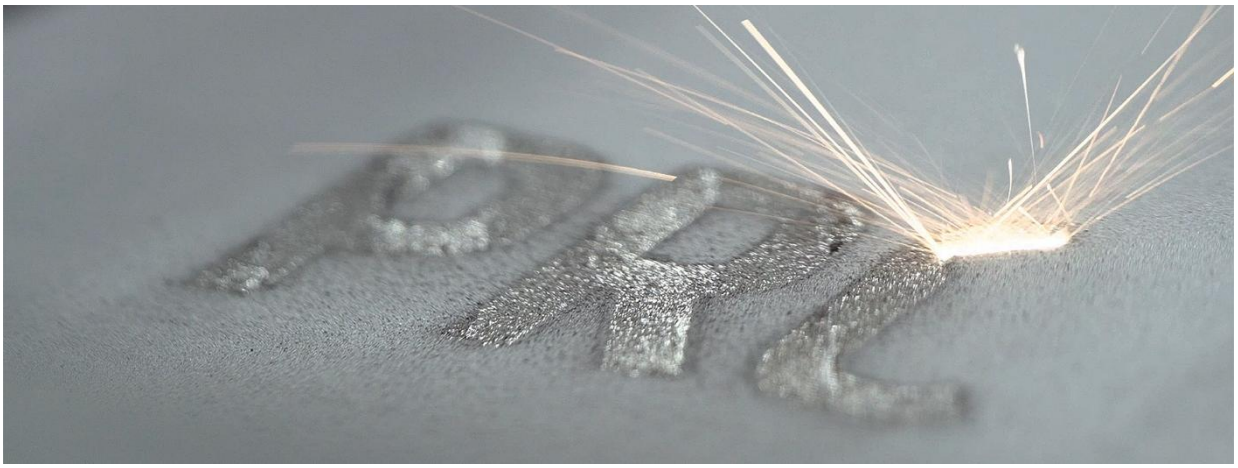
Steel - additive manufactured

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

Additive manufacturing has been finding its way into more and more industrial sectors for years. It is no longer just plastic components that are 3D printed, but also highly stressed metal components. The material portfolio includes the processing of a variety 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. In contrast to many conventional manufacturing technologies such as turning, milling or eroding, no material is removed, but built up in a targeted manner.

In the additive manufacturing process of selective laser melting (SLM), parts are produced from fine metal powder. The powder is applied in thin, flat layers and melted into the desired components using a powerful laser in an inert gas atmosphere.
The layered structure offers the potential for fast, material-saving and customized production. Additive manufacturing also offers a high degree of design freedom and new possibilities in product design.



In the additive manufacturing of metal components, fine metal powder is melted together layer by layer using a powerful laser. Almost 100% of the unmelted powder can be reused after the process.

PROTIQ GmbH is an additive manufacturing service provider and part of the Phoenix Contact Group. With over 10 years of experience, PROTIQ focuses on industrial customers and also successfully serves special requirements and high quality standards. At the same time, PROTIQ is characterized by the active development and qualification of new, innovative materials for additive manufacturing.
In addition to its own production facilities, 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 the fully automated quotation calculation with live pricing and direct online ordering, a production order can be completed within a few minutes and production can begin immediately. This allows the customer to take full advantage of the speed benefits of 3D printing.

In addition to various light metals, copper materials and over one hundred plastics, the material portfolio on the Protiq Marketplace currently includes nine different steels. In the field of additively manufactured steels, the choice of material is also based on the required component properties. Depending on the individual requirements, wear-resistant tool steels, stainless steels, heat-resistant nickel-based alloys or resilient case-hardening steels are available.

Application example Direct Tooling

A special core competence of PROTIQ is direct tooling, which describes the additive manufacturing of production tools and their use in series production. Thanks to its proximity to the Phoenix Contact tool shop, PROTIQ has been building up important expertise in the additive manufacturing of injection molds for over 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 material requirements include high hardness and wear resistance. This is why the tool steel MS1 (1.2709) with a tensile strength of over 1950 MPa and a hardness of 54 HRC is primarily used here.

"Cooling close to the contour" are the key words that make additively manufactured tools stand out. In the injection molding process, the shaping tools are filled with liquid plastic. The heat released when the melt cools is dissipated via cooling holes through which water flows. Additive manufacturing makes it possible to redesign these cooling channels so that a free-form cooling water flow close to the surface can be used. This generates optimized heat removal, higher cooling rates and reduced cycle times. Savings potentials of 30% - 40% are not uncommon here.

