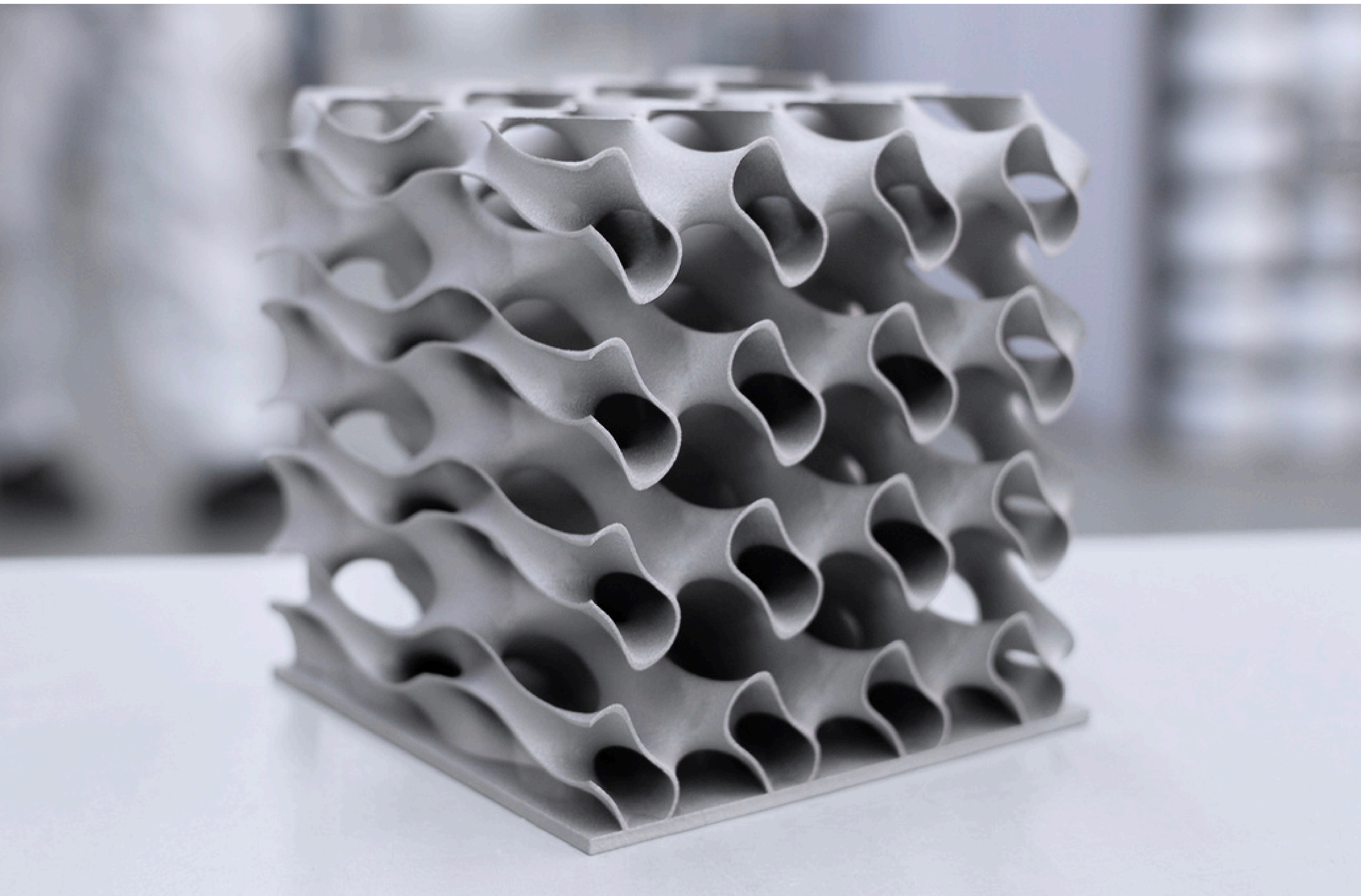
PRINTING INSTEAD OF CASTING?

3D printing as an addition to zinc die casting



The production of prototypes from zinc previously required a lot of time and money. However, this problem can now be solved with the help of additive manufacturing: A process developed by PROTIQ allows components to be produced from Zamak 5 using 3D printing.

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Components made from the zinc alloy Zamak 5 are widely used in industry. The fields of application for this standard material range from passenger car components and electrical connectors to fittings in the window and furniture industries. Such components can be manufactured economically in large quantities using zinc die casting. In this process, molten metal is pressed into a previously manufactured steel mold under high pressure. This original mold, the tool, defines the geometry of the components and at the same time represents the greatest financial investment in production. Tooling costs are usually allocated across the planned production volume; for large quantities, the share per part is often only a few cents. For small batches, however, the tool becomes a problematic cost factor.

Even minimal changes to the geometry require an adaptation of the tool or even the manufacture of a completely new one. For this reason, prototype tools are only used in component development once the final component geometry has largely been defined. As a result, functional prototypes made of Zamak 5 only become available at a very late stage, when changes can hardly be implemented anymore. In times of ever shorter product life cycles and reduced development times, this represents a major challenge for companies competing in highly contested markets. 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 used a UV laser and a photopolymer resin that cured under UV light. The resulting components were primarily suitable as demonstration models and prototypes.

