Precautions

1. General Precautions

- The data indicated in this brochure are representative values which obtained by our own testing methods. Furthermore, the written contents in this brochure are based on the current available information and data etc. Please be mentioned that we do not provide any warranty about the accuracy or suitability thereof for any particular applications.
- The detailed technical information will be given to you when you contact us.
- For the detailed safety information, please refer to Materials Safety Data Sheet for TPX™.
- Please pay attention to industrial property rights about applications listed in this brochure. Before using TPX™, please evaluate the practical applicability of TPX™ and make sure whether any problems will not be caused.
- Please avoid fire, direct sunshine, water wetting and any abrupt temperature change at the storage place of TPX™.
- Please avoid the outdoor usage of TPX™ for a long period of time as it may cause the color change or the quality deterioration.
- These precautions are given on the assumption that TPX™ would be used in a normal way. If TPX™ is used in any special way, please take additional safety measures.

2. Use of TPX™ for Medical-related applications and Food contact applications

- Please contact us when you intend to use TPX™ in such applications.
What is TPX™?
TPX™ is a 4-methylpentene-1-based olefin copolymer. TPX™ has a characteristic molecular structure. Although TPX™ is a crystalline olefin resin, it shows transparency. Because of its excellent heat-resistance, release property and chemical resistance, TPX™ is used for industrial materials, including mandrels and sheaths in the manufacture of high-pressure rubber hose, mold cups for LED and other applications as well as for release film in the FPC manufacturing process and release paper in the manufacture of synthetic leather. Furthermore, TPX™ possesses a lowest density among thermoplastic polymers and then provides the molded articles with lower weight. This leads to reduce the environmental load for transportation. It is also noted that TPX™ is a halogen-free resin denoted as environmentally-friendly material. TPX™ is also used for food-related applications such as food wraps, food preservation packs, baking carton and microwave oven tableware.

TPX™ aerates the high added value products as functional resin, which the other conventional resins cannot achieve.
**Heat resistance**

Since TPX™ has a melting point in the range from 220°C to 240°C and a high vicat softening point, it can be used at high temperatures. However, as heat distortion temperature almost same as polypropylene, please carefully consider if TPX™ would like to be used under a high-loaded environment.

**Releasability and Non-compatibility**

The surface tension of TPX™ is 24mN/m, which is the lowest after fluorine resin. Hence, TPX™ shows excellent releasability among various materials. TPX™ is used as release material in hardening process of thermostetting resins (urethane, epoxy etc.) Furthermore, since TPX™ shows incompatibility against thermoplastic resins (PET, PP etc.), it is used to create a porous structure in PET or PP membranes.

**Transparency**

Although TPX™ is a crystalline resin, it exhibits excellent transparency (Haze : < 5 % ) and light transmittance. Especially TPX™ is used for optical analysis cells because of the higher UV transmittance as compared to glass and other transparent resins.

**Chemical resistance**

Because of its stable C-C bonds, TPX™ has better chemical resistance rather than polycarbonate and acrylic resin. TPX™ basically shows excellent chemical resistance particularly against acids, alkalis and alcohol. For this reason, TPX™ is used in various applications which require chemical resistance, such as cosmetics containers caps and tubes, experimental apparatus and analytical cells.

**Gas permeability**

TPX™ has a characteristic of excellent gas permeation because of its molecular structure. TPX™ is widely used for gas permeative applications such as gas separation membranes.

**Excellent Low Dielectric Properties**

Since TPX™ has a non-polar structure, its dielectric properties are almost same as fluorine resins. It should be noted that TPX™ dielectric properties are hardly affected by frequency and TPX™ can be injection-molded unlike PTFE. Hence, TPX™ shows stable dielectric properties in the wide range of frequency.

**Low density**

The density of TPX™ is the lowest (830 kg/m^2) among thermoplastic resins, and its specific volume is larger than that of other transparent resins. For this reason, it is possible to reduce the weight of injection-molded articles by using TPX™ or also TPX™ compounded with other resin.

