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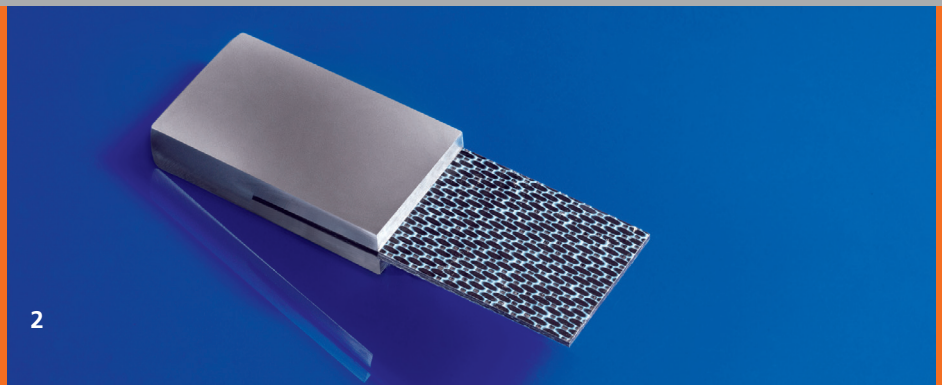

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1 *Specimen of a hybrid composite of aluminum and CFRP with a polymer based decoupling layer and produced in high-pressure die casting.*

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HYBRID CASTING: ALUMINUM CFRP HYBRID COMPOSITES WITH A POLYMER BASED DECOUPLING LAYER

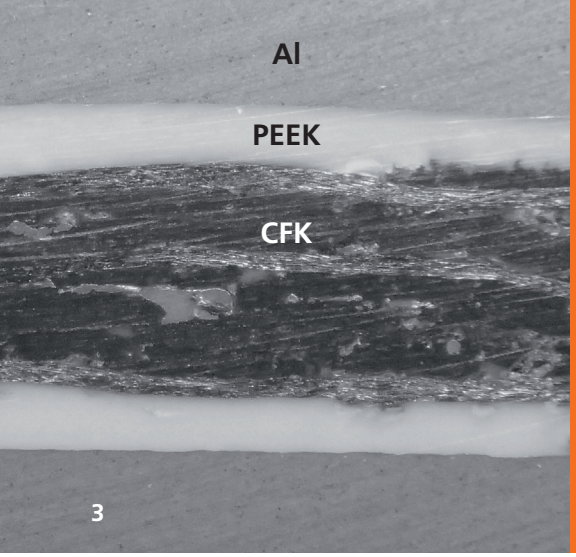
Casting specialists at Fraunhofer IFAM are developing an innovative technology for joining cast parts made of aluminum directly with carbon fiber reinforced plastics (CFRPs). The research group "Hybrid Casting" at Fraunhofer IFAM aims to develop a reproducible, industrial-scale process that obviates electrochemical corrosion for the long term between CFRPs and aluminum.

Motivation

Lightweight construction is increasingly making use of promising hybrid designs that feature both fiber reinforced composites (FRCs) and lightweight metals. Such hybrid components combine the advantages of both their constituent materials, since different parts of the component can be designed to meet different local requirements. Nowhere is the development of smaller, lighter CFRP/aluminum joints of greater importance than in aerospace and automotive manufacturing. Key material properties include high load-bearing capacity, low susceptibility to corrosion, and opportunities for economical production.

State of technology

Conventional adhesive or mechanical processes are currently used for joining individual components to make hybrid materials. Alternative joining methods are needed in order to reduce the weight of integrated structures and enhance their mechanical properties. Hybrid casting technology has some advantages over conventional joining techniques. Advantages include streamlined pretreatment of joint surfaces, the minimization of material thickening and the reduction of weight.



Technology

Casting specialists at the Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM in Bremen, Germany, are developing potential solutions for various types of hybrid joints produced in high-pressure die casting. Hybrid casting refers to integrating FRCs directly into castings, thereby adjusting mechanical characteristics, or joining CFRP and metallic materials. One kind of hybrid casting results in an electrochemically decoupling layer of polyether ether ketone (PEEK) between the CFRP and the aluminum; this layer averts corrosion. Moreover, integrating the CFRP directly into the aluminum is allows the production of parts that are more compact and lightweight than parts assembled using conventional joining techniques. Fraunhofer IFAM is developing this innovative joining technology as part of a research project sponsored by the Deutschen Forschungsgemeinschaft (DFG). Its project partners are both at the University of Bremen: the FIBRE (Faserinstitut Bremen e.V.) and the bime (Bremen Institute for Mechanical Engineering). Fraunhofer IFAM's role is to work on the challenges regarding casting technology. The institute's specialists can leverage their comprehensive know-how in hybrid casting.

Current studies

Experimental studies are now focusing on the process parameters for using high-pressure die casting to make hybrid composites, as well as on optimizing the quality of the electrochemically decoupling PEEK layer.

In collaboration with its project partners FIBRE and bime, Fraunhofer specialists are using many different destructive and nondestructive analysis techniques during casting to determine the material characteristics of hybrid composites. They are also developing specific simulation models that employ finite-element methods (FEMs) in order to validate their experimental findings and to predict and calculate the mechanical performance of such hybrid structures.

Application

Typical applications include products in the following industries: aerospace (e.g., rudder mounts, sandwich panels, fuselage segments), automotive (e.g., CFRP roofs and suspension links), construction of wind turbines (joints between rotor blades and rotor hubs), and general mechanical engineering (e.g., hydraulic parts, articulated robot arms, force-application parts). Hybrid casting makes it possible to join conventional CFRP parts with metal joints exhibiting electrochemically decoupling layers. It is easy to join these metal connectors, in turn, with other metal parts – making it altogether unnecessary to use adhesive or mechanical processes to join metals with composite fiber materials. The metal joints can easily be removed if a composite fiber component is damaged; the metal connectors make replacing the component simple.

Sponsored by

DFG research project "Manufacturing of intrinsic CFRP-aluminum composites by aluminum casting (Hybrid Casting)".

Project partners

- Faserinstitut Bremen e.V. (FIBRE)
- Bremen Institute for Mechanical Engineering (bime)

2 *A hybrid-cast bracket made of aluminum and CFRP.*

3 *Schematic sectional view of a hybrid composite consisting of aluminum, CFRP, and a decoupling layer made of PEEK.*