Sandwich Construction is Adaptable for High Volume Automotive Production

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Baltek Inc.
3A Composites – Group Structure

Core Materials
- Architecture & Display Europe
- Architecture & Display Americas
- Architecture & Display AP & ME
- ACS
- Transport & Industry

Schweiter Technologies
3A Composites

Airex AG
Sins, Switzerland

Baltek Inc.
High Point (NC), USA

3A Composites China Shanghai, China

3A Composites Ecuador

3A Composites PNG Balsa
Papua New Guinea

3A Composites Glasgow, KY
Light-weighting Concepts

• Material
  • Specifically lighter / stronger materials (e.g. Aluminium, Titanium, HSS)
  • Fibre reinforced plastics (E-glass, Carbon)
  • Foaming to locally reduce density of injection molded plastics
  • Multi-material solutions (primary vs. secondary bonds and joints, welds)

• Geometric Design
  • Ribs, stringers, stiffeners, etc.
  • Shape / profile
  • Sandwich!

• Function Design
  • Functional integration
  • Saving of additional components (e.g. insulation)
Sandwich – The Prime Saver

Combine stiff skins around lightweight core

- Weight savings
- Material (mass) reduction
- Lower cost materials without sacrificing performance

- Functional integration
- Liberates part design
- Skins not limited to FRP
Sandwich: Less Material = Lower Unit Cost

- Equal deflection
- Lower weight
- Significant reduction in material cost
## Products for the Automotive Market

### Broadest Selection of Core Materials Worldwide

<table>
<thead>
<tr>
<th>Structural PET foam core materials</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AIREX® T92</strong> – Easy Processing Structural Foam</td>
</tr>
<tr>
<td><strong>AIREX® T10</strong> – The Industrialized Structural Foam</td>
</tr>
<tr>
<td><strong>AIREX® T90</strong> – Fire Resistant Structural Foam</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Structural balsa core materials</th>
</tr>
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<tbody>
<tr>
<td><strong>BALTEK® SB</strong> – Select Grade Structural Balsa</td>
</tr>
<tr>
<td><strong>BALTEK® SBC</strong> – Plantation Controlled Structural Balsa (FSC Certified)</td>
</tr>
<tr>
<td><strong>BALTEK® IG</strong> – Industrial Grade Balsa</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Structural mat core fabrics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SORIC® XF, SF</strong> – Fast resin flow media bulker mat for closed molding</td>
</tr>
<tr>
<td><strong>SORIC® TF</strong> – Print Blocker mat for closed molding</td>
</tr>
<tr>
<td><strong>SORIC® LRC</strong> – Low Resin Absorption mat for closed molding</td>
</tr>
<tr>
<td><strong>Finishmat® D7760</strong> – Surfacing veil for closed molding (PA6)</td>
</tr>
</tbody>
</table>
Mechanical Properties of Various Core Materials

- Paper
- PP Honeycomb
- 2lb. Urethane
- 4lb. Urethane
- AIREX T92.60
- AIREX T92.100
- BALTEK 3B.100

Graph showing density (kg/m³) and shear modulus (MPa) for different core materials.

Sandwich deflection and core density over core shear modulus graph.

Images of Urethane, BALTEK, and AIREX T92 with labels.
Core Material Performance vs. Cost

Stiffness Per Unit Cost

- BALTEK 5B
- AIREX T92
- Urethane
- PPHC

Relative mass

- Birch hardwood
- Sandwich panels with PP foam cores
- Chosen sandwich panels with end-grain balsa cores
- Sandwich panels with structural foam cores (PU, PVC)

Relative material cost
Manufacturing composite sandwich structures

Technical Requirements

- High
  - Prepreg
- Medium
  - Hand Lay-up
  - RTM
  - Wet comp. molding
  - Thermoplastic pressing
- Low
  - Production Volume
  - Low volume / prototype production

