Do it right, do it light! Ultracom
BASF Continuous Fibre Reinforced Solutions for
Metal Replacement

HeeWon Seo
New Market Development
BASF Performance Material Asia Pacific
Content

■ BASF’s Approach for Automotive Lightweight Design

■ Ultracom™
  • Thermoplastic Composite Material System
  • Automated Manufacturing Cell and Demonstration Part
  • Material and Part Testing

■ Part Design using Advanced CAE Methods – BASF Ultrasim®
  • Ultrasim for continuous fiber reinforced thermoplastics
  • Process simulation
  • Composite optimization

■ Summary and Vision
BASF’s Approach for Automotive Lightweight Design

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Summary and Vision
## Chemistry as enabler

<table>
<thead>
<tr>
<th>Key Customer Sectors</th>
<th>Growth Fields*</th>
<th>Technology Fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation</td>
<td>Batteries for Mobility</td>
<td>Materials, Systems &amp; Nanotechnology</td>
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<tr>
<td>Construction</td>
<td>Heat Management</td>
<td>Raw Material Change</td>
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<tr>
<td>Consumer Goods</td>
<td>Enzymes</td>
<td>White Biotechnology</td>
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<tr>
<td>Health &amp; Nutrition</td>
<td>Medical Solutions</td>
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<tr>
<td>Electronics</td>
<td>Organic Electronics</td>
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<tr>
<td>Agriculture</td>
<td>Plant Biotechnology</td>
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<tr>
<td>Energy &amp; Resources</td>
<td>E-Power Management</td>
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<td>Wind Energy</td>
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<td></td>
<td>Water Solutions</td>
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</table>
Sustainability

Cost

Predictive modeling

Material specific design

Material models

Performance

Process-ability

Alternative raw materials

Sustainability

Raw materials

Life cycle analysis

Manufacturing process

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Content

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- Summary and Vision
Short, long and continuous fiber reinforcement of plastics

**semi-structural parts**

Ultramid® short fibers

Ultramid® Structure long fibers

**structural component**

Composites, e.g. Ultracom™ = Ultramid® + continuous fibers
Synergistic material solutions – combining the best of two worlds

- Geometrical complexity
- Injection molding
- Thermoforming

Ultramid® (short fiber)
Ultramid® Structure (long fiber)

Combination of thermoforming and injection molding
→ complex parts with high stiffness and strength

- Ultralaminate™ (orthotropic)
- Ultratape™ (unidirectional)

Combination of thermoforming and injection molding

Synergistic material solutions – combining the best of two worlds
Weight, cost and performance optimized parts

Ultracom™

- semi-finished products (composites)
- Overmolding material: (compounds)
- Engineering service

Ultralaminate™
Ultratape™

Ultrasim® + Processing + Parts testing

Ultramid® COM
Weight, cost and performance optimized parts

**Ultracom™**

- Semi-finished products (composites)
  - Tapes / Laminates
    - Ultralaminate™
    - Ultratape™

- Overmolding material: (compounds)
  - Ultramid® COM

- Engineering service
  - Ultrasim® + Processing + Parts testing
Ultralaminate™ – Thermoplastic laminate

- Fully impregnated thermoplastic sheet with textile reinforcement
- Suited for orthotropic and quasi-isotropic hybrid parts with large surface

<table>
<thead>
<tr>
<th>Ultralaminate™ B3WG13 WR01 1500 bk564</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matrix polymer</td>
</tr>
<tr>
<td>Reinforcing fiber</td>
</tr>
<tr>
<td>Fiber content</td>
</tr>
<tr>
<td>Textile weave</td>
</tr>
<tr>
<td>Tensile e-modulus</td>
</tr>
<tr>
<td>Tensile strength</td>
</tr>
<tr>
<td>Thicknesses</td>
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</tbody>
</table>
**Ultratape™ – Thermoplastic unidirectional (UD) tapes**

- Fully impregnated fiber tapes that can be used for layered arrangements
- Local reinforcement of parts with anisotropic properties

<table>
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<tr>
<th></th>
<th>Ultratape™ B3WG12 UD01 0250 bk564</th>
<th>Ultratape™ B3WC12 UD02 0160 bk564</th>
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<tbody>
<tr>
<td>Matrix polymer</td>
<td>Ultramid® B (PA6)</td>
<td>Ultramid® B (PA6)</td>
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<tr>
<td>Reinforcing fiber</td>
<td>Glass fiber</td>
<td>Carbon fiber</td>
</tr>
<tr>
<td>Fiber content</td>
<td>60 wt% (40 vol%)</td>
<td>60 wt% (49 vol%)</td>
</tr>
<tr>
<td>Tensile e-modulus</td>
<td>33 GPa</td>
<td>102 GPa</td>
</tr>
<tr>
<td>Tensile strength</td>
<td>770 MPa</td>
<td>1800 MPa</td>
</tr>
<tr>
<td>Thickness</td>
<td>0.25 mm</td>
<td>0.16 mm</td>
</tr>
<tr>
<td>Width</td>
<td>165 mm</td>
<td>165 mm</td>
</tr>
</tbody>
</table>
BASF manufacturing cell for In-mold Forming & Overmolding

- Injection molding machine
- Storage for laminates
- Heating station
- Clamping frame with inserted laminate
- Six-axis robot
- Automatic insertion of laminate into the clamping frame
Prediction of

- Behavior of components incl. manufacturing process
- Anisotropic fiber orientation at each location in the anisotropic molded part

New, expanded numerical material description
Considering

- Anisotropy, nonlinearity, shear rate dependence, tension-compression asymmetry
- Temperature dependence, different kinds of failure

Correct selection/placement of reinforcing fibers and semi-finished product
Part testing with computer tomography (CT)

New at testing laboratory:
CT system

- Observation of inner composite structure in a nondestructive way

T-form welding und a CT video along the welding line
- Exposure to temperatures, climates and liquids
- Quasi-static, dynamic or sudden forces and internal pressures
- Tensile, compressive, flexural or torsional loads

Three-point bending test with CIRO part
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Summary and Vision
Integrative simulation ULTRASIM® for continuous fiber reinforced plastics

- Anisotropic
- Non-linear
- Strain-rate sensitive
- Tensile-compression asymmetric
- Failure modelling
- Temperature dependent
Design concept

- **Topology optimization**
  Where are the main loadpaths in the design space?

- **Composite optimization**
Process simulation

- Draping
- Overmolding
- Combined warpage
Production of serial front seat pan Opel Astra OPC made of thermoplastic laminate and overmolding plastic
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For **cost efficient lightweight design** consider the combination of continuous fiber structures with short/long fiber materials.
THANK YOU