Tailored LFT-D

Endless fiber reinforced long-fiber compound materials for the economical production of thermoplastic structural components
Acknowledgement

- **Titel:** Endless fiber reinforced long-fiber compound materials for the economical production of thermoplastic structural components

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Reasons for the change to fiber reinforced plastics in the automobile industry – body in white in light weight design

The weights of cars permanently increased because of:

Active and passive safety systems
- Airbag systems
- Crash safety
- Side impact protection

Higher demands for comfort
- Driving assistants / sensory system
- Navigation und communication systems
- Increasing motor power
- Increasing volumes of vehicles
- Large number of servo drives

Emission control

E-Mobility
- Hybrid drive
- Pure electric drives
- Battery systems
Lightweight design for structural components

<table>
<thead>
<tr>
<th>Material</th>
<th>Lightweight Potential Reduction with Same Function</th>
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<tbody>
<tr>
<td>Steel</td>
<td>- 40 %</td>
</tr>
<tr>
<td>Aluminium</td>
<td>- 49 %</td>
</tr>
<tr>
<td>Magnesium</td>
<td>- 52 %</td>
</tr>
<tr>
<td>CFRP quasiisotropic</td>
<td>- 75 %</td>
</tr>
<tr>
<td>CFRP unidirectional</td>
<td></td>
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</tbody>
</table>

Source: www.audi.de
LFT production gains a higher market share - EUROPE

- In 2014, the GFP production volume remains below the level of 2004
- The share of thermoplastic form products increased from a market share of 7 to 11%
- Average growth of 4.5% per year
- Strong growth of CFRP of approx. 13%/year

2004 total GFP 1,041 kt
- 74 kt (7% LFT/GMT, 93% GFP in total without GMT/LFT)

2014 total GFP 1,020 kt
- 114 kt (89% LFT/GMT, 11% GFP in total without GMT/LFT)

Source: AVK-TV
LFT production gains a higher market share

Market development of GMT and LFT in Europe

Source: AVK-TV
LFT-D Dieffenbacher direct process

- LFT-D components in automotive applications
LFT-D Dieffenbacher direct process

- Two-machine techniques
  Optimal compounding and fiber integration

- High profitability
  Elimination of cost-intensive manufacture of semi-finished products

- Flexible formulation adaptation to the component requirements

- High mechanical properties
  because of long fibers of >20mm

- Excellent mold flow characteristics

- In-Line processing of recyclate
Dieffenbacher LFT direct process

Direct process for high material properties

Strength/rigidity

Impact strength

- Short-fiber reinforced thermoplastics
- Long-fiber reinforced plastics
- Filler-reinforced plastics
- Elastomers
- Tailored LFT
  - LFT parts with local reinforcements (fabrics, profiles, rovings)

Dieffenbacher process > 20 mm in part (>75%)

Fraunhofer Institut Chemische Technologie

Fabric reinforcement
UD profile reinforcement
Roving reinforcement
Tailored Fiber Placement – LFT-D – process steps

TFP- LFT-D

UD Fiber tape → Tailored Blank → Consolidated laminate → TFP/ T-LFT-D part

Picture: Courtesy of FIBERFORGE

FIBERFORGE RELAY® Station
Tailored Fiber Placement – LFT-D – process steps

TFP- LFT-D

UD Fiber tape

Consolidated laminate

Picture: Courtesy of FIBERFORGE
Fiberforge RELAY® Station

- Tailor-gen® Software for automated ply generation and stacking optimization
- Different tapes can be processed within one blank
- Automatic loading of tape spools for uninterrupted production runs
- Local thickness changes possible

Automatic layer optimization

Automatic superposition of the welding spots

Local thickness changes and holes
High flexibility in the manufacturing process

Combination of materials within one production line as follows:

- Pure LFT-D parts
- Pure Tailored Blank structural parts
- Full size Tailored Blank structure with LFT-D functionalization
- LFT-D with local UD fiber reinforcements
Relay Station

- Spool Holders
- Auto Feeder
- Tape Feeder
- Welder Heads
- Motion Table
- Vacuum Table
Tailored Fiber Placement – LFT-D
TFP- LFT-D

UD- Tape 0° layer
Tailored Fiber Placement – LFT-D
TFP- LFT-D

UD- Tape 45° layer
Tailored Fiber Placement – LFT-D
TFP- LFT-D

UD- Tape 90° layer
Tailored Fiber Placement – LFT-D
TFP- LFT-D

Local reinforcements
Tailored Fiber Placement – LFT-D
TFP- LFT-D

LFT- ribbing
Tailored Fiber Placement – LFT-D Video

Video
Comparison of material properties

Density - fiber reinforced plastics

![Graph showing density comparison of various fiber reinforced plastics materials](image-url)
Comparison of material properties

spec. Tensile Strength/ Stiffness fiber reinforced plastics


- Steel
- ALU
- SMC
- LFT-D
- T-LFT-D
- TFP-Blanks
- CFRP/ Epoxy

spec. Tensile Strength [MPa/ (g/cm³)]

spec. Stiffness [GPa/(g/cm³)]
Economic advantages of endless fiber reinforced thermoplastics

- The high costs of high-performance fibers determine the material costs also with this material group

- PP and PA 66 with quasi-isotropic glass-fiber reinforcement obtain approx. 40-45% of the specific strength of Epoxy based CFRP

- However, the material costs of PP-GF respectively PA66-GF are only approx. 10-20% of Epoxy based CFRP

- Short cycle times of < 60s improve the productivity and profitability

- Near net shape Tape placement process reduced material loss

- Simple process with low reject rate

- Production waste can be recycled - 100% reuse as material
Tailored Fiber Placement – LFT-D
Plant layout
Summary

- Inline Process Technologies for structural applications will become more important in the future
- Thermoplastics with endless fiber reinforcement offer a low cost light weight construction alternative for semi-structural and structural applications
- Tailored LFT-D offers a very high flexibility of different material combinations and fiber orientation
  - LFT-D
  - LFT-D / Tailored Blank
  - plane Tailored Blank Material
  - LFT-D with local endless fiber reinforcement
- High degree of integration of functions by excellent flow properties of the LFT-D Material
- High shearing resistance by the penetration of the long fibers into the endless fiber blanks
- Usage of technical thermoplastic materials like PA 66, PET and PPS
- Excellent recyclability
- Short cycle times of < 60s
Thank you very much for your attention!