reCa-Mit

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INNOVATIVE USE OF RAW MATERIALS IN THERMOPLASTIC PROCESSES PROJECT RECA-HIT

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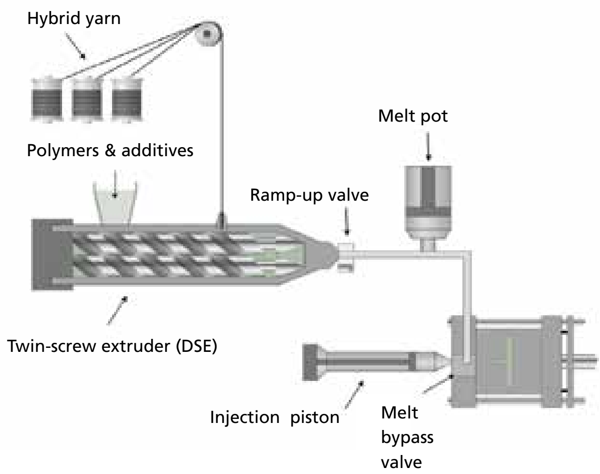

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Starting point

To achieve a sustainable use of limited natural resources, lightweight construction is becoming increasingly important. The use of fiber-based materials as lightweight solutions, for example in mobility, increases the potential to save valuable energy and material resources. However, the economical use of materials and the conservation of natural resources also requires significant improvements in the recycling of fiber-reinforced plastics, especially carbon fibers, which require significant energy to produce. The sustainability potential of this class of material can only be fully exploited by extending its service life using innovative recycling methods.

There are many ways to close material loops. The main difficulty lies in integrating approaches found in research into industrial production and demonstrating that reliable and consistent component quality can be achieved. In addition, industrial-scale reuse is generally limited to short fibers, if it occurs at all. In this context the technology transfer project Reca-Hit, for the substitution of primary raw materials with recycled carbon fiber hybrid yarns in innovative thermoplastic processes, was initiated.

Objective and approach

The aim of the project is to increase acceptance of recycled materials by demonstrating that the material-specific properties remain the same in large-scale applications.

In collaboration with industrial partners, the technology and material innovations are transferred from research to industrial fibers, in order to use recycled materials in industrial applications. Secondary carbon fibers processed to hybrid yarns are used in D-LFT injection molding and 3D skeleton winding (3DSW). It is possible to use a hybrid yarn alone as a substitute for the primary roving, i.e. as a starting material for reinforcement in injection molding. Alternatively, the hybrid yarn, as a local continuous fiber reinforcement, can be combined with a global long fiber reinforcement via 3DSW.

The performance of secondary fibers in comparison to reference samples made of primary materials will be demonstrated by a comprehensive mechanical characterization of the test specimens.

Innovative use of raw materials in plastics production

The injection molding process is a fully developed series-capable plastics manufacturing process, for example for the production of semi-structural components for the automotive reinforced granules. Conventionally, only short-fiber-reinforced granules (SFT-G) or, if enhanced mechanical properties are required, so-called long-fiber thermoplastic granules (LFT-G) are used in injection molding. The production of LFT-G is much more cost-intensive than that of short-fiber pellets. The pellets are produced separately from the raw materials by a supplier of semi-finished products. This process step requires a certain amount of energy and material, and is therefore more expensive. Also, the pellets must be remelted during the manufacture of the components, which requires additional energy.

Further processing in injection molding leads to a significant reduction in the original fiber length in the pellets, which makes using LFT-G even less advantageous.

With the aim of saving resources (by eliminating time-consuming intermediate process steps) and improving properties by achieving the longest possible fiber length in the injection-molded component, direct long-fiber thermoplastic processing (D-LFT), developed in the early 2000s, has been intensively researched and enhanced at Fraunhofer ICT. The direct use of continuous-fiber semi-finished products in the form of rovings and cost-effective, unreinforced standard granules not only saves the intermediate step of producing rod-shaped pellets, but also significantly increases the relative bending stiffness and impact strength compared to short-fiber-reinforced components.

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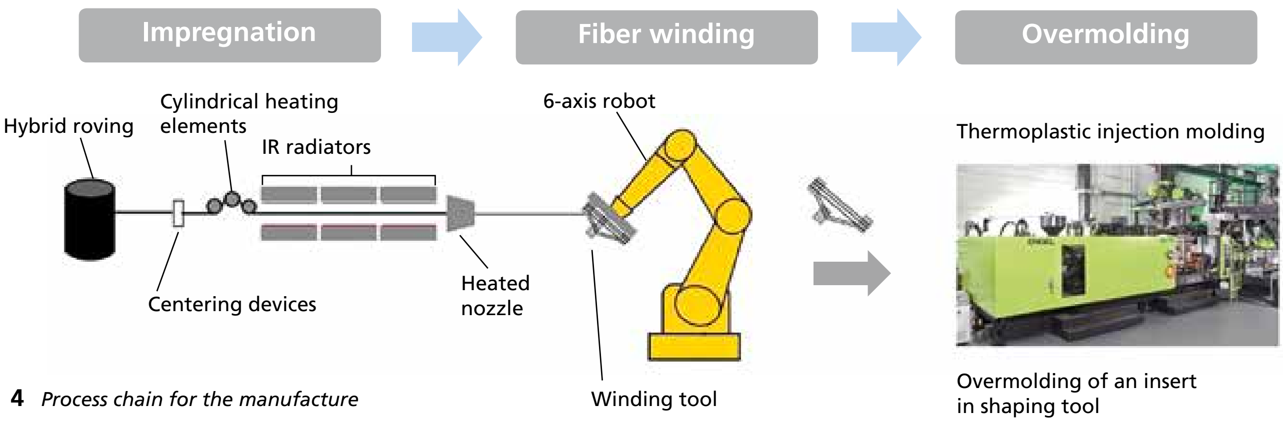
1 *Feeding station for recycled carbon-fiber hybrid yarns in the D-LFT injection molding process.*
2 *Basic setup of the D-LFT injection molding process, shown schematically.*
3 *Generic winding structure with continuous-fiber reinforcement.*

COVER PHOTOGRAPH:
Injection press composite for the processing of directly plasticized long-fiber thermoplastics.

To further increase the lightweight potential of this component class, it is possible to integrate a local continuous-fiber reinforcement into process technology of D-LFT injection molding. Here, 3DSW is one of the most promising approaches. In contrast to other processes, fiber reinforcement is only used locally in the most heavily loaded areas of a component. Compared to conventional injection molded components, the resulting materials thus have advantages in terms of mechanical properties, e.g. better component rigidity and strength as well as lower creep tendency. Since the component areas subject to low loads can be designed with comparatively low fiber contents, significant weight and cost advantages are achieved. This technology is particularly interesting for highly loaded and weight-optimized structural components, such as those in vehicles.

The process chain for manufacturing structural components with local continuous-fiber reinforcement can be divided into three process steps (figure 4): Impregnation and winding of the local continuous-fiber reinforcement, and its overmolding in D-LFT injection molding.

Combination of winding process and D-LFT process subdivided into three process steps: Impregnation and winding of the local continuous-fiber reinforcement, and its overmolding in D-LFT injection molding.



4 *Process chain for the manufacture of thermoplastic winding components.*