Development of a new process for production of continuous fibre reinforced thermoplastic prepregs by direct impregnation

Dipl-Wirt.-Ing. Sebastian Nendel
Dipl.-Ing. Hans-Jürgen Heinrich

Cetex – Institute of Textile- and Processing Machinery nonprofit GmbH
Altchemnitzer Straße 11
09120 Chemnitz
Germany
Lightweight in automotive

Total weight of a typical middle-class vehicle

- Electrics 4%
- Equipment
- Unit 15%
- Chassis 24%
- Body 43%

Optimization of the body is required

Share of total consumption

The vehicle weight caused nearly a quarter of consumption.

Source: VW AG

CO₂ targets of the EU

Europe

2020
95 g CO₂/km

Powertrain

- Weight 23%
- Aerodynamics 19%
- Rolling resistance 13%
- Friction / Electrics 3%

Consumption

100%

Europe
Lightweight construction with textile reinforcing structures

Lightweight materials - characteristics and costs

- Steel
  - Relative component weight with same function: 100%
  - Quality costs: 25%

- Lightweight steel construction
  - Relative component weight with same function: 75%
  - Quality costs: 20%

- Aluminium
  - Relative component weight with same function: 50%
  - Quality costs: 15%

- Magnesium
  - Relative component weight with same function: 25%
  - Quality costs: 10%

- CFRP
  - Relative component weight with same function: 25%
  - Quality costs: 5%

- Audi A8
  - ASF-Spaceframe
  - Relative component weight with same function: 40%

- Volkswagen XL1
  - CFK-Monocoque
  - Relative component weight with same function: 60%

Source: NEK-I, EKP
Quelle: VW AG
thermoPre® - Fiber composites for large-scale production

The Alliance

19 companies and 3 research institutions from the region
thermoPre® - Fiber composites for large-scale production

Material Kit

Possible fiber-matrix combinations

- Carbon fiber (12k, 24k, 50k, 60k)
  - PA 6.6
  - PA 6
  - PBT
- Aramid fiber
  - TPU
- Basalt fiber
  - PC
- Glass fiber
  - PP

Tensile strength
fiber / MPa

6300
3100

Tensile strength
FRP* / MPa

2200
550

* Fiber mass content: 60%
thermoPre® - Fiber composites for large-scale production

UD-reinforcement fiber tape
thermoPre® - Fiber composites for large-scale production

Concept of one stage direct processing

compounding/modification
cascade impregnation
textile reinforcement structure

1 Dosierung Trägerpolymer
2 Dosierung Additiv
3 Dosierung Additiv
4 Extruder
5 Schmelzepumpe
6 Ausspreizvorrichtung
7 Imprägnierwerkzeug
8 Imprägnier- / Laminierkalander
9 Funktions- oder Dekorationsfolien bei Bedarf
thermoPre® - Fiber composites for large-scale production

Thermoplastic fiber composite materials in single step direct processing for large-scale production

Joint Project T1: single step direct processing

aims

• single-step continuous processing
• high process variability and flexibility
• 2.5 times increase in productivity
• suitable process chain for large-scale production
• energy saving
• cost reduction of semi-finished products

Basic Patent No: DE 10 2010 007 491 A1
thermoPre® - Fiber composites for large-scale production

Schematic diagram of the system
Modular structure kit

construction of a multi-directional laminate material of unidirectionally fiber-reinforced thermoplastic individual layers

other layer structures

multiple multidirectional

z = x

multidirectional

z = 3...5

unidirectional
thermoPre® - application fields

Manufacturing process

Thermoplastic prepreg

Ce-Preg®

- multidirectional
  - forming
  - sandwich structures
- layer build-up
- plastification
- unidirectional
  - winding
  - tape laying
- injection moulding
- consolidation
- fibre composite
thermoPre® - Fiber composites for large-scale production

Thermoplastic fiber composite materials in single step direct processing for large-scale production

Joint Project T2: contitaping-plant

aims

• load equitable modular structure kit for consolidated thermoPre® semifinished products
• variable angular positions and feeding units
• highest lightweight potential by UD layer structure
• substitution of tissue-based organosheets
• low cut-off waste semifinished products

Example of load-oriented layer structure
thermoPre® - Fiber composites for large-scale production

Static characteristic value comparison GF-PP for lay-up 4/1

![Graph showing static characteristic values for different materials.](image-url)
thermoPre® - Fiber composites for large-scale production

Demonstrator engine mount VW e-Golf

Joint Project A1: crash-relevant structure components

aims

• lightweight-optimized crash-relevant components
• weight reduction
• proof of suitability for large-scale production with cycle times ≤ 60 s
• function integration
• cost reduction
• recyclable design

weight reduction 35%
aim for cost reduction ca. 30%

metal: cast aluminium/ steel sheet

fiber composite thermoPre- material GF-PP 47
thermoPre® - Fiber composites for large-scale production

1. Heating of GMT-Prepregs (ca. 230° C)
2. Lay down of the heated Organosheets
3. Stamping Tool
4. GFK-Engine-Subframe in Pressing-process
Stiffness-Testing in X (Al-Frame vs. GFK-Frame)
Dynamic Testing – Al-Frame

- Complete Destroyed
Dynamic Testing – GFK-frame

- Only Cut
- ca. 45mm deformation
- ca. 65mm Intrusion-deep
thermoPre® - Fiber composites for large-scale production

engine mount produced with thermoPre®-material in combination with GMT50

<table>
<thead>
<tr>
<th>GMT50</th>
</tr>
</thead>
<tbody>
<tr>
<td>ThermoPre 3,5 mm</td>
</tr>
<tr>
<td>ThermoPre 3,5 mm</td>
</tr>
<tr>
<td>GMT50</td>
</tr>
</tbody>
</table>
thermoPre® - Fiber composites for large-scale production

Thanks for your attention!

Visit us in Hall 8 / Booth A109

Dipl.-Wi.-Ing. Sebastian Nendel

Telefon: 0371/5277-200
Fax: 0371/5277-100
E-Mail: nendel@cetex.de