

TPX™

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.

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Polymethyl Pentene (PMP)

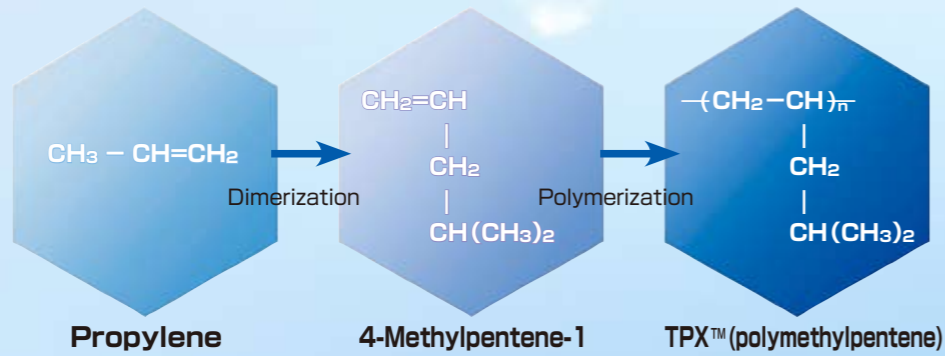
TPX™

What lies ahead... Transparent Polymer X



<http://jp.mitsuichem.com/info/tpx/etpx/eindex.html>

TPX™ is...

