Chair of Carbon Composites
TUM School of Engineering and Design
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Automated Fiber Placement

Advancing manufacturing processes for high performance parts

Introduction

Automated Fiber Placement (AFP) is an automated manufacturing process for composite components. A robot-guided placement head places tapes of CFRP material on three-dimensional tool surfaces under defined pressure and heat.

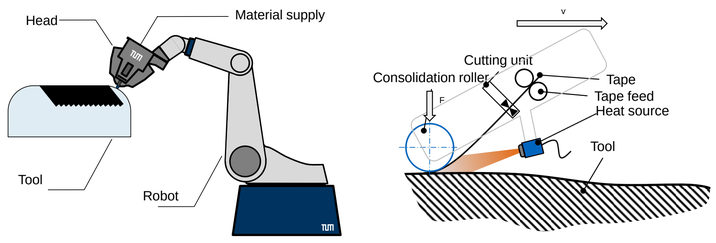

Fig. 1 AFP process

The LCC operates two modern AFP systems for thermoset (TS) and thermoplastic (TP) material processing. During TS-AFP, the placed prepreg slit-tapes are subsequently cured in the autoclave. With in-situ consolidation in TP-AFP, no autoclaving is necessary, as tapes are bonded directly to the substrate under pressure and temperature..

In the topicfield the interaction of various process parameters for both AFP technologies is being investigated experimentally and with simulation support in order to optimise component quality and production times.

Challenges during the process

- Path planning: Appearance of lay-up defects due to non-geodetic curves
- Process development: Interaction of process parameters, material properties and lay-up quality
- Process control: Prozesssteuerung: Heat entry and control during AFPisc and Wärmeeintrag und –Steuerung bei AFPisc using laser and thermal camera, lay-up monitoring with laser profilmetry

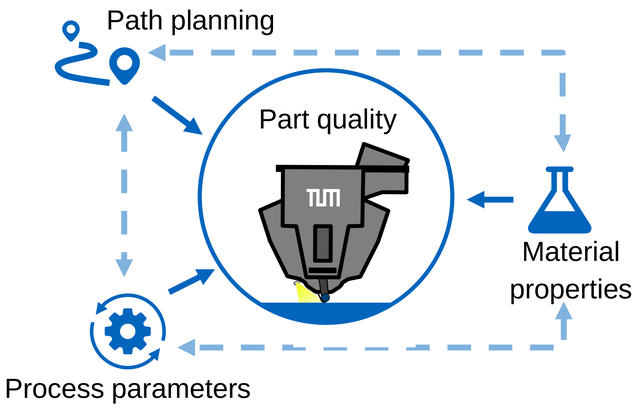

Fig. 2: Factors influencing the AFP process

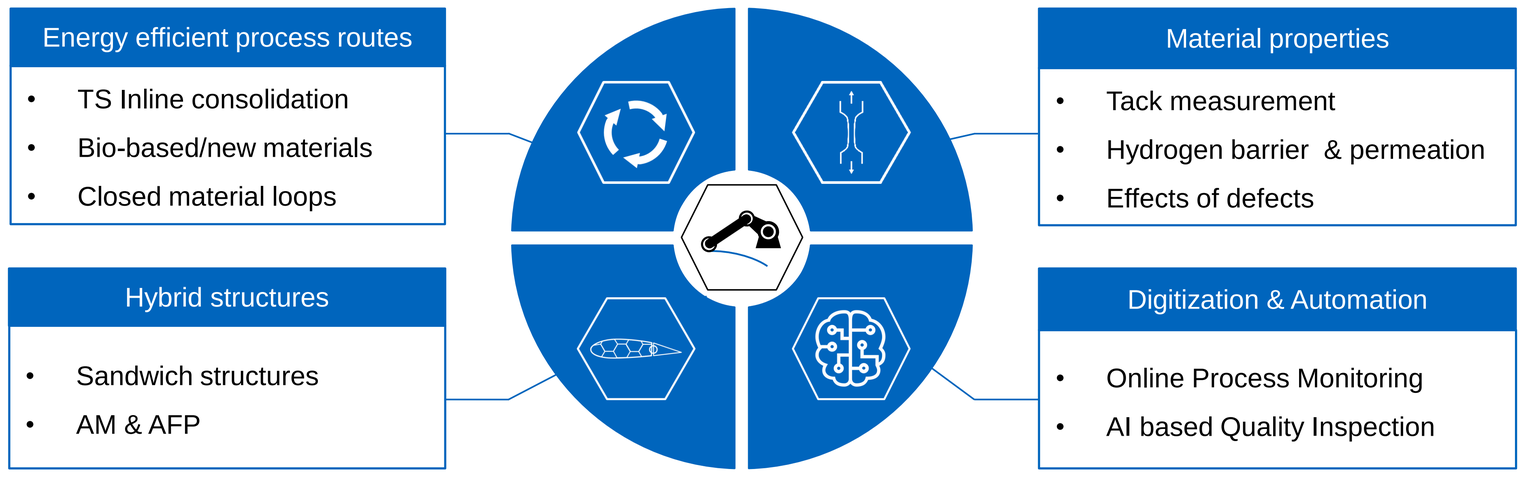

Fig. 3: AFP research topics at LCC

Energy efficient process routes

<u>Inline consolidation during TS-AFP:</u>

Specific process adaptations and innovative material systems make autoclaving and material cooling obsolete

