

Steel – Additively Manufactured

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

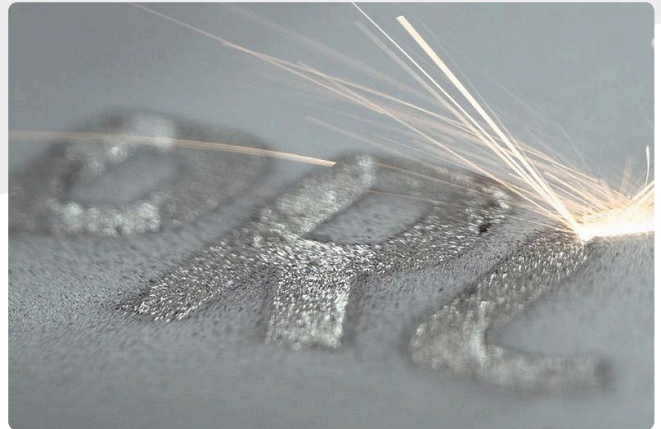
For years, additive manufacturing has been making its way into more and more industrial sectors. It has long since ceased to be only plastic components that are 3D printed; highly stressed metal components are produced this way as well. The material portfolio covers the processing of a wide range of steels, light metals and even precious metals.

What all additive manufacturing processes have in common is that the components are built up layer by layer by adding material. Unlike many conventional manufacturing technologies such as turning, milling or EDM, no material is removed; instead, it is built up in a targeted manner.

In the additive manufacturing process of selective laser melting (SLM), the parts are produced from fine metal powder. The powder is applied in thin, flat layers and fused into the desired components by a powerful laser under a protective gas atmosphere.

The layer-by-layer build-up offers the potential to produce quickly, with minimal material use and individually. In addition, additive manufacturing offers a high degree of design freedom and new possibilities in product design.

PROTIQ GmbH is an additive manufacturing service provider and part of the Phoenix Contact Group. With more than 10 years of experience, PROTIQ focuses on industrial customers and successfully meets special

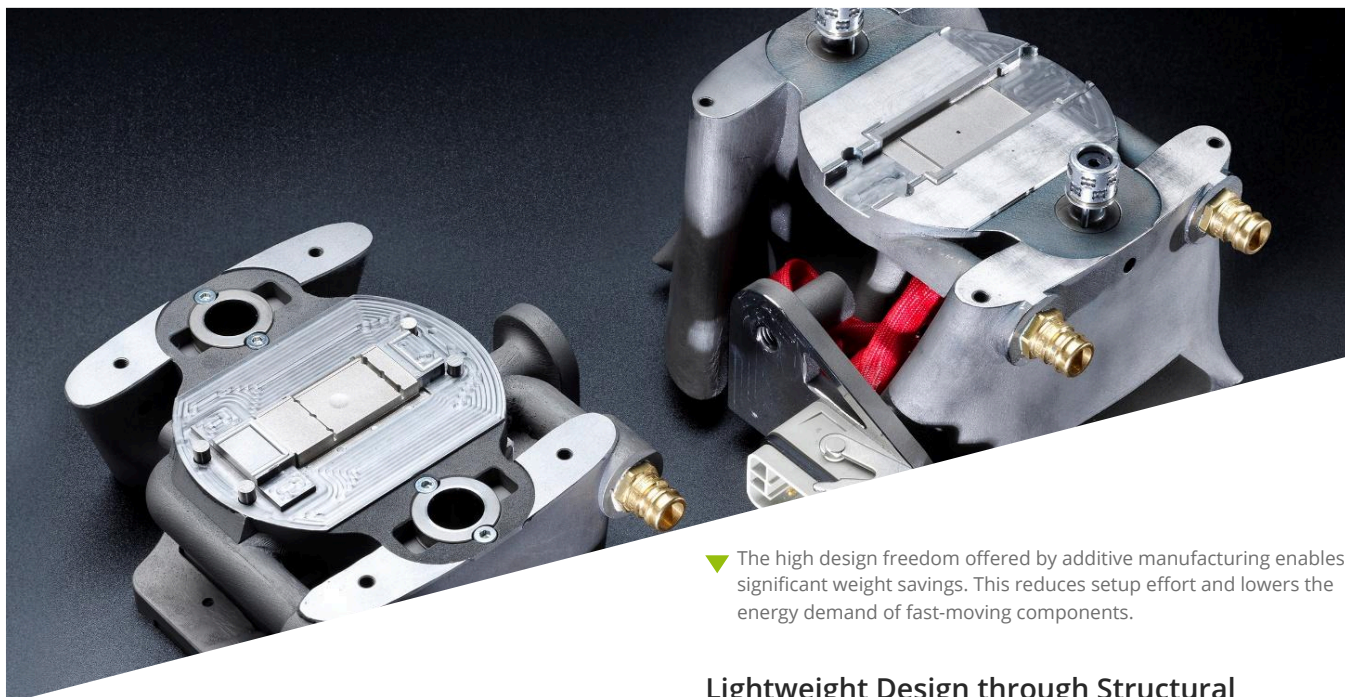


▼ In the additive manufacturing of metal components, fine metal powder is fused together layer by layer using a powerful laser. Powder that has not been melted can be almost 100 % reused after the process.

requirements and high quality standards as well. At the same time, PROTIQ stands out for its active development and qualification of new, innovative materials for additive manufacturing.

In addition to its own production, PROTIQ also operates the PROTIQ Marketplace – www.Protiq.com – where customers can choose from a wide range of materials, 3D printing processes and manufacturing service providers. Thanks to fully automated quotation with live pricing and direct online ordering, a production order can be completed within a few minutes and manufacturing can start immediately. This allows customers to take full advantage of the speed benefits of 3D printing.

