Introduction of L-MODU™ as Polypropylene Modifier

March 30, 2021

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

Low Modulus, Low Melting Point and Low Melt Viscosity 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>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>

<table>
<thead>
<tr>
<th></th>
<th>S400</th>
<th>S600</th>
<th>S901</th>
</tr>
</thead>
<tbody>
<tr>
<td>S400</td>
<td>390</td>
<td>390</td>
<td>50</td>
</tr>
<tr>
<td>S600</td>
<td>130,000</td>
<td>130,000</td>
<td>130,000</td>
</tr>
<tr>
<td>S901</td>
<td>360,000</td>
<td>360,000</td>
<td>360,000</td>
</tr>
</tbody>
</table>

*MFR of S400 is converted from viscosity data.
Proposal for PP modifier application

Elastomer compounds

- Reduction of oil content
- Reduction of oil bleeding
- Improvement of compression set
- Good adhesion property
- Improvement of transparency

Masterbatch / PP Compounds

- Good dispersion of fillers and pigment
- Improvement of process ability
- Enable to increase the filler content
- Improvement of the property of molded products
- Decreasing the color uniformity
- Enable to lower the processing temperature

About L-MODU™
Main application examples

Compound Type
- TPE (thermoplastic elastomers)
- TPV (thermoplastic vulcanizate)
- Masterbatch / PP Compounds

By product use
- Smartphone cable
- Shoe sole
- Pen grip
- Glass run channel
- Color box

Proposal for Modifier application
Technical data
Compounding L-MODU™ to TPS

<table>
<thead>
<tr>
<th></th>
<th>SEBS</th>
<th>PP</th>
<th>Oil (paraffinic)</th>
<th>L-MODU™ (5400)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td>100</td>
<td>66</td>
<td>200</td>
<td>0</td>
</tr>
<tr>
<td>L-MODU™</td>
<td>100</td>
<td>25</td>
<td>100</td>
<td>25</td>
</tr>
</tbody>
</table>

**Reduction of oil bleeding**

**Improvement of compression set**

**Improvement of transparency**

Technical data / TPS
Compounding L-MODU™ to TPS

<table>
<thead>
<tr>
<th></th>
<th>SEBS</th>
<th>PP</th>
<th>Oil (paraffinic)</th>
<th>L-MODU™ (5400)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td>100</td>
<td>66</td>
<td>200</td>
<td>0</td>
</tr>
<tr>
<td>L-MODU™</td>
<td>100</td>
<td>25</td>
<td>100</td>
<td>25</td>
</tr>
</tbody>
</table>

**Good adhesion property**

Test Method
Samples were prepared at 180 °C for 5min. by press molding. Interfacial adhesive forces of the samples were evaluated.

**Technical data** / TPS
Compounding L-MODU™ to TPV

<table>
<thead>
<tr>
<th></th>
<th>EPDM</th>
<th>PP (paraffinic)</th>
<th>Oil (L-MODU™)</th>
<th>Hardness (Shore A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td>100</td>
<td>50</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>L-MODU™</td>
<td>100</td>
<td>25</td>
<td>50</td>
<td>25</td>
</tr>
</tbody>
</table>

**Reduction of oil bleeding**

**Improvement of compression set**

Technical data / TPV

Contact
Improvement of Flow-ability (compound)

Adding L-MODU™ to GFPP compound with keeping the GF content fixed.

| Glass fiber reinforced PP (GFPP) (MFR=5g /10 min, GF30 wt%, hPP base) | 90 | 90 | 90 | 90 |
| homopolypropylene (hPP) (MFR=30g /10 min, Tm=163 °C) | 10 | 7.5 | 5 | 0 |
| L-MODU™ S400 | 0 | 2.5 | 5 | 10 |
| MFR g/10min | 8.1 | 9.0 | 9.7 | 11.7 |
| Flow length *1 cm | 53.9 | 56.3 | 58.5 | 63.4 |
| Flexural modulus*2 GPa | 5.5 | 5.2 | 5.01 | 4.7 |
| Heat Distortion Temperature (HDT) *2 °C | 162 | 162 | 161 | 160 |

*1 Condition of Flow length measurement
Injection Temperature : 200 °C  Mold Temperature : 30 °C  Injection pressure : 80 MPa

*2 Condition of Sample for Physical property
Injection Temperature : 190 °C  Mold Temperature : 30 °C  Injection pressure : 2.5 ~ 3.0 MPa

- Improvement of “Flow length” is possible by adding L-MODU™.
- Addition of L-MODU™ do not have large effect to “Flexural Modulus” and “Heat Distortion Temperature (HDT)”.
  - Which has similar effect not only GF but also other fillers.
Improvement of Flow-ability (compound)

Observation of surface roughness of molded sample of GFPP with L-MODU™.

Condition of measurement
Confocal laser microscope (LSM) \ Objective lens magnification: X10
Measuring point: ① 40 cm from sprue, ② pointed end

![Archimedes spiral diagram]

**Reference**

<table>
<thead>
<tr>
<th>Measuring point</th>
<th>Surface roughness</th>
<th>Sa (μm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>①</td>
<td></td>
<td>2.69</td>
</tr>
<tr>
<td>②</td>
<td></td>
<td>25.5</td>
</tr>
</tbody>
</table>

**L-MODU™ S400 10%**

<table>
<thead>
<tr>
<th>Measuring point</th>
<th>Surface roughness</th>
<th>Sa (μm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>①</td>
<td></td>
<td>1.33</td>
</tr>
<tr>
<td>②</td>
<td></td>
<td>17.2</td>
</tr>
</tbody>
</table>

**Improvement of appearance**
- Surface become smoother by adding L-MODU™.
- Good molding transfer ability
- Delaying the solidification time by adding L-MODU™.
- Good dispersion of GF
- Improvement of dispersion of GF by adding L-MODU™.
Adding L-MODU™ to Pigment compound

Observation of color dispersion of molded sample of Carbon black with 1 Polyethylene 2 Polypropylene 3 L-MODU™.

Evaluation diagram

Difference among base resin for MB

- PP
- PE
- L-MODU™

Uniformity

Carbon black (30 wt%)

masterbatch (0.3 wt%)

PP (Homo PP MFR=30) (99.7 wt%)

Twin screw extruder

Injection molding machine

☐ Good dispersion and diffusion of pigment by adding L-MODU™.
Adding L-MODU™ to Pigment compound

Observation of Luminance standard deviation (color unevenness).

- L-MODU™ has excellent pigment dispersion and diffusion properties, and it is possible to reduce the amount of pigment and use pigments that are difficult to disperse.
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.