Pultrusion technology
- current and future potential for industrial applications
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  - Divisions and locations
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  - Existing markets
  - Developments and challenges
Mitarbeiter: 8.000

Röchling Group

Sales: EUR 1.6 billion

Employees: 8,400

Division
Industrial

Division
Automotive

Division
Medical
Continuity through Change

1822 - 1881
Röchling = Coal

1881 - 1978
Röchling = Steel

1978 - 2005
Conglomerat

Since 2006
Röchling = Plastics
77 Locations Worldwide in 22 Countries

Locations with composite production
Sales by Industry and Market

Customers
Sales by Sector
- Retail and machining 15%
- Electrical and electronics industry 7%
- Chemicals and environment 5%
- Mechanical engineering 5%
- Medical technology 4%
- Paper industry 3%
- Construction industry 2%
- Other 6%

Markets
Sales by Region
- Europe (excluding Germany) 33%
- Automotive technology 62%
- Germany 34%
- The Americas 20%
- Asia 13%

EUR 1.6 billion in sales
The Materials

- **Commodities**  
  (PE, PP, ABS, PVC, PMMA, PS)

- **Engineering plastics**  
  (PA, POM, PET, PBT, PC, PVDF, PE-UHMW, COP)

- **High-temperature plastics**  
  (PSU, PES, PPS, PEI, PAI, LCP, PEEK)

- **Glass fiber reinforced thermoplastics**  
  (PA 6-GF, PA 66-GF, POM-GF, PC-GF, PPS-GF, PP-GF)

- **Composite plastics**  
  (UP-, EP-, VE resins, PUR, glass and carbon fiber reinforced, SMC)

- **Low Weight Reinforced Thermoplastics (LWRT)**

- **Laminated compressed wood**

- **Laminated pressboard**

- **Biopolymers (PLA)**
The Processes

Production Processes

- Injection molding up to 32 KN (multicomponent injection molding, hybrid technology, GID, PIT, overmolding)
- Extrusion blow molding (2D, 3D, suction, sequential)
- Injection blow molding
- Injection stretch blow molding
- Jectbonding
- Compression molding (DLFT, GMT, sheets, compression molded parts, LWRT, SMC)
- Extrusion (profile, rods and sheet extrusion)
- Multi Layer

- Polymerization (vertical casting, shaped part molding, spin casting)
- Filament winding
- Pultrusion
- Polyurethane foaming (PUR)
- Selective laser sintering
Pultrusion technology at Röchling
Pultrusion department

- Approx. 7000 m² workshop area for pultrusion technology in Haren
- 16 pultrusion machines in Haren
- Further pultrusion machines at other locations
Pultrusion department

- 1 pultrusion line for R&D work
- Enclosure for CFRP pultrusion
- Different take-off systems:
  - tandem pullers
  - caterpillar pullers
- Different impregnation technologies:
  - open resin bath
  - direct injection
Process technology
Material: types or resin and fiber reinforcement

- Resin systems:
  UP, VE, EP, PUR, acrylic resin

- Fiber material:
  E-glass, different types of carbon fibers

- Fiber reinforcement:
  - rovings
  - mats
  - “complex”
  - woven fabric
  - non crimp fabric
## Dimensions and tolerances of profile sections

- **Tolerances:** as given per DIN EN 13706

### Table: Tolerances

<table>
<thead>
<tr>
<th>Property</th>
<th>Nominal dimensions (mm)</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall thickness of open and closed profiles</td>
<td>Thickness</td>
<td>T₁</td>
</tr>
<tr>
<td>≤ 16</td>
<td>± 0,10</td>
<td>± 0,10</td>
</tr>
<tr>
<td>16 to 60</td>
<td>± 0,20</td>
<td>± 0,10</td>
</tr>
<tr>
<td>60 to 100</td>
<td>± 0,25</td>
<td>± 0,25</td>
</tr>
<tr>
<td>≤ 0,40</td>
<td>± 0,25</td>
<td>± 0,25</td>
</tr>
</tbody>
</table>

- Flatness in transverse direction
  - Tolerance: \( \pm 0,8 \times 10^{-6} \) mm

- Profile height and width of flange
  - Nominal dimensions (mm): \( B \) and \( H \) 0.5 % with minimum \( \geq 0,20 \) mm and maximum \( \leq 0,79 \) mm

- Shape of angle
  - Tolerance: \( \pm 1,5 \) °

- Straightness
  - Tolerance (Broad flange, width and height dimensions):
    - \( \geq 0,006 \) mm
    - \( \geq 0,004 \) mm for sections with \( B \) or \( H \) < 50 mm
    - \( \geq 0,003 \) mm for sections with \( B \) or \( H \) ≥ 50 mm and < 100 mm
    - \( \geq 0,002 \) mm for sections with \( B \) or \( H \) > 100 mm
    - where \( D \) and \( L \) are in metres.

- Twist
  - Tolerance: \( \leq 1,2 \) ° mm maximum for thickness ≤ 0 mm
  - \( \leq 1,5 \) ° mm maximum for thickness > 0 mm
Applications and markets pultrusion

- Railroad infrastructure
- Electrical insulation
- Bus and railway vehicles / cooling trucks
- Building / construction
- Paper industry
- Renewable energy
- Medical
- Others
Railroad infrastructure

- 3rd rail cover
- Durostone® UPGMZ-LP, Durostone® AGMZ/S

Requirements:
- Electrical insulation,
- high strength,
- low FST properties
Electrical insulation

- U-channel
- Durostone® EPGMZ
- Woven fabric reinforcement

Requirements:
- Mechanical strength
- Electrical insulation
- Fire resistance: UL 94 V0
Transportation – bus and railway vehicles

- **Outside / inside claddings**
  - Mainly thin, flat and long panels,
  - often with stiffening ribs on backside

- **Lengths up to 12 m**

- **Good surface properties required**

- **Painted finish**

- **Railway vehicles:**
  - Strict fire protection requirements
Construction

Thresholds, windows, floor profiles
Medical engineering

Pultruded profiles...

...as patient tables...

...for MRI
Wind energy – rotor blades for small turbines

Rotor blade profile for vertical axis wind turbine (VAWT)

Durostone pultruded profiles with integrated webs
Developments and challenges

- **Continuous improvement of material properties and quality**
  - Warp-free implementation of fabric materials
  - Low deviation of fiber orientation angles
  - Improvement of flame retardant properties
  - Thin profiles

- **Productivity increase**
  - Resin systems with higher reactivity
  - New curing systems
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