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Tailored blank line
with Fiberforge and Fibercon systems

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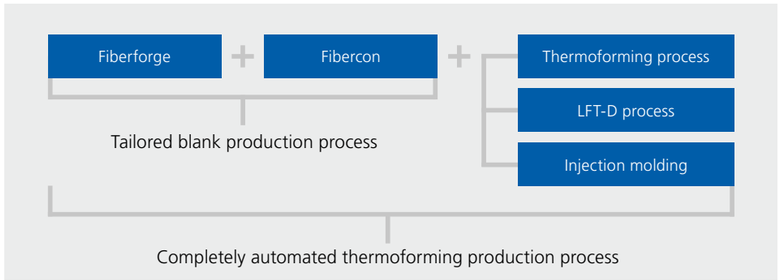
High-volume production of tailored fiber reinforced thermoplastic composites

Continuous fiber reinforced thermoplastics are the future of structural composites. Thermoplastics offer excellent toughness, stiffness, chemical resistance and flammability performance.

To make thermoplastics applicable for high-volume production in the automotive and other industries, the complete production process needs to be highly efficient with short cycle time and low scrap rate.

All of these benefits can now be brought into large-scale production in a precise, fast and economical way with the new Fiberforge and Fibercon systems.

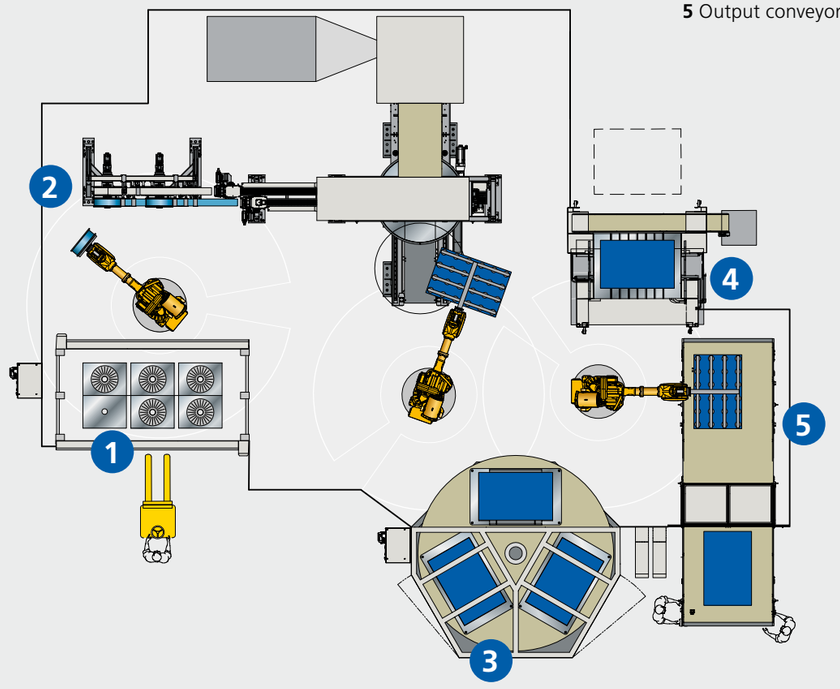
Dieffenbacher as a system supplier can offer the complete manufacturing process:



Using Fiberforge and Fibercon together with downstream systems, such as the handling robot and forming press, more than one million parts can be manufactured per year on just one line. As system supplier of this production line, Dieffenbacher is able to ensure a smooth process and optimum system availability.

Tailored blank line -
Example of an integrated production system

1 Roll destacking station
2 Fiberforge system
3 Fibercon system
4 Cutting system
5 Output conveyor belt



Fiberforge

The world`s fastest tape laying system

Fiberforge creates flat, net-shape engineered laminates from continuous glass or carbon fiber tapes. The system can handle up to four different tape materials in one production run. The complete production process is fully automated, including an automated spool changing system that enables uninterrupted production.

