Advances in Spun-Blown Fiber Technology and its Applications

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Advances in Spun-blown Fiber Technology and its Applications

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OEM & Leader in Meltblown, Spun-blown and Web/Film Stretching Systems

Spun-blown & Meltblown Systems

Web/Film MD/CD Stretched
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

(Drawing is not to scale)
Introduction:
Conventional Meltblowing Systems

(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
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 is a registered trademark of the Biax-Fiberfilm Corporation
Spun-blown Multi-Row Spinnerette

- 2-16 rows of holes
- up to 104 holes/cm
- Parallel air jets
- High productivity
- Flexible air temp
- Strong microfibers
Spun-blown Fiber Formation
### Spunmelt Technology Overview

<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>10 - 500</td>
</tr>
<tr>
<td>Mean Fiber size, μm</td>
<td>1 - 5</td>
<td>3 - 15</td>
<td>1 - 15</td>
</tr>
<tr>
<td>Nozzle Density, hole per cm</td>
<td>10 - 20</td>
<td>20 - 50</td>
<td>20 - 104</td>
</tr>
<tr>
<td>Fiber Strength</td>
<td>Minor</td>
<td>High</td>
<td>Medium</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 (0.2-15μm)
- Wide range of fiber properties

**Polymer Resins**

<table>
<thead>
<tr>
<th>Polymer</th>
<th>Resins</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>Vistamaxx™</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>

_Ultramid®_ is a registered trademark of the BASF Corporation
_Vistamaxx®_ is a registered trademark of the ExxonMobil company
_Hytrel®_ is a registered trademark of the DuPont company
_Kraton®_ is a registered trademark of the Kraton Performance Polymers, Inc.
Common Spun-blown Applications

- Hygiene
- Face Mask
- Air Filtration
- Liquid Filtration
- Battery Separators
- Thermal Insulation
- Acoustic Insulation
- Wipes
- Sorbents
Biax Spun-blown Lines Facts

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

**Typical Die Pressure**
- 20 to 150 bar

**Typical Polymer Throughput**
- 0.04 – 1 g/hr/min

**Typical Nozzle Density**
- 50 – 266 hpi

**Typical Production Rate**
- 10 – 500 Kg/m/hr
The above chart is a guideline based on PP 1500 MFR and 200 HPI Fiber size values depends on many process conditions such as air volume, air temp, polymer throughput, and polymer temp beside the nozzle size and resin type.
Fiber Size Distribution of Spun-blown Fabrics

20 GSM Biax PP Spun-blown

20 GSM Conventional PP Meltblown

Fiber Size, μm

Frequency %

Fiber Size, μm

Frequency %
Spunmelt Fabrics Tensile Strength Overview

Tensile Strength in Machine Direction

![Graph showing tensile strength vs. elongation percentage for different samples.]

<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
Highly Extensile Spun-blown Fabric

15 GSM Spunblown Sample made with ExxonMobil™ PP3155 Resin
Spun-blown PBT Vs Conventional Meltblown PBT

Biax PBT Spun-blown ®

PBT Conventional Meltblown

1000X
50 GSM
27 CFM @ 125 Pa
~60 Kg/m/hr

Sample | Biax-Spunblown | Conventional Meltblown
-------|----------------|------------------------
Mean   | 1.17           | 2.95                   |
SD     | 1.30           | 0.92                   |
Min    | 0.08           | 1.45                   |
Max    | 9.10           | 5.74                   |

1000X
50 GSM
27 CFM @ 125 Pa
~30 Kg/m/hr

- Samples were manufactured to achieve same air permeability
- Biax technology throughput was double the standard meltblown one
Spun-blown PBT Vs Conventional Meltblown PBT

Multipass Oil Bench Filtration Test

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

**Graph Details:**
- **Y-axis:** Filter Efficiency [%], (per 1 µm particles)
- **X-axis:** Test Time, [minutes]
- Data points showing the efficiency over time for two different nozzle sizes.
Secret Behind the High Portion of Submicron Fibers

![Diagram showing fiber temperature and size variation with distance from the spinnerette centerline.](image)

- Fiber Temperature, °C vs Distance from the Spinnerette Centerline, cm
- Fiber Size, μm vs Distance from the Spinnerette Centerline, cm
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)

Recent Patent Application by Biax-Fiberfilm
Spun-blown Elastic Laminates with Vistamaxx

<table>
<thead>
<tr>
<th>Basis Weight, gsm</th>
<th>Carded web/Vistamaxx 7050/Carded web</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Direction</td>
<td>MD</td>
</tr>
<tr>
<td>100% Modulus, N/cm</td>
<td>6.81</td>
</tr>
<tr>
<td>Tensile Strength, N/cm</td>
<td>25.71</td>
</tr>
<tr>
<td>Elongation to break, %</td>
<td>170</td>
</tr>
</tbody>
</table>

Note: un-optimized sample

- **Breathable**
  - Fiber diameter: 8 to 20 μm
  - Good spinning performance
  - Good strength and elasticity
  - Good elongation to break
Spun-blown Kraton Elastomers

100 X

Note: These are stretch engine fabric or film without facings

<table>
<thead>
<tr>
<th>Test Direction</th>
<th>MD 1648 (50 gsm spun-blown Fabric)</th>
<th>MD 6712 SEBS Compound (54 gsm Film)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MD</td>
<td>CD</td>
</tr>
<tr>
<td>100% Modulus, N/cm</td>
<td>0.24</td>
<td>0.24</td>
</tr>
<tr>
<td>300% Modulus, N/cm</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Tensile Strength, N/cm</td>
<td>1.8</td>
<td>1.6</td>
</tr>
<tr>
<td>Elongation to break, %</td>
<td>640</td>
<td>610</td>
</tr>
<tr>
<td>300% elongation hysteresis tensile set, %</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>300% elongation hysteresis recovered energy, %</td>
<td>80</td>
<td>80</td>
</tr>
</tbody>
</table>

- **Breathable**
- Fiber diameter: 8 to 15 μm
- Good spinning performance
- Uniform fiber orientation
- Excellent strength and elasticity
- High elongation to break

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)
- Excellent performance in spinning elastomers
- Wide fiber size distribution but controllable
- High filtration efficiency at lower pressure drop and higher dust holding capacity
Thank you!

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