Advances in Spun-blown Fiber Technology and Its Technical Applications

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Available at: https://works.bepress.com/mohammad_abouelreesh_hassan/9/
Advances in spun\textsuperscript{®} Fiber Technology and its Applications

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Biax-FiberFilm Corporation
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OEM & Leader in Meltblown, 
Spun-blown® and Web/Film Stretching Systems

Spun-blown® & Meltblown Systems

Web/Film MD/CD Stretchers
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)

http://www.textileworld.com
Introduction:
Conventional Meltblowing Systems

MB Single-Row Slot Spinnerettes

(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 Biax-Fiberfilm Corporation
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><strong>Throughput, Kg/m/hr</strong></td>
<td>10 - 100</td>
<td>150 - 300</td>
<td><strong>10 - 500</strong></td>
</tr>
<tr>
<td><strong>Mean Fiber size, µm</strong></td>
<td>1 - 5</td>
<td>3 - 15</td>
<td><strong>1 - 15</strong></td>
</tr>
<tr>
<td><strong>Nozzle Density, hole per cm</strong></td>
<td>10 - 20</td>
<td>20 - 50</td>
<td><strong>20 - 104</strong></td>
</tr>
<tr>
<td><strong>Fiber Strength</strong></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** (0.2-15µm)
- **Wide range of fiber properties**

<table>
<thead>
<tr>
<th>Polymer Resins Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>PP</td>
</tr>
<tr>
<td>PPS</td>
</tr>
<tr>
<td>PET</td>
</tr>
<tr>
<td>PBT</td>
</tr>
<tr>
<td>PE</td>
</tr>
<tr>
<td>PLA</td>
</tr>
<tr>
<td>Nylon 6</td>
</tr>
<tr>
<td>Kraton®</td>
</tr>
<tr>
<td>HALAR®</td>
</tr>
<tr>
<td>Vistamaxx™</td>
</tr>
<tr>
<td>TPU</td>
</tr>
<tr>
<td>Dupont</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.*

*Ingeo™ is a trademark of the NatureWorks, LLC*
Average Fiber Size versus Nozzle Size

The above chart is a guideline based on PP 1500 MFR and 200 HPI Fiber size values depending 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®**

- Frequency %
- Fiber Size, µm

**20 GSM Conventional PP Meltblown**

- Frequency %
- Fiber Size, µm
Spunmelt Fabrics Tensile Strength Overview

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>

"Patent Pending"

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Highly Extensile *Spun-blown*® Fabric

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

![Tensile Strength vs. Elongation Graph](image)

- **Tensile Strength, gf/inch**
- **Elongation %**

- **CD**
- **MD**
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

<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

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Spun-blown® PBT Filtration Performance

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 ]
Secret Behind the High Portion of Submicron Fibers
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)
Spun-blown® Elastic Laminates with Vistamaxx

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

<table>
<thead>
<tr>
<th>Basis Weight, gsm</th>
<th>30/75/30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Direction</td>
<td></td>
</tr>
<tr>
<td></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
### Spun-blown® Elastic Fabrics with Kraton Polymers

**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><strong>100% Modulus, N/cm</strong></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><strong>300% Modulus, N/cm</strong></td>
<td>MD</td>
<td>CD</td>
</tr>
<tr>
<td>300% Modulus, N/cm</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td><strong>Tensile Strength, N/cm</strong></td>
<td>MD</td>
<td>CD</td>
</tr>
<tr>
<td>Tensile Strength, N/cm</td>
<td>1.8</td>
<td>1.6</td>
</tr>
<tr>
<td><strong>Elongation to break, %</strong></td>
<td>MD</td>
<td>CD</td>
</tr>
<tr>
<td>Elongation to break, %</td>
<td>640</td>
<td>610</td>
</tr>
<tr>
<td><strong>300% elongation hysteresis tensile set, %</strong></td>
<td>MD</td>
<td>CD</td>
</tr>
<tr>
<td>300% elongation hysteresis tensile set, %</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td><strong>300% elongation hysteresis recovered energy, %</strong></td>
<td>MD</td>
<td>CD</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

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Mass Production of Solution Blown Nanofibers

Biax Single or Multirow Solution Blowing Setup
Solution Blown Nanofibers

Solution Blowing of PEO/Soy

Solution Blowing of PEO

Big Nozzles

Small Nozzles

Fiber Size Distribution of PEO Nanofiber

Courtesy to The Nonwovens Institute, NCSU
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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 Spun-blown® Pilot Line**
  - 254 µm, 381 µm & 508 µm **Biax spinnerettes**

- **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®**

- Hybrid technology bridging the gap between meltblowing and spunbond processes
- 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

**Solution-blowing**

- Mass production of ~300 nm nanofibers
Thank you!

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