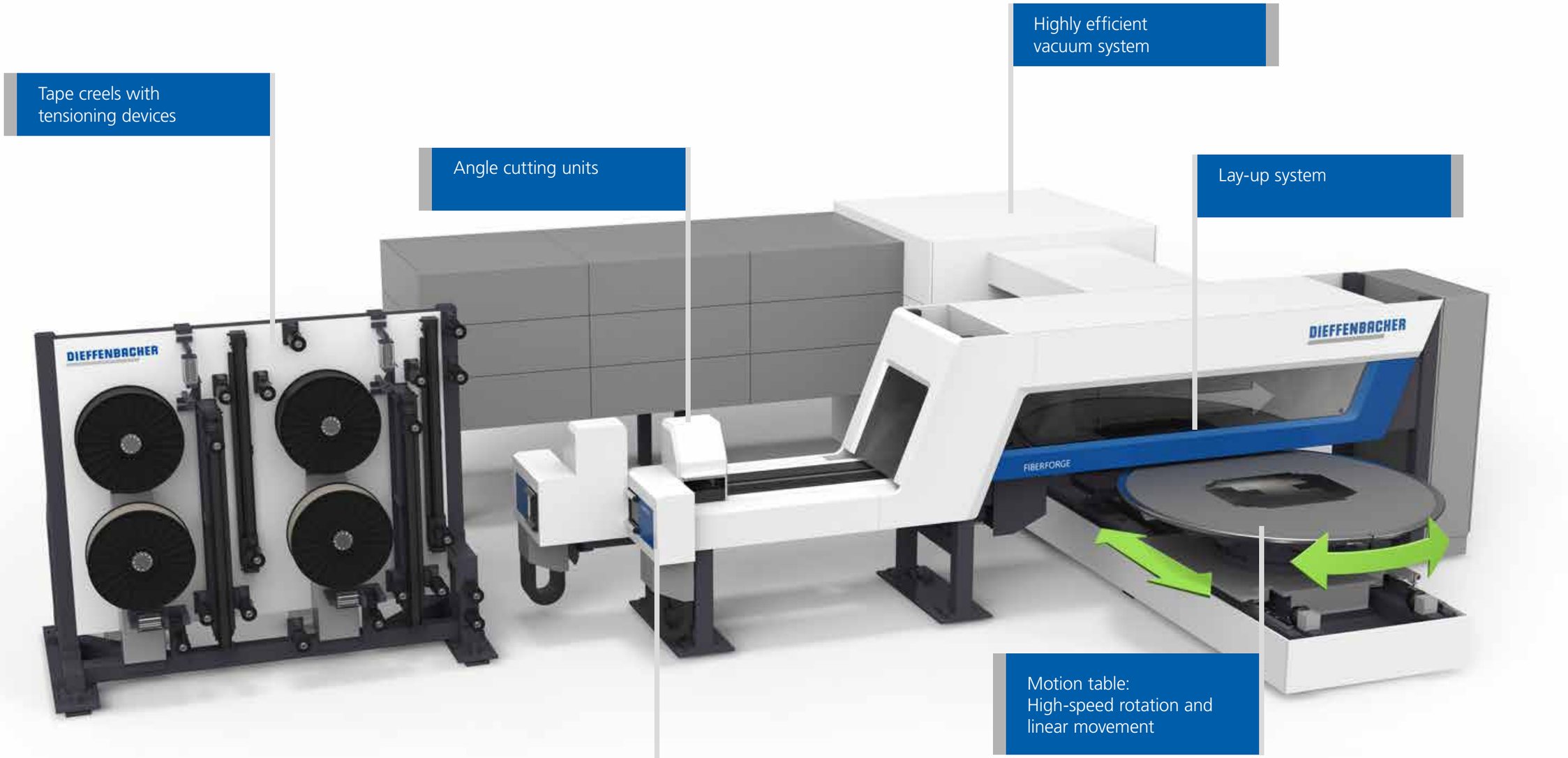
Using continuous fiber tapes minimizes the high cost of waste typically associated with lay-up from fabric materials while concurrently producing lighter laminates with 10-30% higher structural performance than weave-based laminates.

