Advanced Filter Media Structures Using Biax Spun-blown Fiber Technology

Mohammad A Hassan, *Biax-Fiberfilm Corporation*
Advanced Filter Media Structures Using Biax Spun-blown Fiber Technology

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Biax-FiberFilm Corporation

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Leader in Meltblowing, Spun-blown and Web/Film Stretching Systems

Spun-blown® & Meltblowing Systems

Web/Film MD/CD Stretchers
Markets Served

- Sorbents
- Wipes
- Hygiene
- Air Filtration
- Liquid Filtration
- Thermal Insulation
- Acoustic Insulation
Introduction: Conventional Meltblowing Systems

- One-step process for producing nonwoven web
- Extrusion of low melt viscosity polymer to make fine fibers
- Molten polymer streams injected in high velocity hot air jets
- Fibers attenuated by drag force
Introduction:
Conventional Meltblowing Systems

http://www.textileworld.com

Extruder
Injection Port
Static Mixer
Hot Air
Metering Pump
Melt Blowing Die
Drum Collector

Resin Supply
Motor
Band heaters

Slot MB Die

(Drawing is not to scale)
Introduction: Spunbond Process

- Two-step process that involves polymer spinning and fiber bonding
- Extrusion of high melt viscosity polymer to make strong fibers
- Cost effective method of making a fabric

Courtesy to The Nonwovens Institute, NCSU
Spun-blown® Fiber Technology

- One or two-step process that involves polymer spinning and fiber bonding
- Extrusion of low/high melt viscosity polymer to make nonwoven fabrics
- Cost effective method
- Flexible process to make nonwovens fabrics
Spun-blown® Spinnerette System

- 2-16 rows of holes
- up to 104 holes/cm
- Parallel air jets
- High productivity
- Flexible air temp
- Strong microfibers

Polymer nozzles
Spun-blown® Fiber Formation
## Spunmelt Technology Comparison

<table>
<thead>
<tr>
<th></th>
<th>Conventional Meltblowing Technology</th>
<th>Conventional Spunbond Technology</th>
<th>Biax Spun-blown® Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throughput, Kg/m/hr</td>
<td>10 - 100</td>
<td>150 - 300</td>
<td><strong>10 - 500</strong></td>
</tr>
<tr>
<td>Mean Fiber size, µm</td>
<td>1 - 5</td>
<td>3 - 15</td>
<td><strong>1 - 15</strong></td>
</tr>
<tr>
<td>Nozzle Density, hole per cm</td>
<td>10 - 20</td>
<td>20 - 50</td>
<td><strong>20 - 104</strong></td>
</tr>
<tr>
<td>Fiber Strength</td>
<td>Minor</td>
<td>High</td>
<td><strong>Medium</strong></td>
</tr>
</tbody>
</table>
**Spun-blown® Spinning Flexibility**

- Spun-blown® is flexible process
- Wide melt flow rate (5 – 2500 g/10 min)
- Wide range of operating conditions
- Process accepts cold or hot air
- Wide range of fiber size but controllable
- Wide range of fiber properties

**Polymer Resins**

<table>
<thead>
<tr>
<th>Polymer</th>
<th>Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>PP</td>
<td>35-2500 MFR</td>
</tr>
<tr>
<td>PPS</td>
<td>0203HS</td>
</tr>
<tr>
<td>PET</td>
<td>F53HC</td>
</tr>
<tr>
<td>PBT</td>
<td>TIC 2008</td>
</tr>
<tr>
<td>PE</td>
<td>DOW™ DNDA -1082 NT 7</td>
</tr>
<tr>
<td>PLA</td>
<td>NW 6252D, 6202D</td>
</tr>
<tr>
<td>Nylon 6</td>
<td>Ultramid® B27</td>
</tr>
<tr>
<td>Kraton®</td>
<td>MD6705</td>
</tr>
<tr>
<td>HALAR®</td>
<td>1400LC</td>
</tr>
<tr>
<td>Vistamxx®</td>
<td>6202</td>
</tr>
<tr>
<td>Vistamxx®</td>
<td>7050</td>
</tr>
<tr>
<td>TPU</td>
<td>Isothane® &amp; Texin®</td>
</tr>
<tr>
<td>Dupont</td>
<td>Hytrel® 3078</td>
</tr>
</tbody>
</table>
**Biax Spun-blown® Lines Facts**

**Nozzle Size**
- ID: 0.006” ~ 0.150 mm
- ID: 0.026” ~ 0.660 mm

**Die Pressure**
- 20 to 150 bar

**Polymer Throughput**
- 0.04 – 1 g/h/min

**Nozzle Density**
- 50 – 266 hpi

**Production Rate**
- 10 – 500 Kg/m/hr

**Average Fiber Size**
- 1 – 15 µm
The above chart is a guideline and fiber size values can be tuned by many process conditions such as air volume, air temp, polymer throughput, and polymer temp beside the nozzle size.
Fiber Size Distribution of PP Spun-blown®

20 GSM Biax PP Spun-blown®

20 GSM Conventional PP Meltblown
Spun-blown® Versus Conventional Spunmelts

Tensile Strength in Machine Direction

<table>
<thead>
<tr>
<th>Sample</th>
<th>$d_f$, fiber size, µm</th>
<th>STDEV, µm</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-4</td>
<td>2.33</td>
<td>1.35</td>
</tr>
<tr>
<td>S-5</td>
<td>4.39</td>
<td>2.98</td>
</tr>
<tr>
<td>S-6</td>
<td>19.48</td>
<td>1.49</td>
</tr>
</tbody>
</table>