**Steam resistance**

TPX™ shows a very low water absorbance as polyolefin and therefore the dimension of a product is hardly changed by water absorbance. Furthermore, since TPX™ does not hydrolyze in boiling water, it can be used in drug experimental apparatus and animal cages which require the steam sterilization.

**Food sanitation**

Hygienic approved TPX™ grades (JPN standards tests, US FDA-standards and EU-food standard) are also available and they are used for food wraps and microwave oven tableware.

**Low refractive index**

The refractive index of TPX™ is 1.463n, or lower than fluorine resin. Because of this, TPX™ can be used as low refractive materials.
TPX™ expands the possibilities of advanced technologies.

**As auxiliary material for use in the hardening process**
- LED molds: RT18
- Rubber hose mandrels and sheaths: MX002, MX004, DX820M

**As high-value-added product**
- RT18, MX004, MX0020, DX820, DX845
- Transparency
- Releasability
- Heat resistance
- Low density
- Chemical resistance
- Low dielectric properties
- Gas permeability
- Food sanitation
- Steam resistance

**Release films**
- Release papers for synthetic leather: DX820, DX231, DX310

**As resin modifier**
- Non-compatibility
- Heat resistance
- Distribution is controllable by stretching conditions.

**As food container/packaging material**
- RT18, RT31, MX0020, DX820, MBZ230
- Heat resistance
- Releasability
- Gas permeability
- Food sanitation

**Additional applications**
- Hollow fibers
- Animal cages: MX004(XB), RT18(XB)
- Experimental apparatus
- Cosmetic container caps and tubes: MX004, RT18
- Synthetic papers: DX820
- Heat-resistant tablewares for microwave oven
- Food wraps and baking cartons
**TPX™ meets a broad range of needs with a full grade mix.**

### Physical Properties

<table>
<thead>
<tr>
<th>Test Condition</th>
<th>Test Method</th>
<th>Limit</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density (kg/m³)</td>
<td>ASTM D1505</td>
<td>833</td>
<td>DX845</td>
</tr>
<tr>
<td>MFR (g/10min)</td>
<td>ASTM D1269</td>
<td>2.1</td>
<td>DX231</td>
</tr>
<tr>
<td>Melting Point (°C)</td>
<td>ASTM D542</td>
<td>2.1</td>
<td>DX820</td>
</tr>
<tr>
<td>Water Absorption (%)</td>
<td>ASTM D570</td>
<td>&lt;0.01</td>
<td>MX004</td>
</tr>
</tbody>
</table>

### Mechanical Properties

| Flexural Modulus (MPa) | ASTM D790 | 1600 | MX002 |
| Flexural Strength (MPa) | ASTM D790 | 45 | MX310 |

### Thermal Properties

| Expansion Coefficient (cm/cm°C) | ASTM E831 | 1.17×10⁻⁶ | MBZ830A |
| Vicat Softening Point (°C) | ASTM D1526 | 158 | DX560 |
| Heat Distortion Temperature (°C) | ASTM D638 | 197 | 2.1 |

### Electrical Properties

| Dielectric Breakdown Voltage (KV/mm) | ASTM D149 | 65 | DX560 |

### Moulding Properties

| Moulding Temperature (°C) | ASTM D149 | 1550 | MBZ830A |

### Processing Method

| Injection Moulding | | | |
| Paper Coating Extrusion | | | |
| Film Extrusion | | | |
| Mandrel Extrusion | | | |
| Fiber Extrusion | | | |
| Pipe Extrusion | | | |

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**As for the EU Directive, it is necessary to check the conformity of the application on the basis of the final product. TPX™ contains chemical substances whose Specific Migration Limit (SML) is 0.05 mg/kg and 5 mg/kg. For details about EU Directive as well as details about the conformity of TPX™ with the FDA regulations, please contact our responsible department.**
We will provide the full-support to our customers for the choice of a suitable grade.

