Introduction of L-MODU™ for Nonwoven application

March 30, 2021

Idemitsu Kosan Co., Ltd.
Advanced Materials & Performance Chemicals Department
What is L-MODU™?

Low Melting Point and Low Crystalline Polypropylene
What is L-MODU™? — Properties —

Properties of L-MODU™

<table>
<thead>
<tr>
<th></th>
<th>Method</th>
<th>L-MODU™</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>S401</td>
</tr>
<tr>
<td>MFR (g/10 min) (230 °C, 2.16 kg)</td>
<td>ISO 1133</td>
<td>2,600*</td>
</tr>
<tr>
<td>Molecular Weight (Mw)</td>
<td>GPC (Idemitsu method)</td>
<td>45,000</td>
</tr>
<tr>
<td>Molten Viscosity (mPa·s) (190 °C)</td>
<td>Idemitsu method</td>
<td>8,500</td>
</tr>
<tr>
<td>Density (kg/m³)</td>
<td>ISO 1183</td>
<td>870</td>
</tr>
<tr>
<td>Melting Point (°C)</td>
<td>DSC (Idemitsu method)</td>
<td>80</td>
</tr>
<tr>
<td>Softening Point (°C) (Ring-and-ball)</td>
<td>ISO 4625</td>
<td>93</td>
</tr>
<tr>
<td>Tensile Modulus (MPa)</td>
<td>ISO 527</td>
<td>90</td>
</tr>
<tr>
<td>Elongation at Break (%)</td>
<td>Idemitsu method</td>
<td>600</td>
</tr>
</tbody>
</table>

*MFR of S401 is converted from viscosity data.
Proposal for Nonwoven application

"Light" fabric weight

"High" strength

L-MODU™

Soft

Crimp

"Good" dispersion

"High" hydrostatic head

Fine fiber

"Good" heat-seal ability

"Good" process ability
Proposal for Nonwoven application

Diversification of customer needs

- **High added value**: Differentiation by providing higher quality nonwoven fabric
- **Solution**: Improve competitiveness by early resolution of existing issues
- **Low cost**: Control manufacturing costs and improve competitiveness
- **SDGs / Environmentally friendly**: Work for sustainability such as recycling and product loss reduction

**L-MODU™**

L-MODU™ answers the various needs of our customers.
Main application examples

Nonwoven type

Spunbond (S) Nonwoven

Meltblown (M) Nonwoven

SMS [Multi] Layer Nonwoven

By product use

Disposable diaper

Filter

Medical

Industrial

Packaging

Proposal for Nonwoven application
Main application examples

By using L-MODU™ at Spunbond nonwoven

For example

- **Fine fiber • High strength**
  - Nonwoven
  - Technical data 4-1 • 4-2 • 4-3
  - Improvement of nonwoven strength is expected by fine fiber.
  - By the effect of fine fiber, it is possible to combine various embosses (special shape/small area) without reducing the strength.

- **Fine fiber • Light weight**
  - Nonwoven
  - By making the fine fiber, it is expected to reduce the fabric weight (light weight) without reducing the strength.

- **Fine fiber • High HH**
  - Nonwoven
  - By making the fine fiber, it is expected to increase the HH (Hydrostatic head).

- **Good spinnability**
  - Nonwoven
  - With the excellent spinnability, it can be expected to reduce product loss due to fiber breaking or defects.
  - Since it is 100% homopolypropylene, the product can be recycled.
Main application examples

By using L-MODU™ at Spunbond nonwoven

For example

- **Soft Nonwoven**
  - Soft nonwoven can be obtained.
  - Improvement of softness can be expected by reducing the embossing temperature.

- **Cottony Nonwoven**
  - Fluffy and bulky nonwoven (crimp nonwoven) can be obtained.

