Composites – Lightweight production solutions from a single source.
The days in which composites were the exclusive preserve of the aerospace or motor racing industries are long gone. The trend towards electric mobility and lightweight construction will accelerate the deployment of CFRP components in the automotive industry. These high-quality composite materials are also playing an increasingly important role in rail transport, agricultural machinery, the sports and leisure industry and renewable energies. The properties of these modern materials can be “customized” through the selection and quantity of the components and the choice of production process.

FRIMO has many years of extensive experience in tooling and equipment for the material-saving and economic processing of composites and delivers customized production facilities, for instance for RRIM, SRIM/GMPU, long fiber injection, CRP, GMT, LFT, BMC, SMC and RTM, that are ideally adapted to the manufacturing process.

**Thermoplastics / Organo Sheets**
- Material Handling
- Heating
- Forming
- Flexible Trimming
- Automation
- Tests
- Handling of components
- Tool Handling / Storage

**Duroplastics**
- Material Handling
- Pre-Forming / Pre-Cutting
- RTM
- Flexible Trimming
- Automation
- Tests
- Handling of components
For the processing of thermoplastic composites FRIMO offers innovative tooling and equipment for a wide range of different applications. Our customers can rely on solutions that are tailored to their needs and take into account the special requirements of the relevant industry.

Composites are already used in the aircraft industry on a series-production scale in order to achieve both weight reduction and enhanced strength at one and the same time. The clips for the aircraft body which were traditionally made of aluminium can be mentioned as one example. For the Airbus A350 XWB these are made of organo sheets (a carbon-fiber fabric with a thermoplastic matrix) using a fully automated production facility from FRIMO.

Due to the large variety of clip geometries, more than 2,000 tools were built, which are changed by means of a fully automated tool changing system. This function is integrated into the customer’s PDA. Thus thousands of clips with different geometries can be produced with extremely short cycle times, and without folds or pores, while guaranteeing the highest levels of quality and reproducibility.

The FRIMO service portfolio includes:
- Tooling technology for complex structural components
- Press technology
- Process interlinking (automated or partially automated)
- Post-processing by punching, flexible trimming, joining or assembly
- Process data acquisition
- Safety engineering

More than 2,000 tools for the aerospace industry

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Multifunctional equipment for on-road test

The system which FRIMO installed at the Institute of Plastics Processing in Aachen consists of two separate stations, a heating and a consolidation station, connected by a shuttle system. This allows to handle semi-finished products of 500 x 750 mm in size and to manufacture components with a depth of up to 300 mm. In addition to conventional stamp forming, various compressed air (diaphragm) forming processes are possible, as is vario-thermal direct processing.

Using inline impregnation technology it is possible to combine customized preforms to suit from virtually any thermoplastic semi-finished products and reinforcing textiles. The preforms are built using film stacking, impregnated in the heating station and then transformed from first heat into complex three-dimensional components. 3D preforms can also be directly impregnated and consolidated with variothermal tools without pressing.
A wide range of structural components is manufactured by use of RTM (Resin Transfer Molding) processes. This means that fiber fabrics or preforms are inserted into the tool and the reactive matrix material is injected into the closed mold. FRIMO offers everything from the appropriate tailor-made tooling and equipment right through to complete production solutions for the use of the widest range of different epoxy- or polyurethane-based matrix materials.

New approaches and solutions for the series-production manufacture of structural components using the RTM process are opening up unprecedented opportunities in terms of the quality, efficiency, ergonomics and robustness of the process. Moreover, such components can also be designed with filigree or even bionic surface structures in the future, also with in-mold painting.
Thermosetting composites - Structural components in the RTM process

Monocoques in the RTM process

For the world’s first series-production RTM monocoque FRIMO provided the complete tooling and equipment. A monocoque is a self-supporting passenger cell, i.e. the carrying structure of the vehicle is a shell. The unique structure of the outer skin of this shell absorbs all the external forces acting on it. All the other elements of the vehicle are mounted on this structure. For a current supercar the carbon-fiber monocoque is not, as was previously widely the case, made of carbon fiber prepregs but uses the RTM process, for which FRIMO developed and delivered the manufacturing equipment. A particular challenge in this case was the cycle time requirement.

For the monocoque so-called preforms are built on the lower part of the tool to create a total preform. After the tool is closed, epoxy resin is injected into the cavity, whereupon the fiber preform is completely impregnated with the resin [resin transfer molding - RTM]. After curing the monocoque can be removed from the tool.

