps are necessary apart from creating the model: as soon as the data is available, production can begin.

The surface of additively manufactured components is generally rougher than that of cast parts, but can be post-processed after the printing process. In return, subsequent joining is unnecessary in most cases for more complex geometries, since internal components and structures can also be produced directly in the additive process.

When it comes to large series, the unit price in additive manufacturing does not decrease to the same extent as in zinc die casting. For this reason, additive manufacturing is particularly suitable for small series, prototypes, customized products and low runners, while zinc die casting remains the more economical solution for large-scale series. The additive manufacturing of Zamak 5 components is therefore a good complement to existing processes and is not intended to replace zinc die casting completely.

Further information:

[protiq.com](https://www.protiq.com)