Thermoplastischer Leichtbau in Serie
Thermoplastic Lightweight Design in Volume Production

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Center for Lightweight Composite Technologies
Content

- Thermoplastic tapes based on woven fabrics (organic sheet)
- Tapes with continuous fiber reinforcement and thermoplastic matrix
- Pick-&-place approach for the stacking; stacking unit
- Consolidation with heating-&-cooling; consolidation unit
- Single-step and multi-step approach for the shaping and functionalization
- Summary
Trends in Composites for Automotive Applications

Flashlights

**Technologies and Parts**
- Organic sheet and HP-RTM in series production
- SMC und Carbon-SMC
- Foam injection molding widely used
- Specific applications in focus: leaf springs, roofs, door modules ..

**Manufacturing Technology**
- Fully automated productions cells
- Multi step processes

**Materials / Semi finished Goods**
- Pultruded profiles
- New flat composites materials, Cross-Ply
- **Thermoplastic UD-Tapes**

**Driving Boundaries**
- Electric Vehicles
- **Circular Economy - Recyclability**
Center for Lightweight Composite Technologies

Organomelt

Tape Technology

HP-RTM Technology

T-RTM Technology

SMC Processing
Can Composites enable new large-scale Substitutions?
Bringing injection molding and composite manufacturing together

Most suitable combination

Composite manufacturing

Injection molding
Examples – Systems and Solutions for ...

Composites based on Curing Resins (Thermosets)

Composites based on Heating, Melting and Cooling (Thermoplastics)
ENGEL v-duo
Technology for Composite Presses

Clamp unit of an injection molding machine with horizontal closing direction

Press for HP-RTM (eg.) with vertical closing direction

ENGEL duo

Tonnage 350 – 5.500 tons

Tonnage 400 – 3.600 tons
ENGEL v-duo
Cushion Pad and Platen Parallelism Control

- Ultrasonic sensor on each tie bar
- Platen parallelism 0.2 mm
- Parallellism on the Part 0.05 mm (with parallelism control)
- Active correction of part wall thickness
- Coining and precision opening
Thermoplastic based Composite Technologies
Woven Fabric in Thermplastic Matix
Organomelt
Established Technology for Organo Sheet and Cross-Ply Materials

- Fully automated handling of blanks and parts
- Precise regulation of the infrared heating process
- Control of IR-heating, handling, and molding with ENGEL CC300
Processing of Organic Sheets and Tape Blanks
Employing a horizontal Clamping Unit

Articulated Robot (Hot Handling)

- Placement of the organic sheet or the tape blank in the infrared oven
- Insertion of the heated material in the mold (hot handling)
- Removal of the finished part
Processing Technology for large scale Production
Thermopl. Composites and Tapes

- Rapid one-sided heating of thin composite materials
- Fast handling between IR oven and mold
- Shaping of the composite and molding of any functional elements in one shot
From woven Fabric to Tape-based Composites

Tablet cover with woven fabric organic sheet, decorative film layer, and injection molded outer edges

www.cfrt.covestro.com – CF-Tape
Processing of Tapes with unidirectional Fibers
Load optimized Composite Structures
Components from Thermoplastic Tapes
Robot Lever

- Stacking
- Consolidation
- Shaping
- Cutting
- Assembly

37% weight reduction
20% higher acceleration
Tape Processing
Modules of a Standard Manufacturing Sequence

Tape production
Punching / Cutting
Stacking of Tapes
Stack Consolidation
Infrared heating
Injection molding

<table>
<thead>
<tr>
<th>roll</th>
<th>cutout</th>
<th>stack</th>
<th>blank</th>
<th>heated blank</th>
<th>composite part</th>
</tr>
</thead>
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![Images of tape processing stages: roll, cutout, stack, blank, heated blank, composite part]
Pick-&-Place Approach for Tape Processing

- Net-shape stacking
- Flat stack
- Position and gap control
- Materials mix
- No specific tape width
Pick-\&-Place Approach

Net-shape tape stacks bevorhand of consolidation
Position an Gap Control
Efficient and precise Pick-&-Place Technology

- High stacking rate
- High stacking precision

→ Utilization of an optical measurement system
Tape Stacking Unit

- Pick-&-place approach
- Net-shape stacking
- Optical measuring device
- Correction of position and angular orientation
- Fixation with heated pins
Consolidation Unit – in Cooperation with FILL

- Consolidation (heating and cooling) between thin steel platens exposing the blank’s outer shape
- Separate stations for loading/unloading, heating and cooling
- Equipment for manufacturing of a finished blank per one minute
- Net-shape consolidation
- Different thickness area possible
ENGEL Tape Processing Technology
Consolidation Unit

Working principle

Heating — Cooling — Loading/Unloading — Shuttling

Consolidation quality
porosity analysis with CT → Porosity << 1%
**Tape Processing**

**From Tape to Thermoplastic Composite Part**

**Hot handling**
- IR Oven
- Processing machinery
- Demoulding

**Stacking robot**
- Tape magazine
- Vision system
- Stacking table

**Articulated robot**
- Magazine base layer
- Stacking table
- Consolidation press
- Rack or IR Oven
One-step vs. Two-step
Possible Issues with Tape Processing

- Fibers and matrix might be pushed in flow channels during shaping of the blank
- Reduction of flow channel crosssection
- Complete filling of the flow channels
  → Incomplete filling during injection
Processing Routes for thermoplastic Tape

Aspects

- Surface appearance
- Degree of draping and shaping
- Precision of outer contour
- Demands on fiber orientation
- Definite transition from composite fraction to injection molding fraction

Component from organic sheet cut after shaping
Automotive Composite Applications
Medium to large volume Production

- Door modules
- Rear walls
- Center tunnel
- Seat pan
- Instrument panel carrier
- Engine hood
- Trunk cover
- Trunk door
- Composite roof
- Roof beam
- Brake pedal
- B-pillar inner
- ..

Test geometry for organic sheet components and tape-based components
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Laboratory Equipment
Center for Lightweight Composite Technologies - Linz

in situ reactive unit
processing machine for caprolactam

ENGEL v-duo 3550/1700
Clamping force 17,000 kN
max. clamping surface 1,750 x 2,170 mm
incl. injection unit
incl. articulated-arm robot (7 axes)

ENGEL v-duo 1560/700
Clamping force 7,000 kN
max. clamping surface 1,000 x 1,440 mm
incl. injection unit
incl. articulated-arm robot (6 axes)
Summary

- Utilization of thermoplastic tapes manufacturing for load optimized composite parts
- Net-shape stacking
  - Minimization of scrap rate
  - No cutting operation after consolidation
- Reasonable Limitation of stacking operation
  - Stacking and consolidation in the cycle time of the injection molding machine
- Consideration of multi-step approach for shaping and functionalization

Tape stacking unit – laboratory setup
Thank you!

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