A different approach - Structural components by use of HD-RTM with optimized fiber preforms

High-pressure resin transfer molding (HD-RTM) is taking on increasing significance in the mass production of structural components made from fiber-reinforced plastics. Working with optimized fiber preforms offers significant advantages in the production of these high-strength components with the required shapes and properties. The “Part via Preform” (PvP) technology developed by Toho Tenax Europe leads from roving spool to preform in a single step. This thread used here makes it possible to automatically produce preforms that are already in the three-dimensional shape of the component. FRIMO has positively tested the behaviour of these optimized preforms in further processing through HD-RTM using a component developed specially for the purpose. During the tests, the preforms were saturated with various matrix materials, based on polyurethane and epoxy resin. FRIMO has constructed and produced a test tool for this to further process the complex preforms through HD-RTM. The tool has been fitted flexibly, but close to production-oriented specifications. Its features include:

- Flow front sensors for resin detection
- Automatically controlled vacuum components with change options
- Various types of sprue
- Tool change inserts to vary the geometry of the component
- Flexibly adjustable fiber clamps
- Steel cavities
- Close-to-production tempering device
The FRIMO Group is a specialist in technology for lightweight construction solutions and natural fiber processing and has already demonstrated its expertise in the field of NFPP manufacturing and processes in a large number of completed reference projects. These include complete production units for the pressing of different natural-fiber carrier components. The combination of various technologies and the integration of different process steps play a significant role when developing and designing innovative and economical production solutions.

A clever combination - Forming and back injection molding in one step thanks to organo sheet injection

With the organo sheet injection (OSI) process, FRIMO offers an innovative and ingenious way to combine forming and back injection molding in one step in order to speed up the process and make it more economical. This allows the originally separate steps of the pressing of semi-finished tabular sheets and the subsequent back injection to be integrated into a single process.

The preheated flat semi-finished products, e.g. NFPP (natural fiber mats + PP) or organo sheets (CF, GF, aramid-fiber fabrics / mats with different thermoplastic matrix structures) are first formed in the mold and then immediately back-injected. During this back injection, features such as mounting lugs or targeted reinforcements etc. can be integrated and the edge of the part completely finished. The combination of process steps into a single process can result in considerable cost savings on the part of the tool in addition to the reduction in cycle time. Moreover, the costs of handling and storage are reduced.

Fields of application for the organo sheet injection procedure:
- Glass- or carbon-fiber-based structural components
- Seat frames, seat shells
- Body parts
- Applications in the aviation industry field
- Applications in vehicle interiors (natural fiber PP)
- Door, side, pillar or seat back panels, which can then be laminated with decorative textiles or films

Equipment assemblies supplied by FRIMO on the example of fully automated carrier press systems for door panels in the context of a sustainable manufacturing concept (material / energy consumption, space):
- Mat magazine (as a turntable or double mat magazine for an uninterrupted change of material)
- Mat alignment (possible with a flexible robotic solution)
- Sizing press
- Mat transfer
- Forming press
- Forming tool
- Removal of component part
- Tool change
- Raw part punch for trimming
- Device to pinch “Master Location Points”
- Handling robots (e.g. for laser marking)
- Periphery: extraction system, unloading shuttle, cooling station, waste conveyor system
- System control unit
FRIMO - For the right mix and a perfect final result

FRIMO PURe Mix - The right mix makes the difference

Along with its production facilities for lightweight components, FRIMO can deliver the matching mixing and metering equipment. Here, too, FRIMO is breaking completely new ground by manufacturing all PURe Mix mixing and metering machines from an absolutely standardized construction kit. From this it is possible to configure any machine, ranging in technology from the very simplest to the most elaborate. Mounted on a base frame and equipped with an electronic control unit, the machines can work completely self-sufficient. In the arrangement of the components, particular emphasis is placed on ease of operation and maintenance. Mixing and metering equipment for the smallest output capacities and for abrasive or corrosive materials is also part of the product portfolio. At the same time, with the PURe Mix systems, almost all epoxy resin- or polyurethane-based matrix materials can be processed.

Perfect subsequent machining - Punching, Flexible Trimming, Joining or Assembly

In the context of system solutions for the processing of high-quality fiber-reinforced plastics [composite technologies], FRIMO develops and supplies the tooling and the necessary equipment for the post-processing of lightweight components. This can be done, for example, by means of trimming using punching or robot-assisted systems and also by means of various joining or assembly processes.

Within the framework of a technology-neutral advice and optimal technology package, FRIMO supports customers in the early stages of development:

- Comprehensive consultation
- Component, process and production optimization
- The manufacture and testing of systems and tools in the FRIMO TechCenters
- Validation of materials, technologies and processes along the whole production chain
- Use of synergies between the various technologies
- Combination of process steps to reduce the handling operations

Customer benefits:

- Technically mature and proven production systems
- Optimally matched processes
- Minimized production risk in series production
- Years of expertise
- Worldwide handling of large projects as a general contractor
- Production of prototype parts
- One face to the customer for all participating project partners
- Worldwide Service