Lightweight construction through structural optimization and functional integration

In addition to implementing efficient cooling solutions, the weight of the tool can also be significantly reduced to make set-up processes more efficient and enable faster tool movements. With conventional tools weighing over 30 kg, tool changes require the addition of lifting equipment. Thanks to a typical weight reduction of up to 70% through direct tooling, tool changes can now be carried out manually and more quickly. PROTIQ uses computer-aided topology optimization software to design these lightweight injection moulds. Finite element simulation is used to identify component areas that are only subject to low loads. Material is saved in these areas without restricting the stability of the mold.

Load-optimized component design, supported by numerical structural optimization, naturally offers great potential not only for injection moulds. The best-known areas of application for this form of lightweight construction are in the automotive and aerospace industries. Additively manufactured components made of aluminum, titanium, stainless steel or high-strength steels reduce weight and thus save energy and costs during operation. Especially in the current times of rising energy prices and scarce raw materials, it is also worth taking a closer look at moving components in traditional machine building. Lighter robot heads in a production line, for example, mean less moving mass so that smaller, cheaper motors can be used

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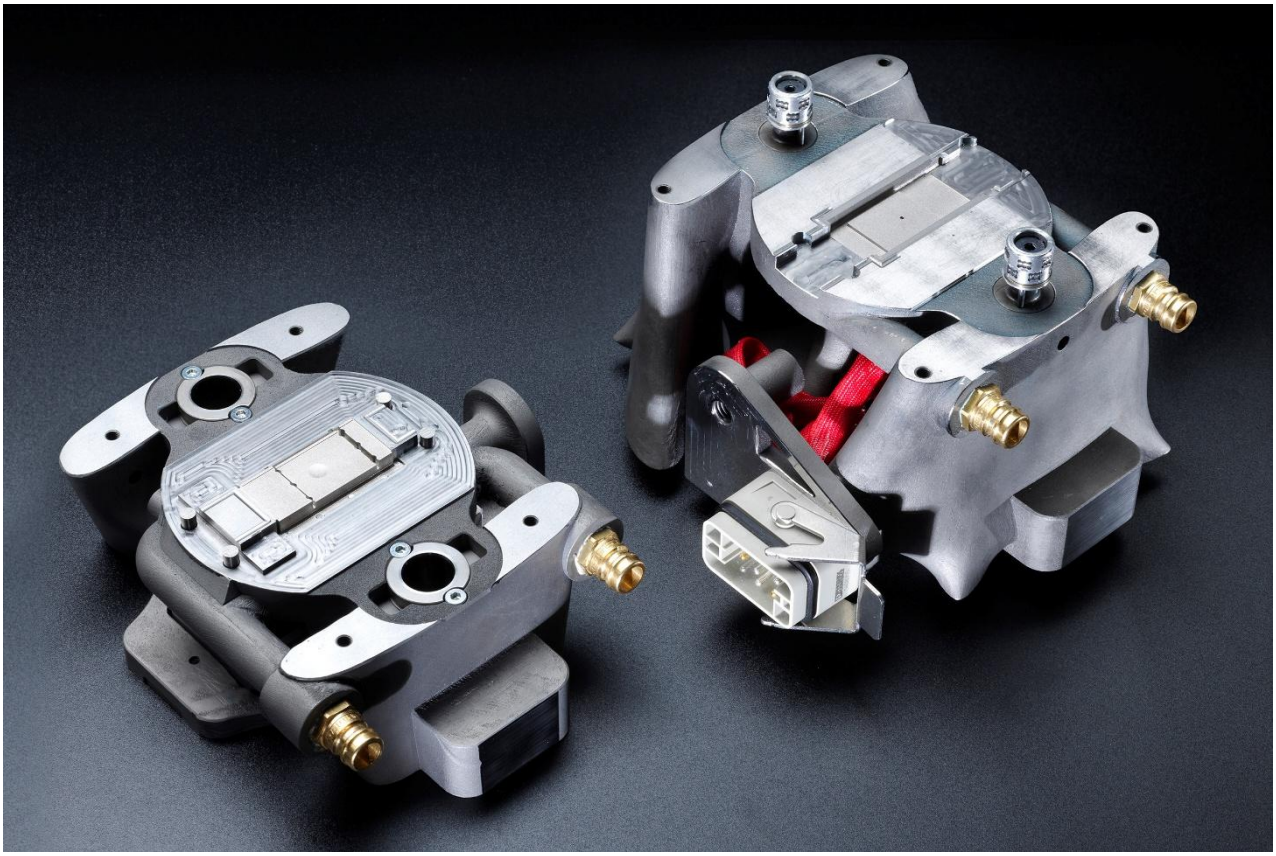
At the same time, almost 100% of unused powder can be returned to the process, making 3D printing very material-efficient.

