A New Generation of Thermoplastic Honeycomb based on Polyester Spunbond

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Johns Manville

- Major fiber glass manufacturer in North America and Europe.
- Over 150 years of proud history; A Berkshire Hathaway company since 2001.
- Leader in key markets

Johns Manville Engineered Products

- **Glass Fibers**
  - Glass fibers for composite reinforcement, glass nonwovens, and wallboard reinforcement

- **Nonwovens**
  - Glass and polyester nonwovens for roofing, flooring, filtration, and etc.

- **Glass Textiles**
  - Woven and nonwoven wall coverings
Johns Manville produces polyester (PET) spunbond nonwoven fabrics for the following market applications:

- **Commercial Roofing**
  - Carrier material in bitumen based roofing products for flat roofs and underslating for pitched roofs

- **Filtration**
  - Automotive – cabin air
  - Liquid filtration – pool & spa, coolant oils
  - Air filtration – industrial baghouse filtration
  - Specialty – cover stock for HVAC and HEPA filter medias, support for PTFE lamination

- **Reinforcements**
- **Carpet**
- **Geotextile**
- **Specialty**
Spunbond Process Overview

**Spunbond Process**
(Stretching and web formation)

- Spin pack
- Polyester Filaments
- Quench air
- Stretch nozzle
- Rotary plate
- Lay belt
- Compressed air
• Filament Structure

Regular Polyester

Heterofil Polyester

Core

Sheath
Honeycomb Welding Process:

- Evalith® spunbond is continuously inserted into honeycomb process
- Welding process: Nonwoven layers are sequentially heat-melted -> compressed -> impregnated and joined
- Expansion process: The material stack is reheated to softening temperature -> extended -> cooled and fixed
Honeycomb welding process for a dazzling array and sustainable manufacturing of honeycombs.

- Through innovative welding process no need for auxiliary (glueing) materials
- Fast and economic process
- Expansion of honeycombs can be done at customer or at honeycomb manufacturer

- Nonwoven honeycombs are breathable and porous –
  - for pressure equalization and mechanical bonding
  - Amount of porosity and depth can be tailored

Microscopic cross sectional view of a honeycomb wall

Microscopic view of a honeycomb wall surface
**FC** thermoformable

100% thermoplastic PET
Compressive: 0.9 Mpa @ 50 kg/m³
Temperature resist. (short): > 200° C

**FCI** resin impregnated

Phenolic / Sat PET / Epoxy / PU resin
Compressive: > 8 Mpa @ 80 kg/m³
Compressive: > 1160 psi @ 5 lb/ft³

**PURcomb** foam filled

Low friability
High compressive (impregnated)
Thermal conduction: 0.03 W/mK @ 85 kg/m³

**Types of Honeycomb**
New honeycombs for a unique variety of requirements and processes:

- **Lightweight:** Honeycombs offer high mechanical performance at low weights (e.g. >0.8 MPa compression load @ 50 kg/m³ density) – up to 8 MPa compression load for impregnated honeycombs

- **Enhanced resistance to humidity:** Honeycombs do not degrade in humid testing conditions

- **Outstanding impact and shear resistance:** Honeycombs impregnated with thermoset resin
New honeycombs for a unique variety of requirements and processes:

- **Complex shaping:**
  Honeycombs offer very good thermoforming performance

- **Rapid manufacturing processes:**
  one shot thermoforming processes @ temperatures up to 200°

- **Improved material bonding:**
  better shear resistance through mechanical bonding of resins and glues – and good bonding to filling materials like foams and fibers
Honeycomb between two structural composites sheets

- Wall structure could be impregnated with the same resin as the cover layers and cured in one

- Cover layers as prepreg with partially impregnating the porous honeycomb walls through capillarity effects and curing afterwards

- Cover layer as a thermoplastic sheet material
  - Honeycomb walls will be partially impregnated through capillarity effects depending on melt viscosity of the thermoplastic polymer

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Optimized bonding to the honeycomb structure could be achieved in all cases
Impregnated:
mechanical stability

Transportation / construction floor panels:
Value proposition:
- cost of ownership (life cycle)
- ease of repair
- lightweight

Formed:
forming processes

Transportation interior trim
Value proposition:
- good mechanical performance in wet / hot testing conditions
- good thermoforming process
- vibration / noise dampening

Filled:
Foam impregnated

Insulation Panels
Renewable Energy
Value proposition:
- shear resistance
- higher dynamic performance
Impregnated:
- mechanical stability
- fire resistance

Formed:
- forming processes
- lightweight

Filled:
- Foam impregnated
- Shear resistance

Applications:
- Panel Boards
- Automotive
New Honeycomb Properties

- Impact
- Insulation properties
- Peel strength
- Resistance to humidity
- Thermo-formability
- Material cost

- FCI (thermoset impregnated)
- FC (polyester thermoplastic)
- PURcomb (foam filled)
New Honeycomb Properties

- Impact
- Insulation properties
- Peel strength
- Resistance to humidity
- Thermo-formability
- Material cost

**Materials:**
- FCI (thermoset impregnated)
- FC (polyester thermoplastic)
- PURcomb (foam filled)
- Paper honeycombs
New Honeycomb Properties

- Impact
- Insulation properties
- Peel strength
- Resistance to humidity
- Thermo-formability
- Material cost

Graph showing comparison of different honeycomb materials:
- FCI (thermoset impregnated)
- FC (polyester thermoplastic)
- PURcomb (foam filled)
- Aluminum honeycombs
Evalith® Honeycomb Family

**FC** thermoformable  **FCI** resin impregnated  **Purcomb** foam filled

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<th>Property</th>
<th>Unit</th>
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<td>length / width</td>
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New honeycombs for outstanding performance and processability

- Made from polyester spunbond nonwoven
- Continuous filaments
- Polyester reinforcement and resin
  - recyclability
  - compatible with glues and resins
- Superb mechanical performance through high quality raw materials and high draw ratio
  - high temperature resistance
  - good dimensional stability
  - enhanced processability
- Adjusted porosity of nonwovens for
  - controlled resin / glue take up
  - pressure equalization during processing
  - optimized bonding of surface layers to the honeycomb structure
- Improved edge stiffness of web for high impact resistance