The Performance of L-MODU™ for HMA Base Polymer Use

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Idemitsu Kosan Co., Ltd.
Performance Materials Laboratories
Performance Chemicals Department
Introduction of L-MODU™

New Polyolefin developed by IDEMITSU

Propylene

Single Site Catalyst
(Developed by Idemitsu)

low Mw and low modulus PP

L-MODU™

New type of polypropylene was developed by using precise control technology of stereo-regularity and molecular weight.
Introduction of L-MODU™

Control technology of Stereo-regularity and Molecular weight

- **Isotactic**
  - High crystalline – High stiffness
- **Middle Range**
  - Low crystalline – Soft
- **Atactic**
  - Amorphous

**Conventional catalyst**

- Heterogeneous distribution

**IDEMITSU Metalloocene catalyst**

- Homogeneous distribution
Introduction of L-MODU™

Relationship between Crystalline Structure and the Feature

High crystalline

Crystal Lamella

Elongation

High Modulus
High Strength
Low Elongation

Low crystalline
L-MODU™

Tie Molecule

Elongation

Suitable Modulus
Suitable Strength
High Elongation
Elastic behavior

Amorphous

Elongation

Break

Low Modulus
Low Strength
High Elongation
# Introduction of L-MODU™

## Typical Properties

<table>
<thead>
<tr>
<th>Properties</th>
<th>Test Method</th>
<th>L-MODU™</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>S400</td>
</tr>
<tr>
<td>Density (kg/m³)</td>
<td>ISO 1183</td>
<td>870</td>
</tr>
<tr>
<td>Softening Point (°C)</td>
<td>ISO 4625</td>
<td>93</td>
</tr>
<tr>
<td>Molecular Weight (Mw)</td>
<td>GPC (Idemitsu Method)</td>
<td>45,000</td>
</tr>
<tr>
<td>Molecular Weight Distribution</td>
<td>GPC (Idemitsu Method)</td>
<td>2</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 *1</td>
<td>600</td>
</tr>
<tr>
<td>Molten Viscosity at 190 °C (mPa s)</td>
<td>Idemitsu Method</td>
<td>8,500</td>
</tr>
</tbody>
</table>

*1 : JIS-K 7113-2, Half-size
Introduction of L-MODU™

Benefits for hot melt adhesive

- High bond strength
- Long open-time
- Low VOC
- Transparency
- Odorless
- Excellent heat resistance
IDEMITSU L-MODU™ will bring Great Advantage for HMA !!

1. **Excellent Sprayability** even at severer conditions (120 °C Spiral, ΩSpray)  ➤ P. 8

2. **High Bond Strength** Saves up to approx. 30% of HMA  ➤ P. 9

3. **Sprayable at Lower Temperature**  ➤ P. 10

4. **Wide Formulation Options**  ➤ P. 11
The Performance of L-MODU™ for Nonwoven
Excellent Sprayability

L-MODU™ based HMA has Excellent sprayability even at severe conditions such as 120°C, ΩSpray. This feature is attributed to the controlled Mw and Mw distribution which is brought by originally developed metallocene catalyst.

<table>
<thead>
<tr>
<th><strong>Spiral Spray Test</strong> (4 gsm, 150 m/min)</th>
<th><strong>ΩSpray Test</strong> (4 gsm, 100 m/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>L-MODU™ based HMA @120°C</strong></td>
<td><strong>L-MODU™ based HMA @150°C</strong></td>
</tr>
<tr>
<td>LM-B (30/50/20)</td>
<td>LM-A (50/40/10)</td>
</tr>
<tr>
<td>[Image of Spiral Spray Test]</td>
<td>[Image of ΩSpray Test]</td>
</tr>
<tr>
<td>APAO based HMA @120°C</td>
<td>APAO based HMA @150°C</td>
</tr>
<tr>
<td>APAO/TF = 80/20</td>
<td>APAO/TF/oil = 50/40/10</td>
</tr>
<tr>
<td>[Image of APAO Based HMA]</td>
<td>[Image of APAO Based HMA]</td>
</tr>
</tbody>
</table>
The Performance of L-MODU™ for Nonwoven
High Bond Strength

L-MODU™ based HMA has good NW/PE bond strength and higher NW/NW bond strength compared with other type. This feature is attributed to excellent cohesion strength of L-MODU™ and anchor effect arising from appropriate crystallization speed after deeply penetrated to NW.

T-Peel strength of each HMA (CD)

Advantage: Saves up to approx. 30% of HMA
L-MODU™ can achieve 300gf T-Peel strength with 3gsm others 4.5gsm.
The Performance of L-MODU™ for Nonwoven

Sprayable at Lower Temperature

L-MODU™ based HMA is sprayable at lower temperature and produces good bond strength as well. This feature is attributed to lower melting point of L-MODU™.

<table>
<thead>
<tr>
<th>Formulation (BP/TF/oi) Application Temp.</th>
<th>PE/NW</th>
<th>NW/NW</th>
</tr>
</thead>
<tbody>
<tr>
<td>LM-B 30/50/20 120°C SBS Market 150 °C APAO 50/40/10 160 °C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**T-Peel strength of each HMA (CD)**

- **Film destruction**
- **NW destruction**

**Advantage**: Fitting for thin materials, Prolong maintenance term of application systems, Saving energy cost, Securing staff safety
L-MODU™ will perform good bonding strength with various oil content. For example if you would like to increase the oil content, “30%” is possible (LM-C).