Technical data 4-4
Main application examples

By using L-MODU™ at Meltblown nonwoven

For example

- **Soft Nonwoven**
  - Technical data 4-5
  - Soft nonwoven can be obtained.
  - Nonwoven fabric with less rustling sound can be obtained.

- **Good spinnability Nonwoven**
  - High flow-ability by adding L-MODU™ shows excellent spinnability of meltblown.

- **High Filter property Nonwoven**
  - Technical data 4-6
  - Nonwoven with good balance of filter property and air permeability can be obtained by fine fiber of meltblown.
## Main application examples

By using **L-MODU™** at **SMS multi layer nonwoven**

<table>
<thead>
<tr>
<th>For example</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fine fiber • High strength</strong> Nonwoven</td>
<td>Addition of L-MODU™ to spunbond</td>
</tr>
<tr>
<td><strong>Fine fiber • High HH</strong> Nonwoven</td>
<td>Addition of L-MODU™ to spunbond</td>
</tr>
<tr>
<td><strong>Fine fiber • Light weight</strong> Nonwoven</td>
<td>Addition of L-MODU™ to spunbond</td>
</tr>
<tr>
<td><strong>Soft</strong> Nonwoven</td>
<td>Addition of L-MODU™ to spunbond</td>
</tr>
<tr>
<td><strong>Low friction noise</strong> Nonwoven</td>
<td>Addition of L-MODU™ to meltblown</td>
</tr>
</tbody>
</table>

### Proposal for Nonwoven application

**Technical data** | **Contact**
--- | ---
2008-02-2 |
Technical data
Improvement of spinnability by L-MODU™
Mechanism of effect to fine fiber

Schematic figure of one fiber

Unstable

Stable

Solidification position of the spin-line is shifted to downstream and neck-like deformation is suppressed by blending L-MODU™.

The wide process window could be obtained.

You can arrange the process condition to make a Fine Denier Fiber.

Technical data / Spunbond(S) nonwoven
**Improvement of spinnability by L-MODU™**

1. Able to change to fine fiber condition

2. Become stable and able to reduce product loss

<table>
<thead>
<tr>
<th>Spinning velocity</th>
<th>Only General PP</th>
<th>General PP + L-MODU™ 5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 × speed (Standard)</td>
<td>○ stable spinning</td>
<td>○ stable spinning</td>
</tr>
<tr>
<td>2 × speed</td>
<td>○ stable spinning</td>
<td>○ stable spinning</td>
</tr>
<tr>
<td>3 × speed</td>
<td>△ unstable spinning</td>
<td>○ stable spinning</td>
</tr>
<tr>
<td>4 × speed</td>
<td>× impossible spinning (fiber break)</td>
<td>○ stable spinning</td>
</tr>
<tr>
<td>5 × speed</td>
<td>× impossible spinning (fiber break)</td>
<td>○ stable spinning</td>
</tr>
</tbody>
</table>

*Tested under certain specific condition

**Technical data** / Spunbond (S) nonwoven

- Spunbond nonwoven
- Meltblown nonwoven
- SMS multi layer nonwoven
Fine fiber / High strength nonwoven with L-MODU™

L-MODU™

Fiber diameter becomes finer

Increase of fiber number which cross on the embossing

Strength of Nonwoven UP

**SEM image**

<table>
<thead>
<tr>
<th>Fabric weight</th>
<th>Only General PP</th>
<th>General PP + L-MODU™ 5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber diameter (Spunbond layer)</td>
<td>15 gsm</td>
<td>15 gsm</td>
</tr>
<tr>
<td>1.6 denier (16 μm)</td>
<td>1.1 denier (13 μm)</td>
<td></td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>35 N/5cm</td>
<td>45 N/5cm</td>
</tr>
<tr>
<td>MD</td>
<td>13 N/5cm</td>
<td>20 N/5cm</td>
</tr>
<tr>
<td>CD</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Technical data** / Spunbond (S) nonwoven
Cottony nonwoven with L-MODU™

