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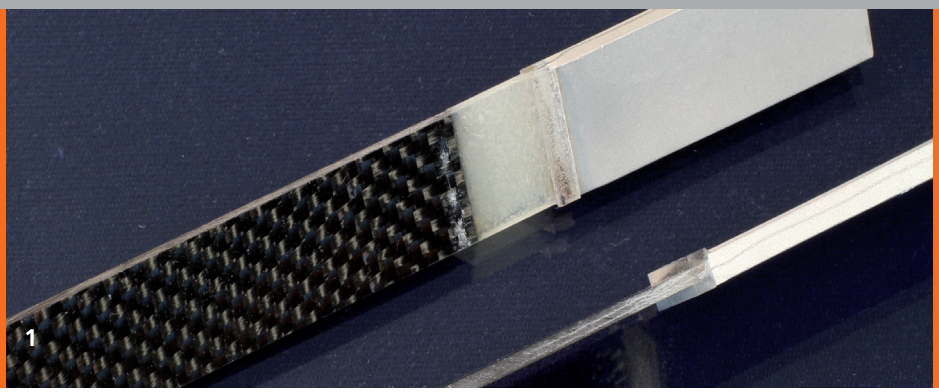

1 *CFRP-aluminum hybrid joint.*

CONSTRUCTION OF LIGHTWEIGHT CFRP-ALUMINUM TRANSITION STRUCTURES

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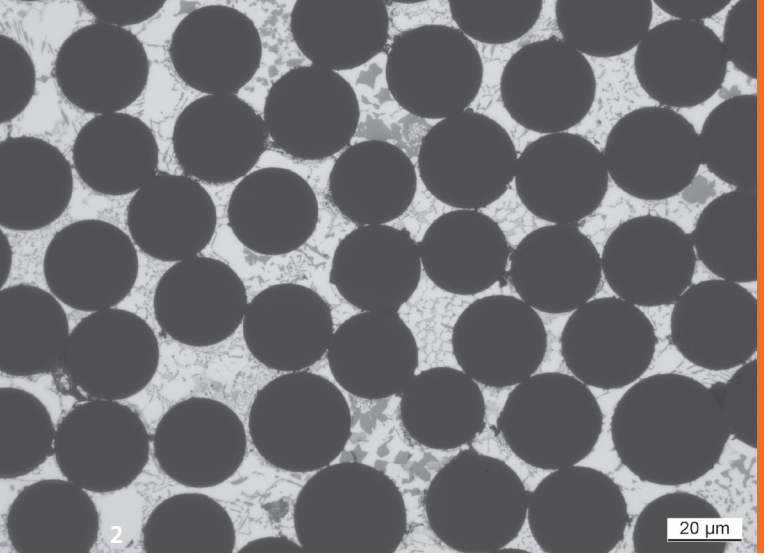
Combinations of fiber composites and aluminum are increasingly needed in lightweight design in order to match local demands with the respective material properties. A major focus in aircraft and automotive construction is on the development of lean, weight-minimized CFRP-aluminum combinations that are characterized by a high load-bearing strength and minimum susceptibility to corrosion, while at the same time being cost-effective to produce.
The DFG research group "Schwarz-Silber" (FOR 1224) at the University of Bremen has therefore set itself the goal of developing and researching innovative transition structures for the connection of CFRP and aluminum. The research group plans, designs and produces innovative joining concepts using casting, welding and textile engineering techniques. Experimental and numerical investigations thereby support the validation and further development of the solutions.

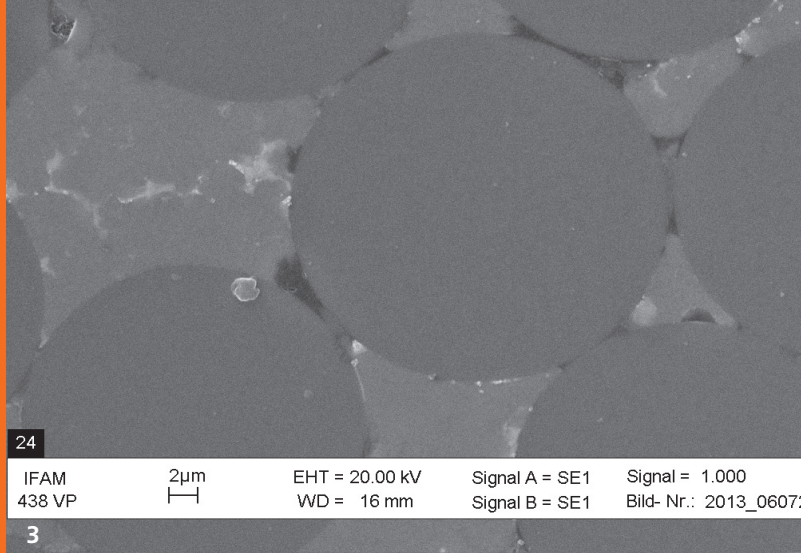
Proposed solutions

Solutions for form-locking and material-integrated joints are being investigated for the development of integral CFRP-aluminum constructions. Two approaches are being studied as potentially very promising solutions.

Foil concept

- Production of a titanium tape structure in the hybrid area
- Welding connection of the titanium tape structure to aluminum





Fiber concept

- Integration of glass fibers in aluminum high pressure die casting
- Textile engineering production of glass fiber/carbon fiber combinations

State-of-the-art

Conventional combinations of CFRP and aluminum are produced by adhesion of laminates and bolted joints. These structures have the disadvantage of becoming thicker in the joint area, of fiber damage and stress increase at the bolts with the associated weight increase, and susceptibility to corrosion.

Potential applications

Typical applications lie in products for the aerospace industry (e.g. lower rudder hinge, sandwich plates, rump segment), in motor vehicle engineering (e.g. CFRP roof, trailing arms), in wind turbine construction (rotor blade, rotor hub connection), and in general machine engineering (e.g. hydraulic elements, articulated arms for robots, power transmission). In addition, a further motivation for the use of such hybrid materials could be the setting of a defined thermal expansion (e.g. in heat pipes for satellites, telescopes or textile machinery).

Current studies

The current research goals lie in the further development of the two concepts. For the foil concept, the studies are predominantly concentrated on the welding of aluminum and titanium foils using lasers and the layer-by-layer production of the CFRP-titanium transition structure. For the fiber concept, the Fraunhofer IFAM is conducting research into the integration of different fiber materials (glass, ceramic and basalt fibers) into aluminum die-cast parts. The studies focus here on the process engineering production of the fiber/aluminum part joint. In particular, research is being conducted into the infiltration of metal melts into fiber materials and the positioning and fixing of the limp fibers during the casting process. Recent developments focus on the conception of a high pressure die-casting mold with modifications for partial sealing and fixing of the fibers. The use of a specially designed mold for the infiltration process aims to enable the process to be expanded to the industrial scale. Priority is being given here to the automatic fixing and partial infiltration of the fibers. The further processing to create complete structures of aluminum and CFRP is being carried out in collaboration with the project partners. At this stage, the fibers protruding from the cast structure are connected with carbon fiber and consolidated using thermoset matrix systems.

Sponsored by

DFG Research Group "Construction Methods for Lightweight CFRP-AluminumAluminium Transition Structures"

Project partners

- Faserinstitut Bremen e.V. (FIBRE)
- Bremer Institut für angewandte Strahltechnik GmbH (BIAS)
- Bremer Institut für Strukturmechanik und Produktionsanlagen (BIME)
- Stiftung Institut für Werkstofftechnik (IWT), Bremen

3 *Metallographic microsection of the glass fiber-aluminum area.*

4 *REM micrograph of an aluminum-wetted glass fiber.*