Fiberforge is equipped with an angle cutting system to cut the edges of the tape precisely and near-net shape to the part geometry, ensuring additional material efficiency. With its capability to lay up multiple tape sections in one cycle, performance can be increased. This leads to a significant benefit in the production of multiple parts as well as frame-style parts.

Fiberforge System Highlights:

- Highest throughput – up to 490 kg of material per hour
- Lay-up cycle time less than one second / course
- Multiple tape segments in one cycle
- Minimum waste with integrated angle cut system
- Multiple layers with accurate, repeatable and reliable positioning
- Fully automated production process, including automatic spool-changing system
- User-friendly software generates component design from 2D model
- Industry 4.0 ready

Tape laying requires less than 1 second per cycle – 3.5 times faster than before.



Process Summary

1. Fiberforge includes two parallel running rapid tape dispensing systems that feed composite tape through a track positioned above a two-axis motion table. Based on the specifications of the part being produced, tape lengths are fed into the track, cut and placed on the table.
2. As the tape is placed and fixed by the vacuum system on the table, a series of ultrasonic weld tips descend and rapidly tack the tape to the ply beneath it.
3. The motion table is equipped with a vacuum system to hold the tape lay-up firmly in its position.
4. Following welding, the table indexes to a new position to lay the next two courses. This process repeats until a multi-ply tailored blank is constructed.
5. Following lay-up, the blank is picked up, then consolidated and thermoformed into a 3D part.

Fiberforge Specifications

Maximum Blank Size	Diameter of 2.000 mm
Tack System	2 x 12 ultrasonic spot welders
Creel System	4 spools up to 630 mm diameter, up to 65 kg of material per spool
Maximum Throughput*	490 kg/h
Cutting System	+45° to -45° angle cut
Resolution	C = 0.01° Y = 0.025 mm U = 0.1 mm
Repeatability	C = ±0.05° Y = ±0.2 mm U = ±2.0 mm
Tape Width Range	50 mm - 165 mm
Tape Thickness Range	0.1 mm - 0.4 mm
Tape Length Range	50 - 2000 mm

* Based on 165 mm PPIGF tape width, 0,25 mm thickness and 2000 mm average tape length.

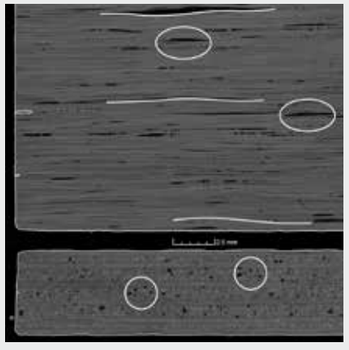
Fibercon

Vacuum-assisted consolidation of tailored blanks

The Fibercon system is designed for the consolidation of tailored blanks of all kinds. It transforms continuous-fiber tape layup created by the Fiberforge system into flat, net-shape engineered laminates with exceptional quality. This is achieved with a novel process technology of high-efficiency vacuum consolidation.

During the entire process, the material is kept under high vacuum pressure. Due to the absence of air, the void content can be reduced significantly. The quasi inert atmosphere reduces the level of oxidation under processing temperature and re-duces the degradation of the material. All of this contributes to great benefits and results in the exceptional quality of the blanks. The system is even able to heal impregnation defects, which may stem from the manufacturing process of the thermoplastic tape material.

Fibercon can process multiple tailored blanks at once, large blanks with nested parts as well as parts with thickness variations (e.g. local reinforcements). With a powerful infrared heater the tape layups reach the process temperature very quickly. Fast cooling is achieved by a water-cooled conductive system. Fibercon can process all thermoplastic matrix materials. Thanks to a special surface treatment of the tooling, the system does not require any release agent for processing common automobile-grade polymers.