<u>Closed material loops:</u>

The recycling of tape scrap in the TP-AFP enables closed material loops and improves the eco-balance of the components

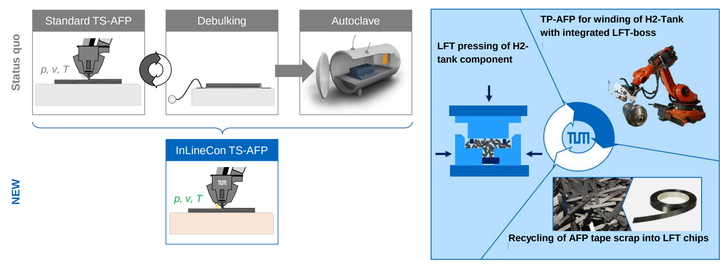

Fig. 4: Application examples of energy-efficient process routes

Material properties

- New materials (UV curing, bio-based, towpregs, etc.)
- Resource-efficient manufacturing due to a profound understanding of process-material interactions

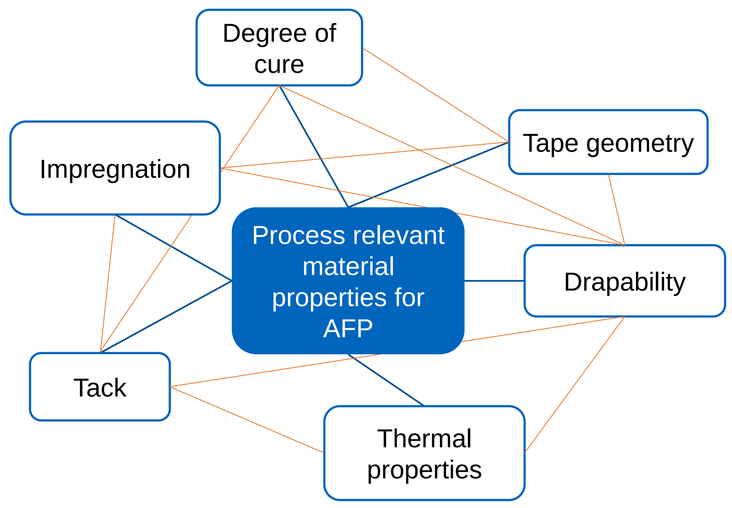

Fig. 6: Characterisation of process relevant properties for AFP

Hybrid structures

<u>Combination AFP – 3D printing</u>

- Freedom in component design
- Bonding of core and layers through suitable material selection

<u>AFP & Sandwich structures</u>

- Process automation enables cost-efficient production
- Interaction of process and materials

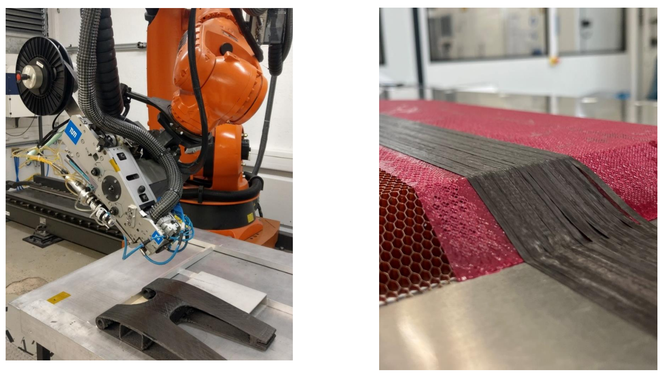

Fig. 5: Manufacturing of hybrid structures

Digitization & automation

<u>Automated quality inspection</u>

- Material lay-up & surface scanning
- Image data processing
- AI based defect detection and prediction

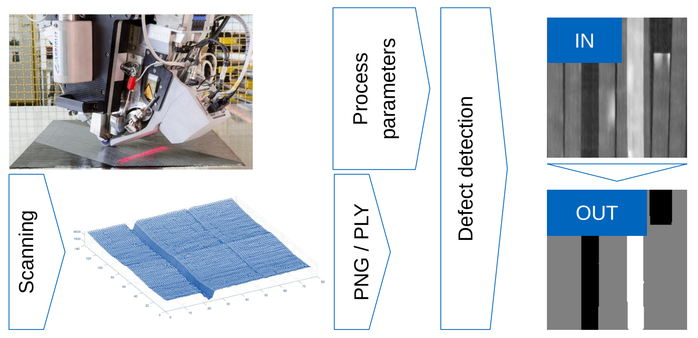

Fig. 7: Automated defect detection

More information and contacts: