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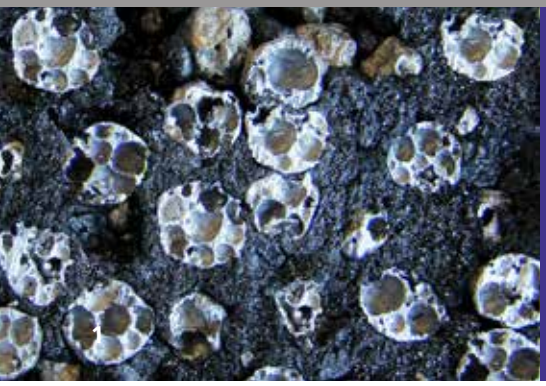

1 *Hybrid particle foam for increased impact performance.*
2 *Door frame structure in hybrid design achieves the required structural performance and offers.*
3 *Combination of continuous-fiber reinforcement and metal inlays in complex 3D structures manufactured by fiber winding.*

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IN COOPERATION WITH

IAM Institute for Applied Materials FAST

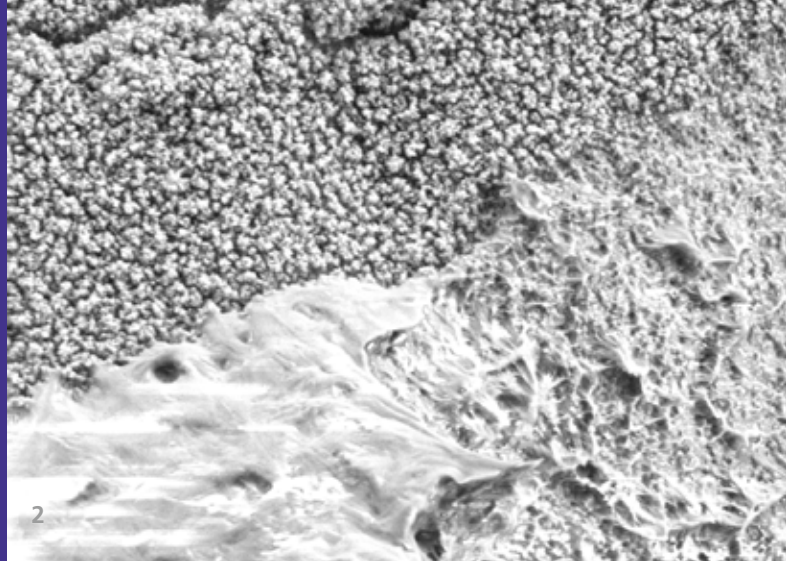
POLYMER-METAL HYBRIDS
APPROACHES FOR MANUFACTURING HYBRIDS IN IN-MOLD ASSEMBLY PROCESSES

Motivation and objectives

Hybrid materials, i.e. composites made by mixing or joining several materials, play a very important role in industrial applications. The aim of hybrid lightweight construction is the mass reduction of lightweight structures and a simultaneous increase in the performance of the construction, in terms of higher strength, stiffness or improved fatigue strength. In addition to fiber-reinforced polymers, high-strength steels as well as light metals like aluminum and magnesium offer a high potential for lightweight design. One major advantage of metals is furthermore the excellent processability. A disadvantage of all light metals is the low stiffness. However, this can be improved by combining them with fiber-reinforced polymers that have a high absolute and specific stiffness.

Research partners

The development of modern tailored composites and hybrids requires extensive knowledge of their processing and material properties, and a methodological description of their mechanical performance.
In order to achieve this, Fraunhofer ICT, together with research partners at the Karlsruhe Institute of Technology (namely the Institute for Applied Materials and the Chair for Lightweight Technology at the Institute of Vehicle System Technology) follows a holistic MMP (Methods-Materials-Processes) approach to describe the investigated hybrid materials.



Approach

The processing equipment available at Fraunhofer ICT offers a broad variety of technologies that allow the in-mold assembly of fiber-reinforced polymers with metal components. The processing of FRP-metal hybrids based on available composite manufacturing technologies is a complex task which requires a multidisciplinary and holistic approach. Knowledge of the interaction between material and processing allows the resulting properties to be derived. Vice versa, it is also possible to tailor the mechanical properties of composites and hybrids. The direct in-mold assembly reduces production expenditure as separate joining operations can be omitted. In order to achieve this, material and process development are combined in the fields of:

- Integration of metal inserts into fiber-reinforced polymers (RTM, SMC, injection molding, LFT, stamp forming)
- Consolidation and in-process forming of fiber-metal laminates
- Manufacturing of sandwich materials with metal foam cores or metal face sheets using PUR spraying
- Combination of continuous-fiber reinforcement and metal inlays in complex 3D structures manufactured by fiber winding
- Hybrid particle foams for improved crash performance
- Coating of metal surfaces with corrosion protection and nano-porous adhesion layer with microwave-generated PECVD

1 *Laser-structured surfaces of metal sheets improve adhesion to thermoplastic tapes.*

2 *Nano-porous adhesion layer infiltrated with polymers. Pull-off test shows rupture of the polymer – not of the adhesion layer.*

Hybrid sandwich structures with CFRP face sheets and aluminum foam cores, with the ratio of face sheet and core thickness adjusted for optimal specific bending stiffness.