Sample picture
Efficient Sandwich Part Production 1/2

Process details

<table>
<thead>
<tr>
<th>Resins</th>
<th>Thermoplastic (PP, PA, PET etc.) Thermoset (Epoxy, PU etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperatures</td>
<td>Depending on resin</td>
</tr>
<tr>
<td>Pressures</td>
<td>1-20 bar</td>
</tr>
<tr>
<td>Cycle time</td>
<td>Starting at ≈ 60 sec.</td>
</tr>
</tbody>
</table>

- Simple, easy-to-control process
- Low investment required
- Cost efficient thermoplastic resins possible
- Use of metal face sheets possible (thermo-bonding)
Process Speed

Short Cycle Time Allows Consolidation While FoamRemains Cold

Foam core temperature and resin viscosity

- Injection
- Pre-Hardening

- Foam core (insulating) heats up slowly
- Remains below T_g for some 30-60 seconds

T_g PET approx. 75 °C

Injection Pre-Hardening
Thermoforming AIREX® Cores into Shape

- PET foam cores are very simple to thermoform ≈ 160 ºC
- No spring back
- Large elongations possible
- Thickness differences of up to 75%
- Surface remains the same (skin adhesion assured)
Efficient Sandwich Part Production 2/2

High Pressure Resin Transfer Molding (HP-RTM)

- High pressure?
  - High pressure mixing unit
  - Injection pressure in mold depending on feed rate
- HP-RTM well established for monolithic structures
- Process in development for sandwich structures
  - Only thin skins needed
  - Lower pressure in mold sufficient for full fiber wetting
  - Advantage for cost-effective core materials such as PET
Process optimization

• Requirements for resin system
  • Low viscosity for fast filling
  • Low temperature fast curing to keep foam cold
    • Softening ($T_g$) of PET foam is around 75 °C

• Mold Temperature: low is best for foam

• Softening of foam is avoided with short cycles

PET foam mechanical properties vs. temperature

Curing behavior of Loctite Max 2 at 70 °C mold temperature

Blue: 90°C mold temperature
Green: 65°C mold temperature

Ion viscosity at 70 °C mold temperature

Accelerator amount
- Low
- Medium
- High

Minimum viscosity

10 mPas

3 min
Examples of Successful Automotive Production

Structural floor of GM Corvette and Cadillac Roadster (approx. 70’000 pa)

- Weight reduction
- Side impact improvement
- Noise reduction

Process description

<table>
<thead>
<tr>
<th>Fibers</th>
<th>E-Glass Continuous Filament Mat</th>
</tr>
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<tbody>
<tr>
<td>Resin</td>
<td>Thermoset</td>
</tr>
<tr>
<td>Core</td>
<td>AIREX® T92.130</td>
</tr>
<tr>
<td>Process</td>
<td>Wet Compression molding</td>
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</tbody>
</table>

Interiors trim parts (approx. 120’000 pa)

- Weight reduction (~40%) @ 1 mm thicker
- Crash behavior
- Thermal insulation
- Noise reduction

Process description

<table>
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<tr>
<th>Fibers</th>
<th>Glass hybrid fleece</th>
</tr>
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<tbody>
<tr>
<td>Resin</td>
<td>PP fibers in fleece (thermoplastic)</td>
</tr>
<tr>
<td>Core</td>
<td>AIREX® T10.100</td>
</tr>
<tr>
<td>Process</td>
<td>Hot Compression molding</td>
</tr>
<tr>
<td></td>
<td>(thermoplastic at 180 - 220 °C)</td>
</tr>
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Learning's for Cost Efficient, Short Cycle Sandwich Production

- Composite Sandwich combines *material* AND *constructive* light-weighting design strategies thus maximizing both weight & cost saving
- Sandwich permits use of lower cost materials to create higher performing parts
- Sandwich can utilize both metal and composite facing materials as well as thermoset & thermoplastic resin systems
- AIREX®, BALTEK® & SORIC® cores offer far superior performance to urethane, plastic & paper honeycomb.
- AIREX® & BALTEK® products are renewable & recyclable
- Several series applications ongoing and successful
- RTM is most challenging
- Want ribs? Try a sandwich instead
Questions?

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