Besides various light metals, copper materials and plastics, the material portfolio on the ProtIQ Marketplace currently includes different steels. In the field of additively manufactured steels, too, the choice of material depends on the required component properties. Depending on individual requirements, wear-resistant tool steels, rust-proof stainless steels, heat-resistant nickel-based alloys or resilient case-hardening steels are available.



▼ The high design freedom offered by additive manufacturing enables significant weight savings. This reduces setup effort and lowers the energy demand of fast-moving components.

Application Example: Direct Tooling

A particular core competence of PROTIQ is direct tooling, which refers to the additive manufacturing of production tools and their use in series production. Thanks to its proximity to Phoenix Contact's toolmaking department, PROTIQ has built up important know-how in the additive manufacturing of injection molds over more than 10 years. Conventionally, injection molds are milled, drilled and eroded from solid metal semi-finished products. By using additive manufacturing, new geometries can be realized and more efficient tools can be produced.

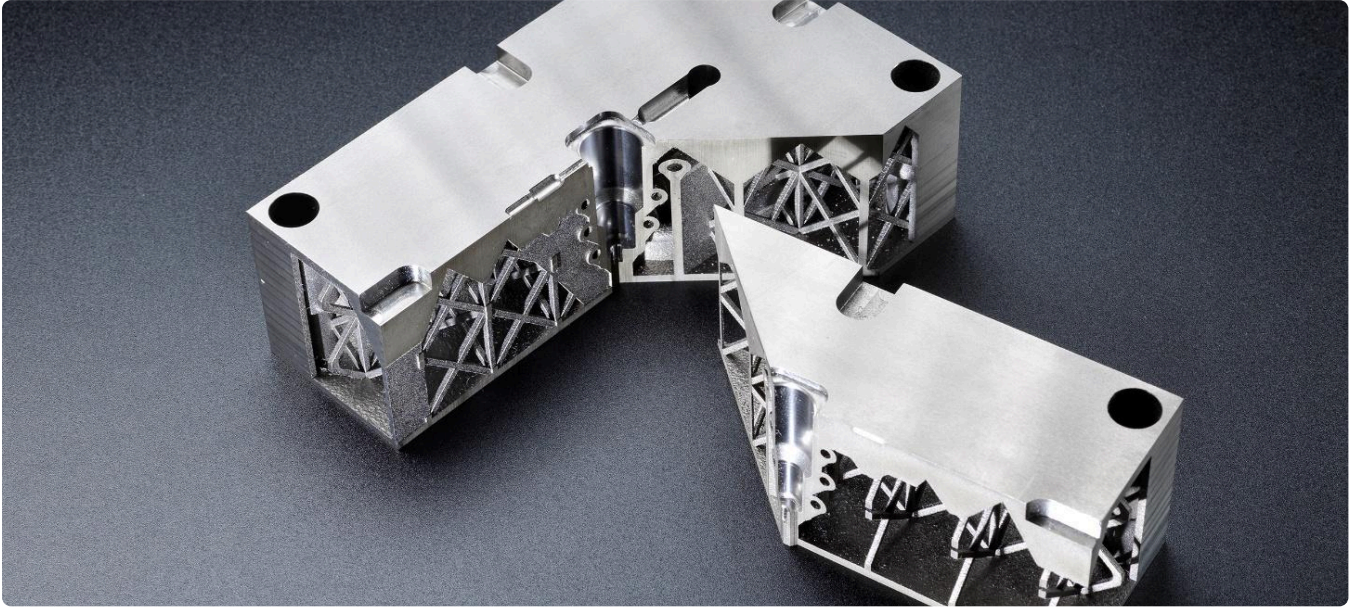
Typical requirements for the material are, above all, high hardness and wear resistance. That is why the tool steel MS1 (1.2709), with a tensile strength of over 1950 MPa and a hardness of 54 HRC, is mainly used here.

"Conformal cooling" is the key phrase that makes additively manufactured tools stand out. In the injection molding process, the shaping tools are filled with liquid plastic. The heat released as the melt cools is dissipated via water-cooled cooling bores. Additive manufacturing makes it possible to redesign these cooling channels so that near-surface, freeform cooling water channels can be used. These result in optimized heat dissipation, higher cooling rates and reduced cycle times. Savings of 30% – 40% are not uncommon here.

Lightweight Design through Structural Optimization and Functional Integration

In addition to enabling efficient cooling solutions, the weight of the tool can also be significantly reduced in order to make setup processes more efficient and allow faster tool movements. With conventional tools weighing more than 30 kg, tool changes require the use of lifting equipment. Thanks to a typical weight reduction of up to 70% through direct tooling, tools can once again be changed manually and more quickly. To design this lightweight construction of injection molds, computer-aided topology optimization software can be used. Finite element simulation is used to identify component areas that are subject to only low loads. Material is saved in these areas without compromising the stability of the tool.

Load-adapted component design, supported by numerical structural optimization, naturally offers great potential not only for injection molds. The best-known fields of application for this form of lightweight construction are in the aerospace industry. Additively manufactured components made of aluminum, titanium, stainless steel or high-strength steels reduce weight and thus save energy and operating costs. Especially in the current times of rising energy prices and scarce raw materials, it is worth taking a closer look at moving components in classic mechanical engineering as well. Lighter robot heads on a production line, for example, mean less moving mass, so that smaller, less expensive motors can be used.



▼ Additively manufactured injection molds with complex conformal cooling channels increase performance in production and reduce cycle times.

At the same time, almost 100 % of unused powder can be returned to the process, which makes 3D printing very material-efficient.

In general, it remains exciting to see what other innovations additive manufacturing at PROTIQ has in store for the 3D printing of steel materials in the future.

Further information:

www.protiq.com