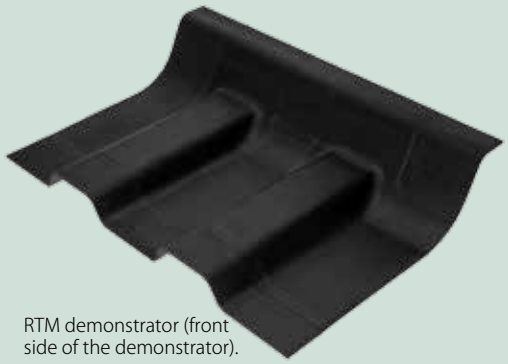
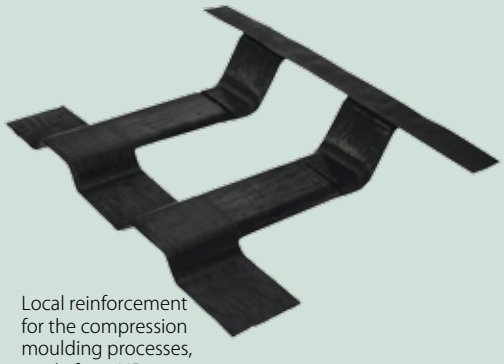


RTM demonstrator (front side of the demonstrator).



Local reinforcement for the compression moulding processes, made from UD tape.

CFRPs for Structural Components in Automobiles

Evaluation of the potential of thermoset and thermoplastic process technologies for high-volume production of carbon-fibre-reinforced plastics (CFRPs) automotive parts, presents Michael Karcher and Prof. Dr.-Ing. Frank Henning.

Project Overview

The project MAI Qfast within the MAI Carbon Cluster (a cluster Initiative programme), is carrying out a systematic evaluation of the potential of carbon-fibre-reinforced plastics (CFRPs) in combination with different manufacturing process technologies including design, manufacturing and benchmarking. Five different processes for CFRPs have been used to create structural components in automobiles. Both, thermoset and thermoplastic matrix systems have been benchmarked and processed either by resin transfer moulding (RTM) or compression moulding. The project consortium consists of BASF as a material and semi-finished product supplier, the Fraunhofer Institute for Chemical Technology for material and process development and in particular, the two independent OEMs Audi and BMW. The project MAI Qfast will answer questions about carbon fibre composites, selection of the matrix system, the most suitable processing technology and the resulting cycle time, energy need, cost effectiveness as well as static and dynamic performance of these components.

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Ambitious Floor Panel Structure as Demonstrator

As the main focus of MAI Qfast is a comparison of the specific potential of thermoset and thermoplastic CFRPs for large-scale production, it was important that the chosen demonstrator - an ambitious floor panel structure - could be produced using either RTM or compression moulding technology. Five different CFRP-materials and three different processes (RTM, SMC and LFT-D) have been developed for benchmarking, for a demonstrator derived from a floor panel structure. The influence of the technology, the material and the component geometry on the cost and performance and the applicability in large-volume production is of major importance for OEMs and their suppliers. Only commercially-available materials have been used to ensure a complete comparability. During the whole project, the engineering work was accompanied by simulation.

Compression Moulding or RTM?

The compression moulding processes are represented by thermoset sheet moulding compound (SMC) and direct long-fibre-reinforced thermoplastics (D-LFT), both combined with continuous fibre reinforcements to improve the mechanical properties. Beside the compression moulding processes, the RTM process using a thermosetting epoxy, a thermosetting polyurethane and a thermoplastic polyamide as resin was selected. For the comparability of these processes, one type of carbon fibre was chosen and used for each technology. Only slight modifications, such as the sizing of the fibre, were carried out.

Comparability of the Benchmark

The same type of carbon fibre (with adapted sizing) was used for all trials, either in thermoplastic or thermosetting resin, as well as for the production of semi-finished sheets for sheet moulding compound (SMC) processing. As a benchmark for the carbon fibre SMC, the long fibre thermoplastic direct process (LFT-D) based on carbon fibres was performed. The LFT-D process combines an in-line compounding unit with a subsequent compression moulding unit. Fibres and resin are gravimetrically dosed and homogenised in the extruder. Meanwhile, the unidirectional reinforcing tapes are heated up and brought into the shape of the demonstrator. The extruded D-LFT material is placed in the mould together with the carbon fibre structure and pressed to the final part. After demoulding, post processing (for example, trimming) is required, depending on the application.

For the third alternative, the RTM process, the carbon fibres were processed to form a non-crimp unidirectional fabric. In this process, several layers of the textile are stacked together, heated and formed to a stiff 3D-shape - a so-called preform. For comparability, stacking of the preforms is adopted for all RTM resin systems. The preform is then placed into the mould, the mould closes and the preform is infiltrated. After a certain curing time, the part can be demoulded.

Demonstrator Production

The demonstrator parts for the RTM and the two compression moulding processes differ in some details (e.g. ribs at the compression moulded parts) according to the material involved, but fit in an identical design space. Before investments were made in mould hardware, the component design was analysed and optimised using the mechanical properties of the selected CFRP systems, which were determined through the characterisation of test specimens. The demonstrator parts produced are to be tested, evaluated and validated as the next phase of the project.