Precautions in molding process

◆ Since TPX™ is in the state of pellets and does not absorb water, it is unnecessary to dry it before molding it.
◆ Since TPX™ is normally molded at high temperatures in the vicinity of 300°C, molding equipment which can be set for such temperature is needed.
◆ It is recommended that the hopper of molding equipment be purged with nitrogen for the purpose of controlling heat decomposition at the time of molding.
◆ It is recommended that in changing the resin, the previous resin be first replaced with a low-MFR PP resin and then switched to TPX™. Especially any contamination of TPX™ with even a very small amount of another resin would cause a serious damage to the appearance of the molded articles, and therefore the previous resin in the molding equipment must be replaced completely.

Injection molding

The viscosity of TPX™ sharply decreased at the over melting point. Therefore, the recommended gate shape is a pin gate to avoid residual strain around the gate. A pin gate at the off center position is especially recommended for shallow products.

◆ Cylinder temperature
Injection temperature is in the range from 290 to 310°C.

◆ Injection pressure/injection speed
Injection pressure and injection speed should be set as low as possible to obtain the product with free residual strain.

◆ Mold temperature
Mold temperature is in the range from 20 to 60°C

Basic mold structure

Although the mold structure for TPX™ is basically similar to a PP type, an ejecting way and a surface finish condition are slightly different due to the TPX™ inherent release property.

◆ Mold materials
A mold material should be chosen from the viewpoints of surface hardness, corrosion resistance, machinability and the shot number to be molded. The recommended mold material for TPX™ should have the below mentioned features.
(1) Fine polished surface like a lens.
(2) Good resistance against cloudy and rusty generated by molding gas

Surface finishing

The surface finish of a mold determines the transparency of a TPX™ product as TPX™ easily catches the surface finish of a mold. Therefore, the suggested mold material for TPX™ should have the below mentioned features.

(1) Good resistance against cloudy and rusty generated by molding gas
(2) Hardness and machinability: HRC 55 above and possible to machine with a machinability of less than 60mm.
(3) Surface hardness: micro hardness of 300 above
(4) Treated surface: surface treatment to increase the surface tension. TPX™ is not suitable for cutting manufacturing due to low mechanical strength.

Extrusion molding

TPX™, being a thermoplastic polyolefin, can be extruded with general-purpose extruders for PP and PE. But some considerations have to be taken into account in extruding TPX™, which has a high melting point. In the case of using any extruders for use for other resins, please select a proper extruder, keeping the following points in mind:

◆ Extruder
(1) High Heating Capacity
Extrusion of TPX™ is generally conducted in the range from 250 to 320°C cylinder temperature. Therefore, the extruder must have sufficient heat capacity.
(2) Temperature control in four or more zones
It is recommended that the temperature control of the cylinder be conducted in four or more zones so that an adequate amount of heat will be given to TPX™ pellets.
(3) L/D
L/D of an extruder is preferably recommended 30 to completely plasticize TPX™ even with large extrusion amount.

◆ Screw
We will propose a screw design suitable for the extrusion of TPX™.
(1) Long feed
Feed zone of 8-12D is suitable for plasticization of TPX™.
(2) Semi-compression screw
A semi-compression screw is suitable for TPX™ extrusion. The proper compression ratio is in the range from 2.6 to 3.8. The desirable length of the compression zone is about 10D.
(3) Long metering
A screw with a metering zone with more than 8D is suitable to homogenize and mix the molten resin efficiently.
(4) Depth
If the screw has a large height at the feed zone, TPX™ pellets hardly receive sufficient heat for plasticizing from the barrel. Therefore, the depth should be around 6mm for the case of an extruder with a diameter of less than 60mm.

Blow molding

The blow molding of TPX™ is limited to the direct blow molding process. The injection blowmolding process is not suitable due to the difficulty of uniform stretching. It should be noted that the transparency of a blow molded TPX™ product is inferior as compared to a injection molded product.

Post-Processing and Coloring

For the purposes of printing, painting and bonding, TPX™ needs to have frame, corona and plasma treatments to increase the surface tension. TPX™ is not suitable for cutting manufacturing due to low mechanical strength.

The most suitable method to color TPX™ is dry blending with color masterbatch. With respect to the choice of color masterbatch, it should have high heat resistance which can be sustained at processing temperature of TPX™.

The more detailed information about TPX™ processing is available as technical brochure.