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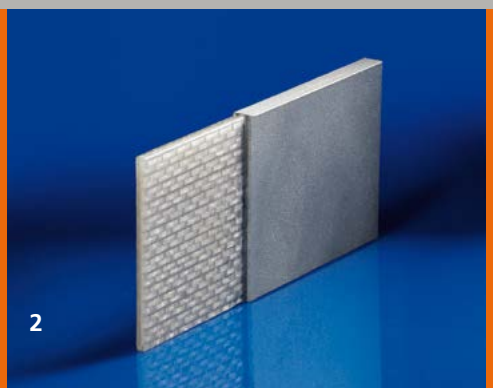

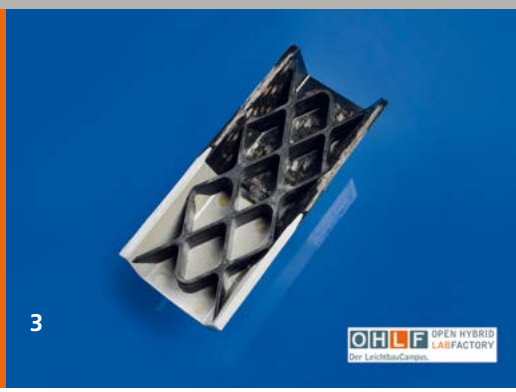

1 *Aluminum-CFRP bracket produced with high-pressure die casting.*
2 *Ceramic fiber-aluminum hybrid connection.*
3 *Hybrid aluminum-fiber-reinforced composite demonstrator with ribs produced through injection molding.*
(Image: © Fraunhofer IFAM / OHLF)

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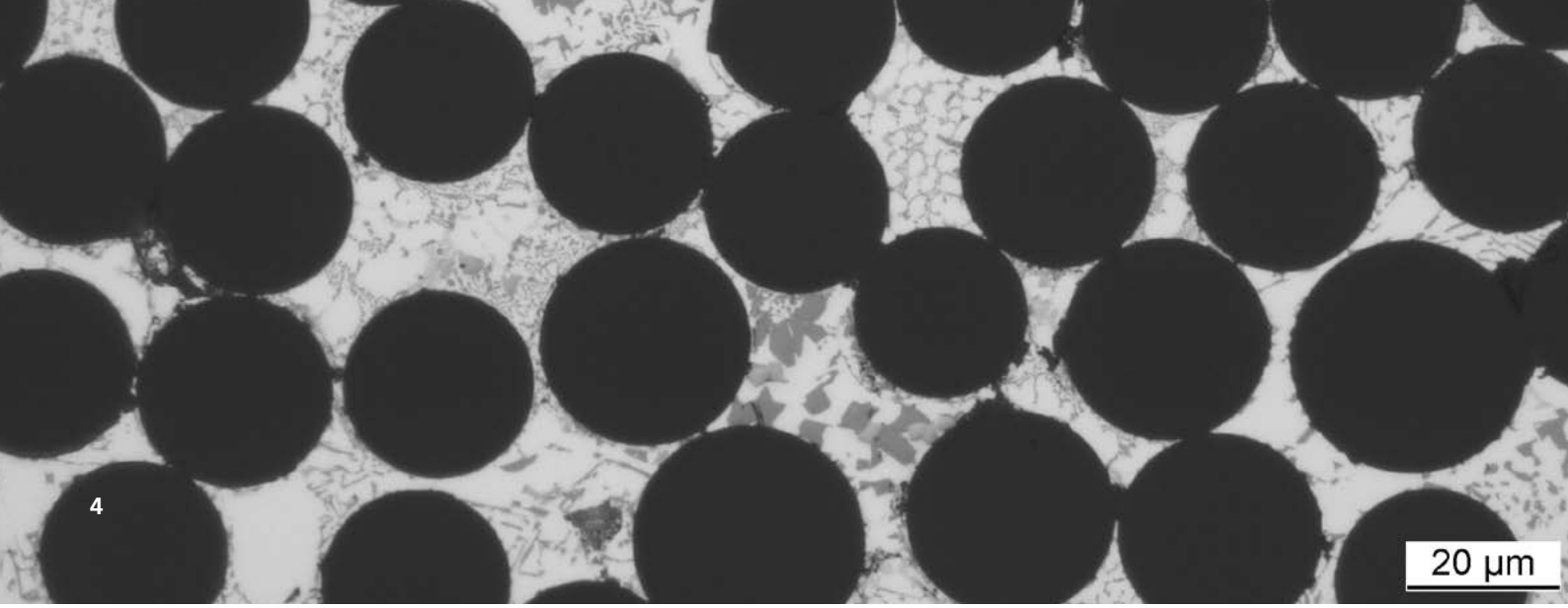
CFRP-ALUMINUM HYBRID CASTING FOR LIGHTWEIGHT CONSTRUCTION