L-MODU™

Crimp effect appear in the fiber

General spunbond Nonwoven

Nonwoven surface

Cross section of nonwoven

Crimp spunbond Nonwoven (PP + L-MODU™)

*with using bicomponent nozzle

Technical data / Spunbond (S) nonwoven
Soft Meltblown nonwoven by L-MODU™

L-MODU™

Softness of Meltblown Nonwoven UP

<table>
<thead>
<tr>
<th></th>
<th>Handle-O-Meter (mN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MD</td>
<td>300</td>
</tr>
<tr>
<td>CD</td>
<td>0</td>
</tr>
<tr>
<td>General meltblown PP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>200</td>
</tr>
<tr>
<td>General meltblown PP + L-MODU™ 20%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100</td>
</tr>
<tr>
<td>General meltblown PP + L-MODU™ 40%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

Soft
High filter property
Meltblown nonwoven by L-MODU™

L-MODU™ Filter property of Meltblown nonwoven UP

*Test method: TSI 8130 using 0.3 µm NaCl aerogel at a flow rate of 32 lpm
Fine fiber / High Hydrostatic Head (HH) nonwoven by L-MODU™

L-MODU™
- Fiber diameter of spunbond layer becomes finer
- Increase of fiber number which cross on the embossing
- Decreasing the embossing temperature
- Suppress the damage to the nonwoven by embossing heat

HH of Nonwoven UP

SEM image

<table>
<thead>
<tr>
<th>Fabric weight</th>
<th>Only General PP</th>
<th>General PP + L-MODU™ 10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber diameter (Spunbond layer)</td>
<td>1.5 denier (15.5 μm)</td>
<td>1.3 denier (14.5 μm)</td>
</tr>
<tr>
<td>Embossing temperature</td>
<td>126 °C</td>
<td>108 °C</td>
</tr>
<tr>
<td>Hydrostatic head</td>
<td>106 mm Aq</td>
<td>154 mm Aq</td>
</tr>
</tbody>
</table>

Technical data / SMS [Multi] Layer nonwoven
Location

CHIBA, JAPAN

Capacity

40,000 t/y

Type of Packing

20 kg  Paper bag
500 kg  Flexible container bag

Idemitsu Kosan Co.,Ltd.

Advanced Materials & Performance Chemicals Department

2-1, Otemachi 1-Chome, Chiyoda-ku, Tokyo 100-8321, JAPAN

e-mail：L-MODU@idemitsu.com

HP  www.idemitsu.com/en
How to make “soft” polypropylene?

- Addition of rubbers
- Copolymerization with ethylene
- Stereo-regularity control

Concept for L-MODU™

Diagram:
- Methyl Group
- Carbon chain
- Metallocene Catalyst
Idemitsu have achieved Unique PP, L-MODU™, that have not only “Stereorandom” but “Sharp Molecular Weight Distribution” by Idemitsu original metallocene catalyst
1. Data and description in this material are information for design of products made from L-MODU™. The content of this material is based upon reliable test and information, but it is not absolute and perfect. Whenever the content of this material is used for design of your products, please test and confirm independently appropriation of such design. The content of this material does not warrant the successful result of its application to your own purpose and usage.

2. The content of this material is based upon reliable tests and information, but it does not warrant the successful results of its application to your own purpose and usage.

3. Data in this material shows sample figures measured under certain specific conditions.

4. Usage of products in this material does not warrant the successful results of applications of the product for specific usage.

5. In case of product being used for purpose and usage introduced in this material, please pay attention to industrial property rights of third party which may relate to such use.

6. The Product is a general industrial product and Seller does not guarantee the quality of medical equipment, medical product applications and cosmetic applications. In case of the product being used for food applications, please consult with the manufacture before such use.

7. Please note that the content of this material may be altered from time to time according to improvement of products without prior notice.

8. Figures of physical characteristics of other resins than the products have been referred from other catalogues and sources thereof.