Fraunhofer ICT

Sustainable lightweight solutions

Selection of thermoplastic sandwich materials

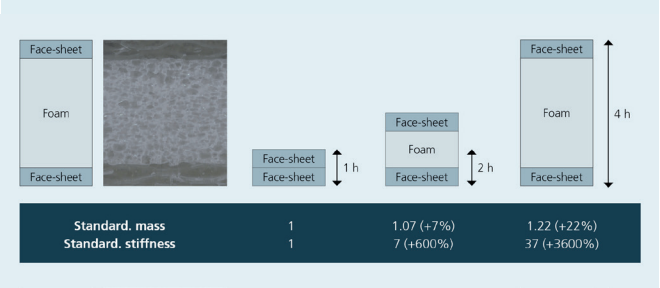
Manufacturing and processing of thermoplastic sandwich composites

Motivation and objectives

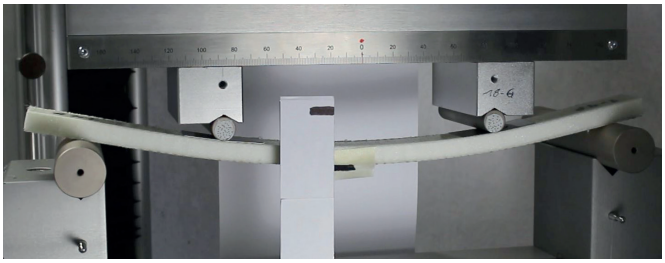
Sandwich composites can offer good bending properties with low weight. This is achieved by combining rigid and solid face-sheets, usually fiber-reinforced plastics, with light, pressure- and shear resistant core materials. To date, adhesive bonding of the individual components is one of the most commonly used methods for sandwich production. However, if the semi-finished products used are based on a thermoplastic matrix, fusion bonding methods can also be applied. This can further exploit the potential for recyclability, sustainability, and lightweight design. Application-specific functionalization can be achieved through thermo-forming and injection molding.

Materials and processes

To process the face-sheets and core into a sandwich composite through fusion bonding, it is necessary for at least one of the components in the interface to be temporarily in a molten state. The resulting intimate contact forms the basis for good adhesion. If the same base polymer is chosen for both the face-sheets and foam core, a cohesive bond can be achieved. The main goal during the process is to prevent the collapse of the foam core. For this purpose, short thermal loads are advantageous, which also lead to short cycle times for production. Fraunhofer ICT is investigating manufacturing processes for cores and face-sheets made from various materials. The developments are carried out through parameter studies on industrial plants, paving the way for industrial transfer. In addition to carbon- and glass-fiber-reinforced face-sheets, the focus is mainly on self-reinforced organo sheets, in which fibers and matrix consist of the same base polymer. The goal is to exploit the maximum lightweight potential from just one material. This is achieved through the combination of different material morphologies: foam, reinforcing fiber, matrix, compact material. Depending on the respective requirements, the appropriate morphology building blocks are chosen. An example of this are mono-material sandwiches, which offer significant advantages in terms of recyclability and sustainability. For the core materials, both conventionally available materials and in-house developments in the areas of extrusion and particle foams are used to achieve an optimal property profile for application in the sandwich.



Significantly improved performance with minimal mass increase using the sandwich approach



4-point bending test

Morphology building blocks

Forming and functionalization

Due to their thermoplastic properties, sandwich composites can be functionalized in processes close to large-scale production. Complex 2.5D shaped geometries with varying wall thickness can be achieved through thermo-forming. For optimized load introduction, core compaction can be used to adjust the stiffness. To meet the requirements of the component, additional functionality can be achieved through overmolding of ribs, clips, or more planar structures. During functionalization processes, low heat transfer into the material is considered to preserve the mechanical performance of the material as much as possible.

Our range of services

We offer our customers expertise in the following areas:

- Benchmark tests
- Feasibility studies
- Process development in fusion bonding, forming, and overmolding on industry-relevant equipment
- Consulting in process and component design
- Characterization of individual components and the composite
- Workshops

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