Whenever there is a need for a weight reduction and masses need to be moved, the focus shifts to fiber composite materials. But it is not always possible to completely eliminate metal. One method that enables the best properties of various materials to be combined is hybrid construction.
At Fraunhofer IFAM, novel technologies for the manufacture of modern hybrid components are being developed. The focus of these technologies lies on establishing series-suitable processes for the direct manufacture of hybrid components – the so-called hybrid casting, in which the connection of the materials occurs during the casting process.

Direct manufacturing of hybrid components by casting

The connection of aluminum or even magnesium with fiber-reinforced plastics such as CFRP offers an especially high potential for lightweight construction due to the good weight-specific properties. For example, complex component areas for load introduction or as strengthening ribs can be created using conventional aluminum casting, while the structural areas experiencing high loads are produced with composites. Hereby, the fiber-plastic composite is directly positioned into the casting die and embedded in the appropriate component areas. Alternatively, dry fibers are partially cast in aluminum and subsequently the non-cast area is further processed to a fiber-reinforced plastic. The embedding of the fibers offers the advantage that the loads are transferred over these to the component via the direction of force. Furthermore, the embedding of CFRP has the advantage that high strengths can be achieved in the interface between the matrix system of the CFRP and the aluminum.



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In addition, through the embedding of the CFRP, form locking through undercuts can be produced directly in the casting process of the metal components.The technologies therefore offer an excellent solution when it comes to placing the right material in the right place according to the component requirements and thus finding an optimal lightweight solution.

The solution – the right material at the right place

Through the combination with plastic injection molding it is possible to create complex structures out of plastic. This is particularly useful where constructive measures are needed for strength, e.g. through ribs, and where lightweight construction can be ensured through the low density of the plastic. However, due to the electrochemical potential difference, the connection of carbon fiber reinforced plastic (CFRP) with aluminum increases the risk of contact corrosion. In order to counter this problem, an insulating layer of the temperature-resistant high-performance plastic PEEK is added between the aluminum and CFRP directly during the casting. This layer is introduced during the manufacturing process of the CFRP before the high-pressure casting.

During the embedding of fibers, on the other hand, electrically insulating glass or ceramic fibers are used as a transition structure between the CFRP and the metal. These fibers are partially cast in aluminum. The non-infiltrated part is directly integrated into the fiber-reinforced composite during the subsequent CFRP manufacture and thus offers an ideal load introduction.

Advantages of hybrid components

The advantages of hybrid castings produced in the casting process lie especially in the shortening of the process route in comparison to sequential manufacturing processes, in which a stringing together of many process steps is necessary in order to produce hybrid components. Thus hybrid castings are not only optimally designed according to the requirements, they are also more cost-effective than differential hybrid assemblies.

An overview of the advantages:

- Optimal for lightweight construction
- Short process route
- Corrosion resistant
- Load path optimized
- Small assembly area

The aim of the »Hybrid Casting« workgroup of Fraunhofer IFAM lies in the targeted development of lightweight construction technologies for the industry. In addition to publicly funded projects, particularly applicated-oriented solutions are developed through industry-focused projects. Hereby, the entire process chain from the fiber composite manufacture to the casting technological implementation for the client is covered through the wide networking capabilities of the workgroup under the Fraunhofer umbrella.

4 *Cross-section of glass fibers cast in aluminum as an insulating transition structure.*