**T-Peel strength of each HMA (CD)**

**Formulation (BP/TF/oil)**
- **LM-C**: 30/40/30
  - 150 °C: 30%
- **LM-D**: 30/50/20
  - 130 °C: 20%
  - 145 °C: 10%
- **LM-A**: 50/40/10
  - 150 °C: 30%
  - 130 °C: 20%
  - 145 °C: 10%

**Film destruction**

**NW destruction**

- 3 gsm Initial
- 3 gsm Aged
- 4 gsm Initial
- 4 gsm Aged
- 5 gsm Initial
- 5 gsm Aged
L-MODU™ will perform good bonding strength with various tackifier content. If you would like to decrease the content of tackifier, “20%” is possible (LM-E).

**T-Peel strength of each HMA (CD)**

- **PE/NW**
- **NW/NW**

Formulation (BP/TF/oil) Application Temp. TF content

- **LM-E**: 70/20/10
  - 150 °C: 20%
  - 135 °C: 30%
  - 130 °C: 50%

- **LM-F**: 60/30/10
  - 150 °C: 20%
  - 135 °C: 30%
  - 130 °C: 50%

- **LM-D**: 30/50/20
  - 150 °C: 20%
  - 135 °C: 30%
  - 130 °C: 50%

NW destruction

- 3 gsm Initial
- 3 gsm Aged
- 4 gsm Initial
- 4 gsm Aged
- 5 gsm Initial
- 5 gsm Aged
Both of paraffinic and naphthenic oils are suitable for formulation with L-MODU™.

T-Peel strength of each HMA (CD)

**Formulation (BP/TF/oil)**
- **LM-D**
  - 30/50/20
  - 130 °C
  - PW90
- **LM-G**
  - 30/50/20
  - 130 °C
  - NS100
- **LM-H**
  - 30/50/20
  - 130 °C
  - NS90S

**Film destruction**

**NW destruction**

**3 gsm Initial**

**3 gsm Aged**

**4 gsm Initial**

**4 gsm Aged**

**5 gsm Initial**

**5 gsm Aged**

Paraffin rich
All kinds of water white resins are possible to use as tackifier with L-MODU™.

The Performance of L-MODU™ for Nonwoven
Wide Formulation Options

T-Peel strength of each HMA (CD)

Formulation (BP/TF/oil) Application Temp. TF type

<table>
<thead>
<tr>
<th>Formulation</th>
<th>PE/NW</th>
<th>NW/NW</th>
</tr>
</thead>
<tbody>
<tr>
<td>LM-I</td>
<td>30/45/25 130 °C Copolymer</td>
<td>Films destruction</td>
</tr>
<tr>
<td>LM-J</td>
<td>30/50/20 130 °C CDPD</td>
<td></td>
</tr>
<tr>
<td>LM-D</td>
<td>30/50/20 130 °C C5</td>
<td></td>
</tr>
</tbody>
</table>

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<td>30/50/20 130 °C CDPD</td>
<td></td>
</tr>
<tr>
<td>LM-D</td>
<td>30/50/20 130 °C C5</td>
<td></td>
</tr>
</tbody>
</table>

- 3 gsm Initial
- 3 gsm Aged
- 4 gsm Initial
- 4 gsm Aged
- 5 gsm Initial
- 5 gsm Aged

NW destruction
# The Performance of L-MODU™ for Nonwoven

## Test Conditions

### HMA Formulation

<table>
<thead>
<tr>
<th>BP/TF/oil</th>
<th>L-MODU™</th>
<th>Tackifier</th>
<th>Diana Process Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S400</td>
<td>S600</td>
<td>S900</td>
</tr>
<tr>
<td>LM-A</td>
<td>50/40/10</td>
<td>40</td>
<td>10</td>
</tr>
<tr>
<td>LM-B</td>
<td>30/50/20</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>LM-C</td>
<td>30/40/30</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>LM-D</td>
<td>30/50/20</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>LM-E</td>
<td>70/20/10</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>LM-F</td>
<td>60/30/10</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>LM-G</td>
<td>30/50/20</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>LM-H</td>
<td>30/50/20</td>
<td>30</td>
<td></td>
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<tr>
<td>LM-I</td>
<td>30/45/25</td>
<td>20</td>
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<tr>
<td>LM-J</td>
<td>30/50/20</td>
<td>20</td>
<td>10</td>
</tr>
</tbody>
</table>

### Spray Conditions

- **Line speed**: 150m/min
- **Nozzle size**: 0.5mm
- **Adhesive weight**: 3, 4, 5 gsm
- **Application temperature**: 120–150 °C

### Aging Conditions

- **2 weeks at 50 °C**

### Substrates

- SMS nonwoven (17 gsm)
- Breathable polyethylene film (20 gsm)
The Performance of L-MODU™ for Woodworking

Key Benefits for End-product

- Excellent heat resistance
- Long open time thanks to low crystallinity and slow solidification speed
- High adhesive strength thanks to excellent cohesion

![T-Peel strength (Plywood/Paper)](image)

- L-MODU™ based
  BP/TF/WAX = 85/10/5
- APAO based
The Performance of L-MODU™ for Packaging

**Key Benefits for End-product**

- High adhesive strength and wider option of additives thanks to excellent cohesion
- Lower dependence on tackifiers thanks to high Tg compared with other polyolefin

**Elongation behavior**

<table>
<thead>
<tr>
<th></th>
<th>Elongation at Break (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>mPE</td>
<td>0</td>
</tr>
<tr>
<td>mPE + L-MODU™ + TF 35/35/30 (wt%)</td>
<td>200</td>
</tr>
<tr>
<td>L-MODU™</td>
<td>800</td>
</tr>
</tbody>
</table>
Location

CHIBA, JAPAN

Capacity

40,000 t/y

Type of Packing

20 kg  Paper bag
500 kg  Flexible container bag

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