Introduction of L-MODU™ as modifier for Film application

April 1st, 2021

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

Low Melting Point and Low Crystalline Polypropylene
## Properties of L-MODU™

<table>
<thead>
<tr>
<th>Property</th>
<th>Method</th>
<th>L-MODU™</th>
</tr>
</thead>
<tbody>
<tr>
<td>MFR (g/10 min) (230 °C, 2.16 kg)</td>
<td>ISO 1133 (JIS K 7210)</td>
<td>S400: 2,600*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S600: 390</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S901: 50</td>
</tr>
<tr>
<td>Molecular Weight (Mw)</td>
<td>GPC (Idemitsu method)</td>
<td>S400: 45,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S600: 75,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S901: 130,000</td>
</tr>
<tr>
<td>Molten Viscosity (mPa·s) (190 °C)</td>
<td>Idemitsu method</td>
<td>S400: 8,500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S600: 50,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S901: 360,000</td>
</tr>
<tr>
<td>Density (kg/m³)</td>
<td>ISO 1183</td>
<td>S400: 870</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S600: 870</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S901: 870</td>
</tr>
<tr>
<td>Melting Point (°C)</td>
<td>DSC (Idemitsu method)</td>
<td>S400: 80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S600: 80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S901: 80</td>
</tr>
<tr>
<td>Softening Point (°C) (Ring-and-ball)</td>
<td>ISO 4625</td>
<td>S400: 93</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S600: 100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S901: 120</td>
</tr>
<tr>
<td>Tensile Modulus (MPa)</td>
<td>ISO 527</td>
<td>S400: 90</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S600: 90</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S901: 90</td>
</tr>
<tr>
<td>Elongation at Break (%)</td>
<td>Idemitsu method</td>
<td>S400: 600</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S600: 800</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S901: 900</td>
</tr>
</tbody>
</table>

*MFR of S400 is converted from viscosity data.*
Proposal for improvement of film application

BOPP
(Biaxial Oriented polypropylene films)

- Stretchability
- Productivity
- Low heat seal Temperature
- Transparency
- Wide resin selectivity

CPP
(Cast polypropylene films)

- Transparency
- Gloss
- Softness
- Impact strength
- Puncture strength
- Good thermoformability

L-MODU™
Main application examples

**Film Type**

- **BOPP** (Biaxial Oriented polypropylene films)
- **CPP** (Cast polypropylene films)

**By product use**

- **Cigarette package**
- **Snack foods package**
- **Bread package**
- **Film in the battery**
- **Fresh food package**

**Proposal for Film application**
Main application examples

By using L-MODU™ at BOPP

For example

**Improvement of stretchability**
- **Technical data 4-1 • 4-2**
- **Good stretchability** even using high crystallinity base PP with adding L-MODU™.
- **High modulus and high transparency** even using high crystallinity PP with adding L-MODU™.
- **Wide resin selectivity** by slow crystallinity rate of L-MODU™.

**Increasing productivity**
- **Technical data 4-3**
- Reducing frequency of film breaking.
- Stable BOPP film production with **low MD stretching rolls temp.**

**Lowering the heat seal temperature**
- **Technical data 4-4**
- Good heat seal strength appears at **low heat seal temperature**.
- Improvement of transparency.

**Preventing separation of AB agents**
- **Technical data 4-5**
- By adding L-MODU™ to the skin layer enable **to prevent separation of AB agents**.
- Which leads to; **Prevention of roll pollution**  **Decreasing of printing failure**
Main application examples

By using L-MODU™ at CPP

For example

**Good optical property**

- Improvement of transparency and gloss by adding L-MODU™.

*Technical data 4-6*

**Improvement of softness**

- Adding softness with suppressing the stickness by keeping the same melting point as PP.

*Technical data 4-7*

**Improvement of Impact strength & Puncture strength**

- Improvement of impact strength and puncture strength from the softness attributed from low crystallinity of L-MODU™.
- Improvement of impact strength and puncture strength with keeping high transparency.
Technical data
Improvement of stretchability with L-MODU™

L-MODU™

Good stretchability even using high crystallinity PP.

Yield stress is reduced

Machine: Bruckner laboratory stretching machine KARO IV
Material: MDO sheet (×5)  TDO ratio: 8.0, 9.5  Stretching speed: 200 %/s
Balance of rigidity and transparency with L-MODU™

L-MODU™

Good balance of mechanical and optical properties especially for high crystallinity PP.

- Appropriate stretching temperature is necessary for good film properties.

**Technical data**

Stretching ratio: \(5 \times (MDO) \times 9.5 \times (TDO)\)
Film thickness: 20 \(\mu\)m
Increasing productivity by L-MODU™

L-MODU™

Good stretchability at low MDO temperature which leads to prevent film sticking to the roll and to keep the productivity.

Low MDO temperature

Image of film cross section

- Random PP
- LLDPE, LDPE
- Homo PP + L-MODU™
- Random PP
- LLDPE, LDPE

Technical data
Effect to heat seal strength by L-MODU™

L-MODU™

Decreasing heat seal temperature.

![Graph showing heat seal strength vs. sealing temperature]

- **Core**: Homo PP
- **Core**: 97% Homo PP + 3% S901
- **Core**: 97% Homo PP + 5% S901

**Skin**: 100% random PP

**Technical data**
Preventing separation of AB agents with L-MODU™

L-MODU™

Preventing separation of AB agents.

Magnified photo of AB agent

<table>
<thead>
<tr>
<th>Resin composition</th>
<th>Core</th>
<th>Homo PP</th>
<th>Homo PP + L-MODU™(S901) 5%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Skin</td>
<td>Homo PP</td>
<td>Homo PP + L-MODU™(S901) 5%</td>
</tr>
<tr>
<td>Haze</td>
<td>%</td>
<td>1.3</td>
<td>1.1</td>
</tr>
<tr>
<td>Gloss (60°)</td>
<td>%</td>
<td>129</td>
<td>144</td>
</tr>
<tr>
<td>Blocking strength</td>
<td>g/100cm²</td>
<td>1.84</td>
<td>0.53</td>
</tr>
<tr>
<td>Pic. C: breaking of membrane</td>
<td>%</td>
<td>4.6</td>
<td>2.8*</td>
</tr>
<tr>
<td>Pic. D: falling off of AB agent</td>
<td>%</td>
<td>0.5</td>
<td>0.2*</td>
</tr>
</tbody>
</table>

Film: thickness 15 µm  *AB agents: silica
Stretch condition: MDO 106°C, ratio 5  TDO 165°C, ratio 8.5

*The ratio of the number of C or D in A−D in the area
Optical property with L-MODU™

L-MODU™

Improvement of transparency and gloss.

Technical data

Film thickness: 50μm
Homo PP
Tm=165°C, MFR=7.0
Random co-PP
Tm=130°C, MFR=7.0
Effect to softness by L-MODU™

1. Softness depends on the content of L-MODU™.
2. Melting point is almost same as that of base PP.

Technical data

Film thickness : 50μm
Homo PP
Tm=165°C, MFR=7.0
Random co-PP
Tm=130°C, MFR=7.0
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
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.