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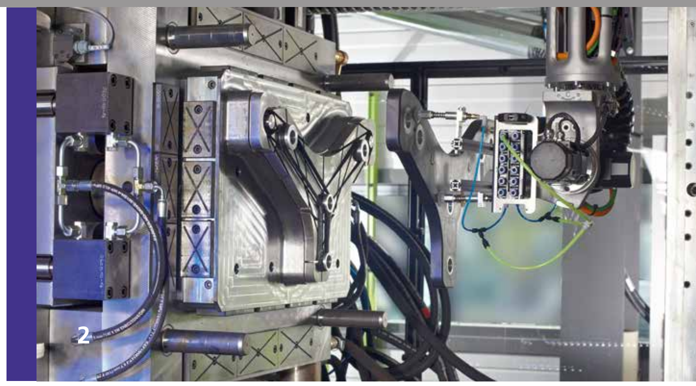

1 *Demonstrator with 3D skeleton structure made of thermoplastic hybrid yarn for a generic structural component.*
2 *Automated component production.*

LOCAL CONTINUOUS-FIBER REINFORCEMENT – TAILORED INJECTION MOLDING

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Lightweight potential for injection molded parts

The reduction of component mass is becoming increasingly important, for example to save fuel and achieve associated reductions in CO_2 emissions in automotive applications. In many cases, metal load-bearing parts can be replaced by short- or long-fiber-reinforced thermoplastics. These composites have become such an integral part of industrial largescale production that it is impossible to imagine production without them, especially due to their economical process-ability and increased functionality.

Limited mechanical properties, such as stiffness and impact strength, prohibit the use of injection molded, thermoplastic fiber composites in applications with higher loads. In addition, the viscoelastic behavior of the polymer matrix at high temperatures or under permanent load is a disadvantage (→ tendency to creep). Local continuous-fiber reinforcement can overcome these disadvantages. Local fiber reinforcement significantly improves the mechanical properties of injection molded parts and reduces the tendency to creep.

Functionality

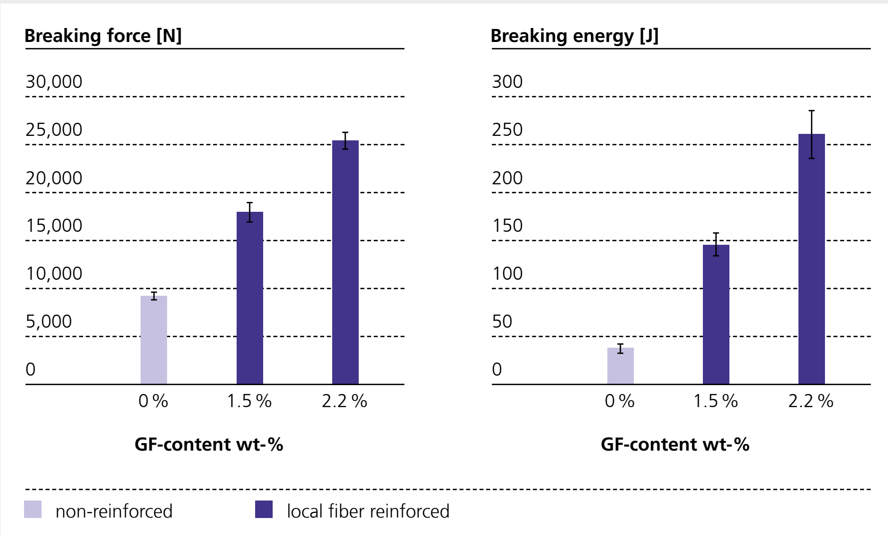
By analyzing the stress curve of parts with pre-defined dimensions, the parts can be divided into load-bearing and non-load-bearing sections. Lines of flux can be identified which show the load gradient inside the injection molded part. The targeted placement of continuous-fiber structures along the application-specific load paths reinforces the component in the areas relevant to its stability.

Smart lightweight construction

When short- or long-fiber pellets are used, the fibers reinforce all areas of the component equally. As the fibers have a higher density than the matrix, the total weight of the component is therefore unnecessarily high, due to the reinforcement of component areas which do not bear significant loads. The targeted placement of continuous-fiber reinforcement in highly loaded areas means that the overall weight of the component is increased only partially, which leads to significant weight savings compared to components processed from fiber-reinforced granules. Ideally, the continuous-fiber structures connect the load application points of the component, for example through metal inserts. The reinforcement materials used (e.g. coiled structures made from hybrid yarn, tapes, UD-profiles, etc.) for the manufacturing of highly stressable hybrid components are selected mainly according to the type and extent of the load and the external load transmission.

Using a robot-assisted impregnation and winding process, local continuous-fiber reinforcements of consistent quality can be produced automatically using hybrid yarn (reinforcement fiber and matrix fiber). As an additional step, the coiled continuous-fiber reinforcements are overmolded as inserts within the injection molding process.

Results of tensile test of demonstrator component (Pegasus-beam, figure 2).



Benefits

- increased lightweight potential due to excellent weight-specific mechanical properties
- increased form stability at high temperature
- lower tendency to creep
- tailored component reinforcement
- optimized load-dependent orientation of reinforcing fibers
- integral design, integration of functional elements

Our service offer

We offer our customers a variety of services, from baseline investigations, feasibility studies and part optimization through to procedural implementation:

- feasibility studies
- benchmark trials
- process development
- consulting service in process and part configuration
- performance of mold trials
- robot-assisted winding tests
- workshops

3 Injection molding compounder at Fraunhofer ICT.

4 Automated impregnation and winding station at Fraunhofer ICT.

5 Coiled reinforcement structures made of pre-impregnated fiber strands, material system PP/GF.