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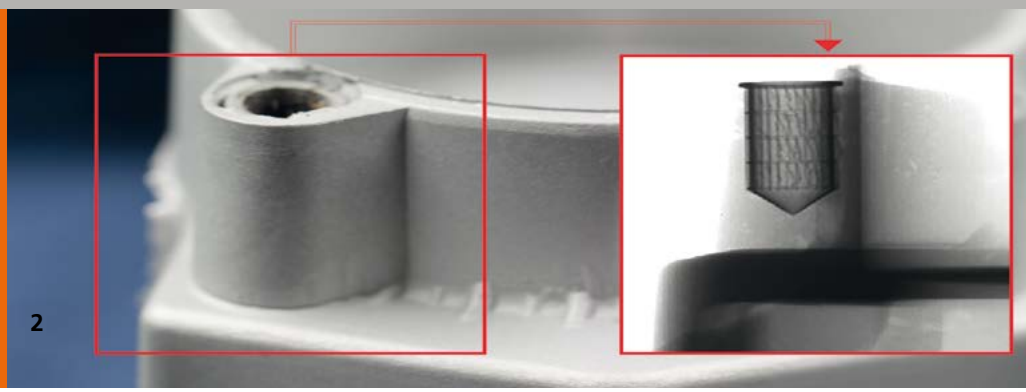

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1 *Crash-box mounting. (Image: © Böllhoff Verbindungstechnik GmbH)*
2 *Embedded AM functional structure.*

INTEGRATION OF ADDITIVELY MANUFACTURED STRUCTURES IN CASTINGS

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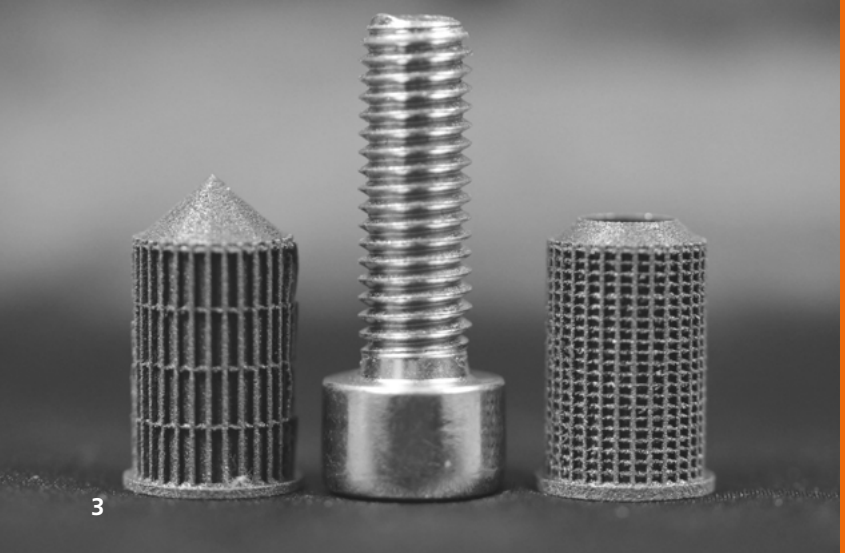
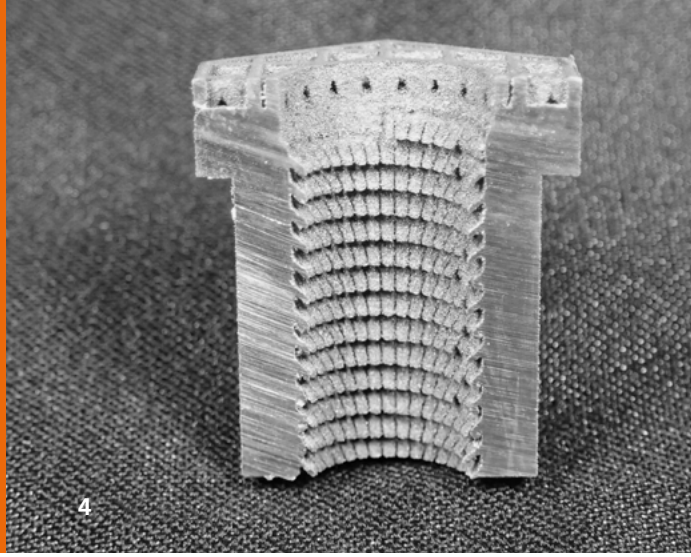
Two of the main competencies at Fraunhofer IFAM are casting technology and Additive Manufacturing (AM) in the field of metals. A current research area concerns the local integration of additively manufactured metal structures in castings with a focus on multi-layered functionalized SLM metal structures that are locally embedded in the casting during the high-pressure casting process. The aim of the technological development is a combination of the advantages of Additive Manufacturing, with its high potential for complexity, and the more cost-effective metal casting process. At the same time, this combination enables the limitations of both processes to be eliminated.

Advantageous combination of additive metallic manufacturing processes and the casting process

In casting, the large series production of geometrically large and thin-walled cast components can be cost-efficiently realized. However, this process reaches its limits in the production of complicated components with functional integration due to strength restrictions and undercuts. The use of AM technologies such as selective laser melting (SLM) enables the creation of complex as well as functional geometries from diverse metals. The component volume, however, is here significantly determined by the production time and hence the costs. Therefore, larger component series are currently not efficient. Under these conditions, the combination of high-pressure casting and the SLM process offers the potential for a cost-effective series process.





Adjustable characteristics of the hybrid process

Depending on the application, the functional AM structures can be conceptualized, designed, and produced according to the requirements. Both the outer shape as well as the inner areas can be functionalized.

Through gradated porous or open-structure layers on the AM component, the bonding characteristics of the cast component can be adjusted. This allows the mechanical values of the joining zone to be optimized and thus undesirable variations in rigidity can be reduced. Furthermore, through a local integration of high-strength metallic AM structures, a load path suitable design and optimization of the hybrid component is possible. This improves the mechanical properties and allows them to be optimally adapted to the respective loads.

For applications focussing on heat transfer, the use of AM structures, for example as a cooling channel, offers distinct advantages. An increased inner surface area as well as a gradated transition zone between the AM component and the casting offer excellent heat transfer coefficients and thus increased cooling performance.

Insight into the research project

In order to demonstrate the combination of both processes, a novel outer and inner functionalized AM structure in the form of a threaded element integrated into a high-pressure casting was realized. The focus of this research initiative was to show that the developed AM structure has a limited volume and thus enables shorter manufacturing times if producing multiple AM parts in a process cycle. The threaded element combines the advantages of plug-in and screw connections while also compensating for their disadvantages. The interior features individual flexible pin-like structures along the slope of a standard thread (Fig. 3).

Standard screws can be quickly connected through the use of the threaded element. If necessary, the screws can be released through a turning motion that is analog to screw connections. On the outer surface area, various open and open-pored textures were investigated in order to ensure an optimal joining to the casting.

3 *Sample geometries for AM structures with surface textures.*

4 *Threaded element with individual flexible pins as an example of an AM structure with interior functions.*