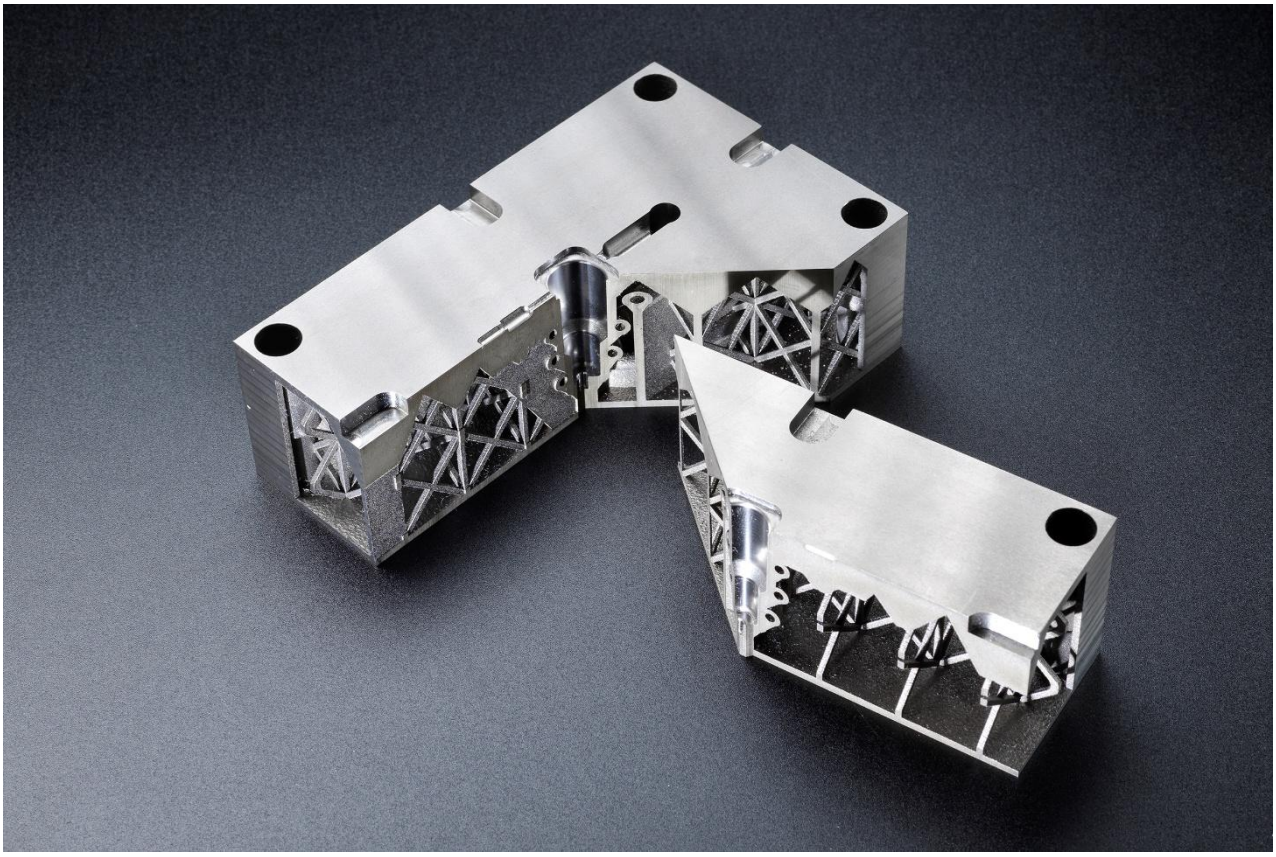


The high degree of design freedom offered by additive manufacturing enables significant weight savings. This reduces set-up times and energy requirements for fast-moving components.

Outlook: Knife steel 440C with up to 67 HRC from 3D printing

Together with the Danish company Nordic Metals, PROTIQ has developed a process with which the stainless, martensitic tool steel 440C can be processed.
Traditional high-strength tool steels such as H11 or H13 are prone to hot cracking during the SLM process. The new steel innovation 440C with a very high carbon content achieves a hardness of 67 HRC and is usually used for ball bearings or high-quality knives and blades. The very high wear resistance also makes this steel interesting for highly stressed forming tools.

This new type of steel is particularly suitable for use in injection molds due to its high thermal conductivity.
In general, it will be interesting to see what innovations additive manufacturing at PROTIQ has in store for the 3D printing of steel materials in the future.



Additively manufactured injection molds with complex, near-contour cooling channels increase production performance and reduce cycle times.

Further informationen:

www.protiq.com