Recent Patent Application by Biax-Fiberfilm

Biax-Fiberfilm Corporation _ Mohammad Hassan - 2015
Spun-blown® Layer for Reusable Cabin Air Filter

<table>
<thead>
<tr>
<th></th>
<th>Biax Spun-blown</th>
<th>Ref #1</th>
<th>Ref #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designed Fiber Size [μm]</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Actual Fiber Size [μm]</td>
<td>2.9</td>
<td>2.6</td>
<td>2.7</td>
</tr>
<tr>
<td>Basis Weight [g/m²]</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>

Bar Chart 1: Elongation%
- Biax Spun-blown: 140%
- Ref #1: 80%
- Ref #2: 80%

Bar Chart 2: Air Resistance, Pa
- Biax Spun-blown: 50 Pa
- Ref #1: 60 Pa
- Ref #2: 60 Pa

Bar Chart 3: MD Tensile Strength, N
- Biax Spun-blown: 7 N
- Ref #1: 5 N
- Ref #2: 5 N

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Highly Extensible Spun-blown® Fabric

15 GSM Spun-blown Sample made with ExxonMobil™ PP3155 Resin

Tensile Strength, gf/inch vs. Elongation %

CD
MD
**Spun-blown® PBT Vs Conventional Meltblown PBT**

### Biax PBT Spun-blown®

<table>
<thead>
<tr>
<th>Sample</th>
<th>Biax-Spunblown</th>
<th>Conventional Meltblown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>1.17</td>
<td>2.95</td>
</tr>
<tr>
<td>SD</td>
<td>1.30</td>
<td>0.92</td>
</tr>
<tr>
<td>Min</td>
<td>0.08</td>
<td>1.45</td>
</tr>
<tr>
<td>Max</td>
<td>9.10</td>
<td>5.74</td>
</tr>
</tbody>
</table>

- Samples were manufactured to achieve same air permeability
- Biax technology throughput was double the standard meltblown one
Secret Behind the High Portion of Submicron Fibers
Multipass Oil Bench Filtration Test

- Conventional Meltblown – nozzle: 0.4 mm
- Biax Meltblown – nozzle: 0.3 mm

F. Efficiency [%] (@ 1 µm particles)

Test Time, [minutes]
Spun-blown® + St. Meltblown
Alternative Electrostatic Charging

- 35% Pressure drop
+ 300% Productivity

~ 10% higher Retention
+ increased Dustholding-capacity

Pressure, [Pa]
Filtration Efficiency [%]
(0.3 μm, 14.1 cm/s)

Data Courtesy is to Reifenhäuser Reicofil
Possible Media Formation

Dual Biax Beam

1. Single/Dual Beam
2. Web to bonding/imposing and winding system
3. Vacuum
4. 2 rotating drum with nip gap and vacuum chambers
5. High loft recoverable nonwovens materials

Hybrid Meltblowing Systems

1. Web to bonding/imposing and winding system
2. Vacuum
3. 2 rotating drum with nip gap and vacuum chambers
4. High loft recoverable nonwovens materials

Single/Dual Beam with Dual Drum

1. Web to bonding/imposing and winding system
Spun-blown™ Highloft Nonwovens for Insulation

Example: Polypropylene High Loft Nonwovens

<table>
<thead>
<tr>
<th>Sample</th>
<th>Nip Gap, (cm)</th>
<th>Bonding</th>
<th>Basis Weight, (g/m²)</th>
<th>Thickness, (mm)</th>
<th>Percent Compression (%)</th>
<th>Percent Recovery (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-7</td>
<td>2.5</td>
<td>Through-Air Bonded</td>
<td>142.6</td>
<td>12.6</td>
<td>72.4</td>
<td>67.7</td>
</tr>
<tr>
<td>S-8</td>
<td>2.5</td>
<td>Through-Air Bonded</td>
<td>302.3</td>
<td>17.8</td>
<td>66.9</td>
<td>75.9</td>
</tr>
<tr>
<td>S-9</td>
<td>2.5</td>
<td>Through-Air Bonded</td>
<td>492.6</td>
<td>23.2</td>
<td>61.7</td>
<td>80.8</td>
</tr>
</tbody>
</table>

Test Standards: Thickness: IST 120.2 (01), Compression and Recovery: IST 120.2 (01)
Biax R&D Center Capabilities

- **40 cm Spun-blown® Pilot Line**
  - 150 µm (0.006”) & 228 µm (0.009”) spinnerettes
  - 508 µm (0.020”) spinnerette

- **64 cm Dual Beam Pilot Line**
  - 254 µm, 381 µm & 508 µm *Biax spinnerettes*
  - 50 cm *Conventional Meltblowing Spinnerette*

- **1.2 m Spun-blown® Pilot Line**
  - 254 µm & 381 µm Biax spinnerettes

- Dual Drum & Flat belt Collection Systems
- 0.75 m Embossing Thermal Calendering
- 1.25 m Winding & Slitting System
- Dual Unwinding System
- Pilot Filter Cartridge Collector
- 50 cm Tantret™ Electrostatic Charging Machine
- 1 m Cross-Direction Stretching System
- 1 m Machine-Direction Stretching System
Summary

Spun-blown process

- Hybrid technology bridging the gap between meltblowing and spunbond processes
- Small fibers compared to spunbond but strong compared to meltblown fibers
- Flexible and cost effective process
- Accommodate spunbond and meltblown polymer resins (MFR 5 – 2500 g/10 min)
- Wide fiber size distribution but controllable
- High filtration efficiency at lower pressure drop and higher dust holding capacity
Thank you!

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