Suede Made from Superfine Fiber Blend-spun via PA6/PE and Its Applications

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1. Technology Process

PA6
LDPE
compatibilizer
melt blend
spinning
matrix-fibril
blend fiber
extracting PE
with solvent
PA6 Superfine fiber
by carded, laminated and needle-punched

by impregnated, pressed, solidified, extracted and buffed, dyed …
2. Morphology Structure
Controlling of the Blend Fiber
2.1 Morphology Structure of PA6/PE Blend fibers

Fig. 1  Morphology Structure of Blend Fibers

a: original,   b: treated by formic acid,   c: dissolved by xylene
2.2 Morphology Structures of the Blend Fibers with Different Viscosity Ratios

Fig. 3 Cross-section of Blend Fibers with Three Different Viscosity Ratios of PA6/PE
2.3 The Effect of Composition Ratio of PA to PE on Morphology Structure of the Blend Fibers

For the lowest viscosity ratio (1.87), all the blend fibers cannot be split into ultra-fine fibers.

Fig. 4 Morphology Structure of Blend Fiber After Treatment with Xylene. 
\( \eta_m(\text{PA6}) / \eta_m(\text{PE}) = 1.87 \)
For the second lowest viscosity ratio (3.72), the blend fiber can be splitted into ultra-fine fiber except with the blend ratio of 65/35(PA/PE).

![Morphological Structure of Blend Fiber After Splitting](image)

**Fig. 5** Morphological Structure of Blend Fiber After Splitting

\[
\eta_m(\text{PA6}) / \eta_m(\text{PE}) = 3.72
\]
For the highest viscosity ratio (PA6/PE=6.15), all the blend fibers with composition ratios from 65/35 to 50/50 can be splitted into super-fine fibers.

Fig.6  Morphological Structure of Blend Fiber After Stripping

\( \frac{\eta_m(\text{PA6})}{\eta_m(\text{PE})} = 6.15 \)
Table 1. Evaluation of the stripping efficiency as a function of viscosity and composition ratio

<table>
<thead>
<tr>
<th>Blend ratio of PA6/PE</th>
<th>65/35</th>
<th>60/40</th>
<th>55/45</th>
<th>50/50</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.87</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>V</td>
</tr>
<tr>
<td>2.50</td>
<td>×</td>
<td>×</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>2.67</td>
<td>×</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>3.58</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>4.29</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>4.72</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>5.14</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>5.66</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>6.15</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
</tbody>
</table>

Note: V indicates the fiber can be stripped. × indicates the fiber can't be stripped.
3. Morphology Structure Controlling for PA6/PE Blend Fiber by Adding Compatibilizers
3.1 Change of Morphology Structures of Blend Fibers by Adding Compatibilizer

Fig. 7 SEM-photos of Cross-sections of blend fibers with different amount of compatibilizers

- a: 0%
- b: 1%
- c: 2%
- d: 3%
- e: 4%
- f: 5%
3.3 Morphology Structure of Blend Fibers After Dissolving Splitting

Fig. 8  SEM-photos of Longitudinal Surface of Blend Fibers Dissolved by Xylene With Compatibilizer of Different adding amount (×1500)

- a: 0%
- b: 1%
- c: 2%
- d: 3%
- e: 4%
- f: 5%

![SEM-photos of Blend Fibers](image-url)
The morphology structures of suede and chamois leather

Fig. 9  SEM Micrograph of artificial Suede

Fig. 10  SEM Micrograph of Chamois Leather
4. Properties of Leather and Artificial Suede
## Table 2  Moisture Permeability

<table>
<thead>
<tr>
<th>Sample</th>
<th>Leather</th>
<th>Artificial Suede</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness (mm)</td>
<td>1.695</td>
<td>1.664</td>
</tr>
<tr>
<td>Moisture Permeability (g.m⁻².h⁻¹)</td>
<td>30.0</td>
<td>28.9</td>
</tr>
<tr>
<td>Moisture Permeability per unit thickness (g.m⁻².h⁻¹.mm⁻¹)</td>
<td>17.70</td>
<td>17.38</td>
</tr>
</tbody>
</table>
## Table 3  Air Permeability

<table>
<thead>
<tr>
<th>Sample</th>
<th>Leather</th>
<th>Artificial Suede</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness (mm)</td>
<td>1.695</td>
<td>1.664</td>
</tr>
<tr>
<td>Mass per unit area (g.m⁻²)</td>
<td>510</td>
<td>560</td>
</tr>
<tr>
<td>Air Permeability (mm.s⁻¹)</td>
<td>10.3</td>
<td>12.7</td>
</tr>
</tbody>
</table>
## Table 4  Mechanical Properties

<table>
<thead>
<tr>
<th>Sample</th>
<th>Leather</th>
<th>Artificial Suede</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breaking Strength (N)</td>
<td>799</td>
<td>857</td>
</tr>
<tr>
<td>Breaking Elongation (%)</td>
<td>39.46</td>
<td>46.09</td>
</tr>
<tr>
<td>Breaking Power (J)</td>
<td>99.20</td>
<td>41.50</td>
</tr>
<tr>
<td>Breaking Time (s)</td>
<td>39.44</td>
<td>27.66</td>
</tr>
<tr>
<td>Maximum Tearing Force (N)</td>
<td>59.60</td>
<td>69.00</td>
</tr>
<tr>
<td>Minimum Tearing Force (N)</td>
<td>35.10</td>
<td>54.00</td>
</tr>
<tr>
<td>Average Tearing Force (N)</td>
<td>47.20</td>
<td>60.90</td>
</tr>
</tbody>
</table>
5. Applications of Nonwoven and Artificial Suede
Garments and Bags

- soft touch
- natural leather feel and appearance.
- change color effects
- good sense level
- fine embossing
- printing performance
- high peel strength
- abrasion resistance
Gloves

- abrasion resistance
- anti-bacteria
- prevent bore
- flame retardant
Cases

- high mechanical properties
- textural clarity
- color and diverse
- natural leather appearance.
Car decorations

- environmental performance
- flame-retardant
- high mechanical properties
- anti-aging
SHOES

- high moisture permeability
- waterproof
- anti-bacteria
- anti-wrinkling
- high peeling strength
- high tensile strength
- high tearing strength
Medical uses

- waterproof
- moisture-permeability
- anti-bacteria
- high strength
Industrial filters

• high overall uniformity of material properties
• high filtration efficiency
• low resistance
• high strength
Ball

- feel good
- wear resistance
- low water absorption,
- appropriate toughness
- flexibility
- quality of light.
• adsorption strong
• absorbent and soft
• not to hurt the surface
• reusable
6. Conclusions
(1) The blend fiber with two-phases structure is obtained by melt blend spinning of PA6 and PE. In order to make PA6 for disperse phase even at higher composition ratio, the viscosity ratio of PA6 to PE should be well controlled.
(2) By changing the amount of compatibilizer in the blends, the spinnability can be improved, and the island’s diameters can become smaller and more uniform. However, too much compatibilizers will lead to the difficulty in splitting process.
The nonwoven and suede manufactured by the superfine fiber have enough tackiness and soft touch, good permeability, higher strength and rub resistance etc. They are widely used for making sporting gloves, sporting shoes, footballs, basketballs, bags, car and sofa coverings, clothes, medical as well as industrial filter materials, etc. In the future, they will have more potential applications.
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THANK YOU FOR YOUR ATTENTION!