State of the art consolidation quality
Porosity < 2%
Fiber ondulations

Fibercon consolidation quality
Porosity << 1%
Perfect fiber alignment

Source of reference: Fraunhofer ICT

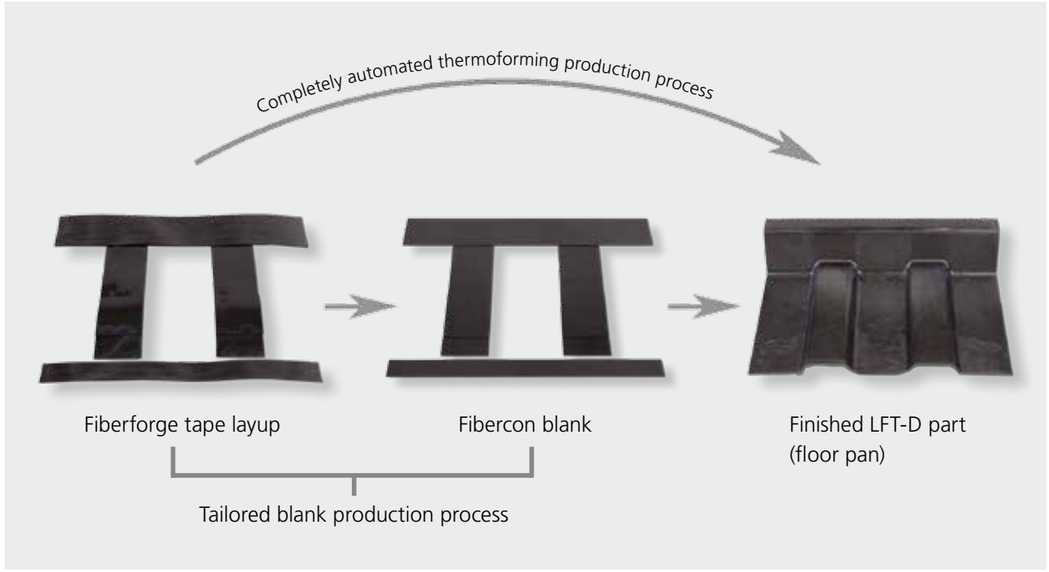
Fibercon System Highlights:

- Perfect consolidation of net shaped tailored blanks
- Very low void content due to vacuum-assisted process
- Capability to heal tape impregnation defects
- Minimized material degradation in an inert atmosphere, resulting in higher component quality
- Minimized squeeze flow at the edges for optimal material utilization
- Short cycle time for high-volume production
- Tailored blanks with thickness variations can be consolidated in one cycle

Process Summary

The Fibercon system is built as a rotary three-stage machine:

1. The first stage is the unloading/loading station, where the previously consolidated blank is removed and the unconsolidated tape layup is placed onto the reception table.
2. The tooling is closed and vacuum pulled inside the cavity. The rotary system moves the tooling into the Infrared heater station, where the tape layups are subjected to high-intensity Infrared radiation. In a short moment under controlled IR heating action the consolidation temperature is reached throughout the blank.
3. The last rotary stage is rapid cooling under homogeneous load to finish the consolidation process.



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Fibercon Specifications

Model	Fibercon M	Fibercon L
Max. Blank Size	950 x 1700 mm	1500 x 2000 mm
Blank Thickness	min. 0.5 mm; max. 6 mm	min. 0.5 mm; max. 6 mm
Dimensions	4600 mm Diameter 2500 mm Height	6000 mm Diameter 2800 mm Height
Transition Time Step to Step	5 s + heating / cooling time	6 s + heating / cooling time
Heating Media	Infrared	Infrared
Max. Heating Temp.	max. 400°C	max. 400°C
Cooling Media	Water	Water

INDUSTRY EXAMPLES:

- Automotive
- Aerospace
- Railway
- Construction
- Packaging
- Sports and leisure

APPLICATIONS EXAMPLES:

- Seat structures
- Load compartment
- Battery compartment
- Inner door