Textile Production Technologies for Multi-Material-Lightweight Components

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Outline

• Motivation
• Tailored Textiles the enabler of multimaterial designs
  – Tailored NCF
  – Open Reed Weaving
• Insert Integration using Laser Cutting
• Z-reinforcement with textile joining processes
• Multimaterial Joints
• Conclusion
Motivation

Considering multimaterial approach in early steps of composite process chains

- Increasing potential of lightweight design and reduced production costs
- Modification of existing design and manufacturing route of multimaterial FRP parts
Tailored Textiles - the enabler of multimaterial designs

Application of Tailored Textiles

• Approach: application of Tailored Textiles
  – Local adaption of textile properties
    ▪ Reinforcements
      - Fiber orientation
      - Fiber amount
    ▪ Insert or joint preparation of reinforcement textile
    ▪ Drapeability
    ▪ Near-net-shape

• Based on conventional textile production processes
  – High process speeds
  – High maturity level
Tailored Textiles – the enabler of multi material composite structures

Tailored NCF

- Local reinforcements
- Addressing joint or insert loads
- Adjusting warp knitting pattern as
- Process aid

ITA and KCTECH
**Local reinforced woven textiles**

- Feed of additional fibres only in certain needle areas
- Possibility of local reinforcements with additional fibre system
- Fabric pattern right side:
  - Basic pattern: carbon fibre, 800 tex
  - Reinforcement: carbon fibre, 800 tex
- Feeding of up to 50 individual threads (carbon, 800 tex) in a multiaxial system
Improvement in material efficiency through tailored fabrics

Reinforcement along the load path of the multimaterial component

- Experimental evaluation of potential for local reinforcements
  - Different load cases
  - Varying reinforcement geometry
  - Comparison to different references

Test direction:
- 0°
- 90°

F: Carbon, 800 tex
H: EP
RIMH135
Fasteners for Multi Material Design applications

Integration of fasteners

Substitution of commercial components by composite parts

Combination of different materials

Detachable and standardized joints

Fasteners
**Innovative LaserInsert-approach**

**Ultra precise laser cutting of carbon fibre stacks**

- Laser source
- Ultra-short pulsed Laser
- Insert Integration
- Consolidation

Supported by:
- Federal Ministry for Economic Affairs and Energy
- on the basis of a decision by the German Bundestag

Images showing the process steps and close-up views of the resulted components.
Innovative LaserInsert-approach

Results

• Reduced process times -> no drilling, adhesive preparation and application
• Higher part performance -> Increased pull-out forces for fasteners
Improvement in mechanical properties by tufting

Tufting in the production of sandwich panels

- Increase in z-Axis properties (local reinforcement)
- Fixation of the Insert on-top of the textile or on the sandwich core
- Increase in insert-in-plane and out-of-plane mechanical properties
- Up to 1000 Stitches per Minute
Joining using textile positive locking

- New shear connectors
  - Surface modification of metal
  - Small metal spines added
  - Afterwards textile production technologies such as RTM
- No damage to textile structure
- Ductile cracking

Adhesive bonding

Form-fit joint

„Additional safety“

New shear connectors

No fibre damage / ductile cracking

Hybrid joint: New shear connectors
Joining – multimaterial joints

Increasing mechanical performances

- Surface modification of metal
  - Shear connectors produced by welding process
  - Shear stress capacity of 1 kN per connector
  - For various metals: titanium, steel, aluminium
  - Different geometries
- In combination with composites
  - Increased stability
  - Force transmission to inner layers
  - Ductile post-cracking behavior
  - High energy absorption
  - Easy manufacturing process

Hybrid joint: New shear connectors

Three shear connector designs: cylindric, pointed, round
Joining – properties of new multimaterial joints

- Higher maximum load
- New multi stage breakdown
- Triple crash energy absorption

![Graph showing force vs. displacement for different connector scenarios.](image-url)
Improvement in preforming efficiency through tailored fabrics

Modification of existing design and manufacturing route of FRP parts

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<th>Concept development based on tailored textiles</th>
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Tailored textiles based subpreform concept
Conclusion

Textile production steps are the enabler for high performance multi material components

- Considering Tailored Textiles based concepts
- Enabling cost effective lightweight components
- Based on conventional textile production processes
  - High process speeds
  - High maturity level, robust manufacturing processes
Thank you for your kind attention!

Our Partners:

- ITA TechnologieTransfer GmbH, Aachen
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