A variety of new 3D printing processes have now become established, such as selective laser melting or laser sintering, which also enable the production of serial components. Then as now, the components are built up layer by layer across different processes. These processes even allow for the efficient production of highly complex geometries, such as elaborate freeform surfaces or internal structures.

Furthermore, the large number of 3D printing processes now available makes it possible to process an ever-growing range of materials.

Zinc components without costly tooling

To increase the freedom of product development for zinc components, PROTIQ GmbH has succeeded—as the world's first 3D printing service provider—in developing a process for the additive manufacturing of the series material Zamak 5. This is achieved using selective laser melting. 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; the build platform is then lowered and another layer of powder is applied. In this way, a metal object is created layer by layer. After the manufacturing process, the part only needs to be freed from excess powder and support structures and removed from the build platform.

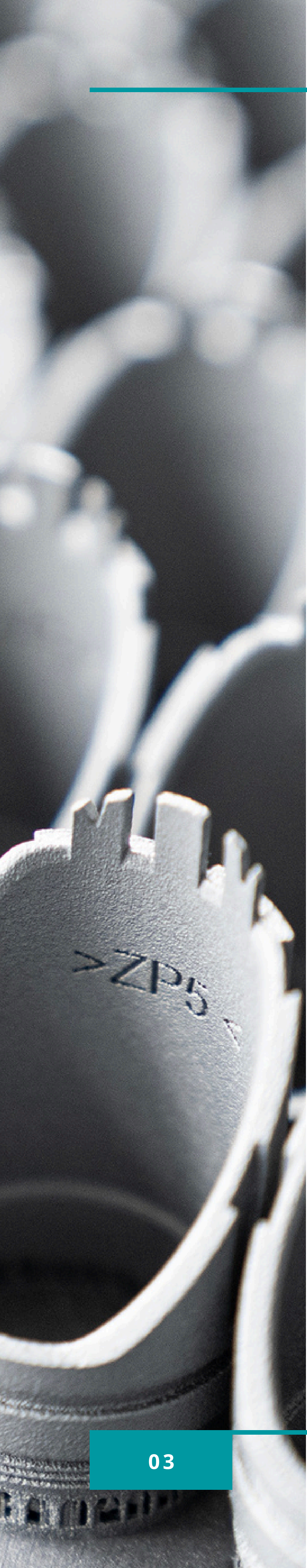
With the help of this additive manufacturing process, the high time and cost expenditure typically associated with zinc die casting for small production volumes can be overcome. Prototypes and small series can now be manufactured at the lowest possible unit cost. This type of production represents a world first, while the material itself remains the proven standard. The material Zamak 5 exhibits an elongation at break of 2 ± 0.5 percent and an elastic modulus of 70 ± 10 GPa. The dimensional accuracy is ± 0.1 millimeters, and the minimum wall thickness is 0.4 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 at early stages of product development. No additional tooling is required, as production is carried out directly from CAD data. After polishing, the additively manufactured parts can be electroplated as usual to achieve a high-quality, high-gloss chrome finish.

In contrast to zinc die casting, which only becomes economical at very high production volumes, 3D printing enables cost-effective production of individual parts and small series, so-called low runners. As a result, product development, series ramp-up, and spare parts supply are economically viable even at low quantities when using additive manufacturing.

New design possibilities

Unlike zinc die casting, the layer-by-layer construction used in additive manufacturing makes it possible to produce almost any conceivable geometry. Restrictions caused by material accumulations, parting lines, or ejector pins are no longer relevant. In particular, small and delicate components can be brought to market within a single day or manufactured in series using selective laser melting. Another notable advantage is the ability to produce any number of different geometries simultaneously on a single machine.



So-called print-on-demand enables the direct production of products immediately after an order is received. In this way, customers save on storage costs, and logistical effort is reduced to a minimum. In the field of paper printing, such business models have already become established: the customer orders a book online and automatically triggers the printing process. The product is then delivered freshly printed the very next day. The new additive manufacturing technology for zinc components now opens up this business field for the production of industrial parts as well. When the advantage of immediate, rapid production is combined with the new freedom of design, the opportunity arises to manufacture customer-specific components in series—"complexity for free" is the key term. Using additive manufacturing technology, product variants or markings, for example, can be freely defined and implemented without significant additional 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, 3D printing only requires a 3D file. As a result, additive manufacturing can generally be started much more quickly and is also significantly more flexible, since no preparatory steps are necessary apart from creating the model. As soon as the data are available, production can begin.

The surface of additively manufactured components is inherently rougher than that of cast parts, but it can be post-processed after the printing process. On the other hand, subsequent assembly is eliminated in most cases for more complex geometries, since internal components and structures can be manufactured directly within the additive process.

When it comes to large production volumes, the unit cost in additive manufacturing does not decrease to the same extent as it does 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 production. Consequently, the additive manufacturing of Zamak 5 components should be seen as a valuable complement to existing processes rather than as a complete replacement for zinc die casting.

**FOR FURTHER INFORMATION,
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