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 of 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.
TPX™ is…

A functional resin that creates high-value-added products.

What is TPX™?

TPX™ is a 4-methylpentene-1-based olefin copolymer. TPX™ has a unique molecular structure. Although TPX™ is a crystalline olefin polymer, 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 to create LED light and other applications such as release film on 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 polymer 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™ provides the high added value as functional polymer that the other conventional polymers cannot supply.
TPX™ shows unique properties not available with any conventional resins.

Heat resistance
TPX™ has a high melting point in the range from 220°C to 240°C and a high Vicat softening temperature. Hence, it can be used for high temperature application. However, as heat distortion temperature of TPX™ is almost same as that of polypropylene, the application under high-stress environment needs to be carefully considered.

Releasability and Non-compatibility
The surface tension of TPX™ (24mN/m) is very low and this value is the secondary lowest as compared to fluorine polymers. Hereby, TPX™ shows excellent releasability against various materials. TPX™ is used as release material in hardening process of thermosetting 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 polymer, 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 polymers.

Chemical resistance
Because of its stable C-C bonds, TPX™ has better chemical resistance as compared to polycarbonate and acrylic polymer. 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 cosmetic container caps and tubes, experimental apparatus and analytical cells.

Gas permeability
TPX™ has a characteristic of excellent gas permeability derived from its molecular structure. Hence, TPX™ is widely used for gas permeative applications such as gas separation membranes.

Low dielectric property
Since TPX™ has a non-polar structure; its dielectric property is almost same as fluorine polymers. It should be noted that dielectric property of TPX™ is hardly affected by frequency and TPX™ can be injection-molded unlike PTFE. TPX™ shows stable dielectric property in the wide range of frequency.

Low density
The density of TPX™ is the lowest (830 kg/m³) among thermoplastic polymers, and its specific volume is larger than that of other transparent polymers. For this reason, it is possible to reduce the weight of injection-molded articles by using TPX™ or also TPX™ compounds.

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

Food sanitation
Hygienic approved TPX™ grades (JPN standards, FDA regulations and EU regulations) are also available and they are used for food wraps and microwave oven tableware.

Low refractive index
The refractive index of TPX™ is 1.463, lower than fluorine polymers.
TPX™ expands the possibilities of advanced technologies.

- As process material for hardening process
- Releasability, Heat resistance, Chemical resistance

- LED mold
- Rubber hose mandrels and sheaths

- Release film
- Release paper for synthetic leather

- As high-value-added product
- Transparency, Releasability, Heat resistance, Low density, Chemical resistance, Low dielectric properties, Gas permeability, Food sanitation, Steam resistance

- RT18, MX004, MX0020, DX820, DX845

- Cosmetic container caps and tubes
- Hollow fiber
- Animal cage
- Experimental apparatus

- As food container/packaging material
- Heat resistance, Releasability, Gas permeability, Food sanitation

- Heat-resistant tableware for microwave ovens
- Food wraps and baking carton

- As resin modifier
- Non-compatibility, Heat resistance

- Synthetic paper
- Distribution is controllable by stretching conditions.

- Thermoplastic resin, Micro-pores, Thermo-plastic resin
### TPX™ meets a broad range of needs with a full grade mix.

<table>
<thead>
<tr>
<th>Physical Properties</th>
<th>Type</th>
<th>Grade</th>
<th>High-Modulus</th>
<th>Intermediate-Modulus</th>
<th>Low-Modulus</th>
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<tr>
<td>Density</td>
<td>Density Gradient Method</td>
<td>kg/m³</td>
<td>MCI Method</td>
<td>RT18, RT31</td>
<td>RTX485</td>
<td>DX231</td>
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<td>MF</td>
<td>Applied Force 200°C</td>
<td>g/10min</td>
<td>MCI Method</td>
<td>RT18, RT31</td>
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### Basic Properties

#### Thermal Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Measurement</th>
<th>Methodology</th>
<th>Value</th>
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<tbody>
<tr>
<td>Vicat Softening Temperature</td>
<td>Injection Molding Specimen</td>
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<td>Heat Distortion Temperature</td>
<td>Injection Molding Specimen</td>
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#### Mechanical Properties

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<tr>
<td>Tensile Modulus</td>
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<td>ASTM D638</td>
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<td>Fractured Stress</td>
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<td>ASTM D638</td>
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<tr>
<td>Fractured Strain</td>
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<td>ASTM D638</td>
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<td>Tensile Modulus</td>
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<td>ASTM D638</td>
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<td>Flexural Modulus</td>
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<td>ASTM D790</td>
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<tr>
<td>Flexural Strength</td>
<td>MPa</td>
<td>ASTM D790</td>
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<td>Izod Impact Strength</td>
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<tr>
<td>Rockwell Hardness</td>
<td>R-scale</td>
<td>ASTM D7885</td>
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### Optical Properties

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<td>Relative Dielectric Constant</td>
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<td>Molding Shrinkage</td>
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### Processing Method

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<tr>
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<td>Injection Molding</td>
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<tr>
<td>Extrusion-Casting</td>
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<td>Extrusion-Press Casting</td>
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<td>Extrusion-Profile type, Mandrel, Pipe</td>
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<td>Extrusion-Fiber Spinning</td>
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<tr>
<td>Direct Blow Molding</td>
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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.
Precautions in molding process

- Since TPX™ pellets do not absorb water, it is unnecessary to dry it before molding process.
- Temperature control of molding equipment needs to be in the vicinity of 300°C due to high melting point of TPX™.
- Nitrogen purging is recommended at the hopper of molding equipment to reduce the heat decomposition of TPX™.
- Before TPX™ molding process, the previous polymer should be fully purged out by low-MFR polypropylene and then switched to TPX™ molding. It is noted that appearance of TPX™ products is seriously affected by small amount of contamination remained in molding equipment.

Injection molding process

The viscosity of TPX™ remarkably 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 270 to 300°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™ injection is basically similar to a PP type, an ejecting method 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 total shot number. The recommended mold material for TPX™ should have the following features.
  (1) Mirror-like polished surface
  (2) Good resistance against cloud and rust generated by molten gas
- Surface finish
  The surface finish of a mold determines the transparency of a TPX™ product as TPX™ easily catches up a mold surface topography. The mold should be polished as fine as possible. A proper thickness of the mold plating is in the range from 0.015 to 0.02mm. Gas generation is occasionally a concern issue as TPX™ is usually injected at nearby 300°C. It is recommended that a mold is occasionally cleaned by cloth during injection molding and anti-corrosion agent is better to be sprayed on the surface of mold.

Extrusion molding process

Although TPX™ can be extruded by conventional extruders used for PP and PE, there are some precautions for the choice of an extruder due to high melting point of TPX™. An extruder for TPX™ preferably possesses the following specifications.

- 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 is 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 30 to completely plasticize TPX™ even with large resin extrusion amount.
- Screw
  We will propose a following screw design for 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 sufficiently.
  (4) Depth
  If the screw has a large depth 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 < 60mm cylinder diameter.

Blow molding

The blow molding of TPX™ is limited to the direct blow molding process. The injection blow molding 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 an 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 its 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.