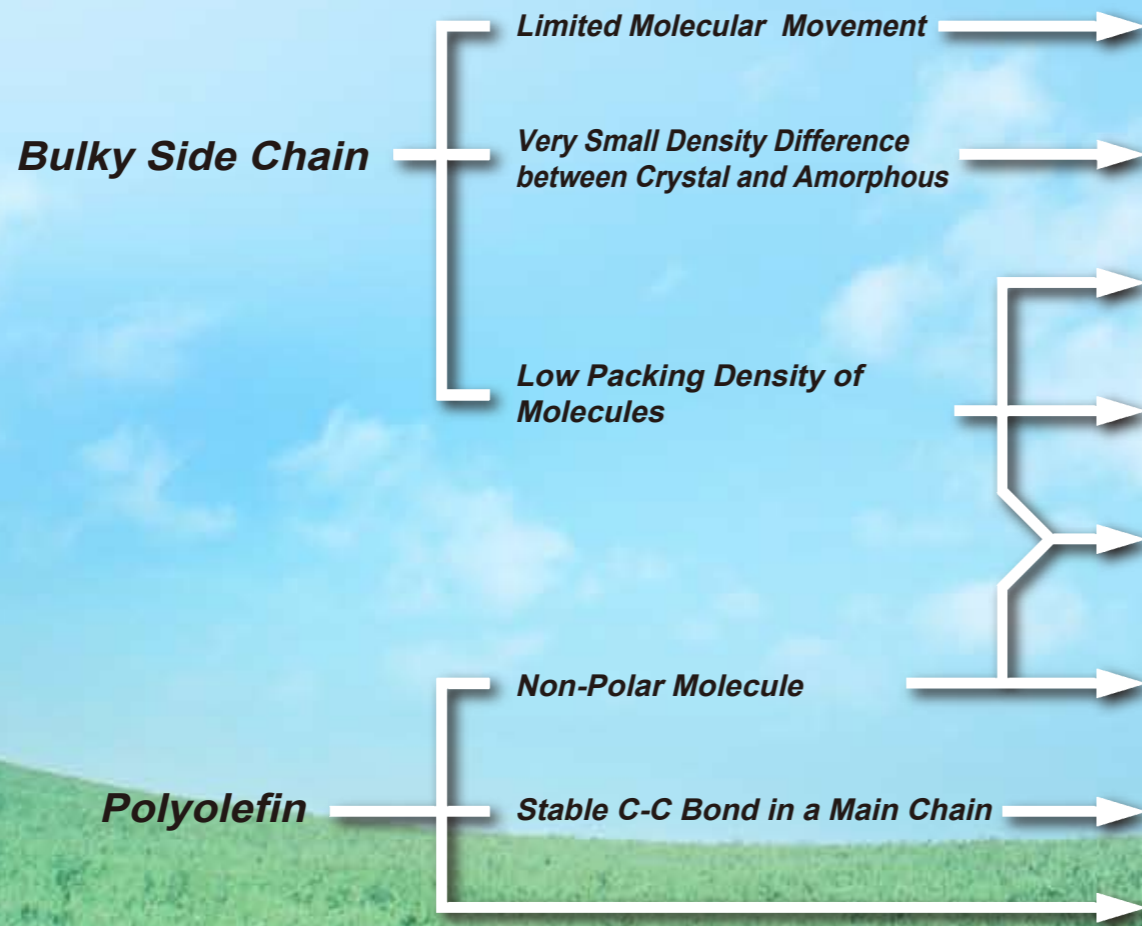


A functional resin that creates high-value-added products.

What is TPX™?

TPX™ is a 4-methylpentene-1-based olefin copolymer. TPX™ has a 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
Tm : 220 ~ 240 °C

Transparency
Haze < 5%

Gas Permeability
10 times larger than PE

Low Density
Density : 830 kg/m³

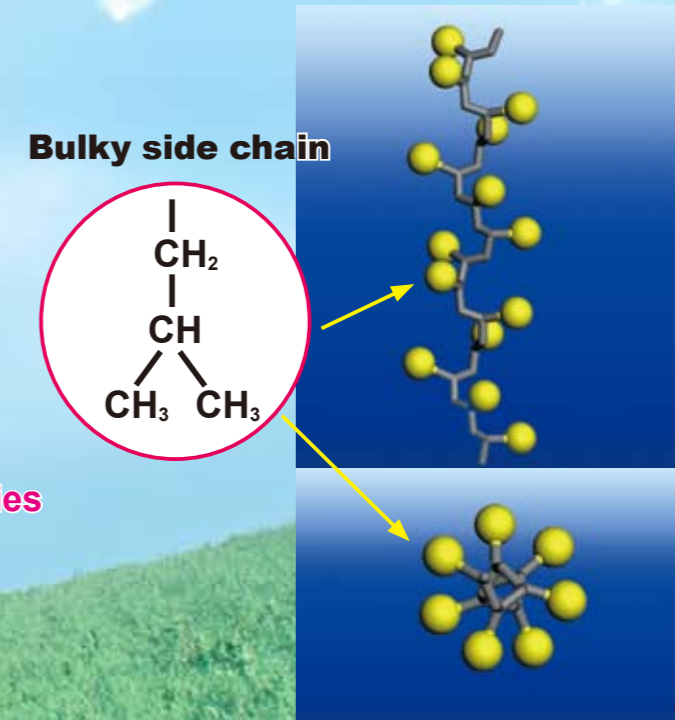
Releaseability
Surface Tension : 24 mN/m

Excellent Low Dielectric Properties
 $\epsilon = 2.1, \tan \delta = 0.0008$ (@10GHz)

Chemical Resistance

Halogen-free
Good for the Environment

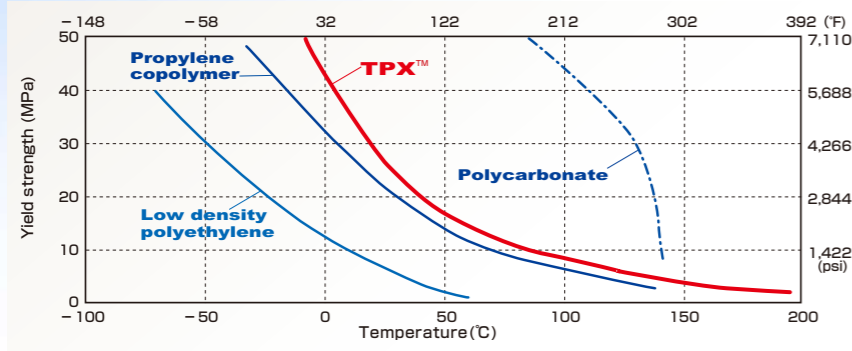
Crystal Structure of **TPX™**
7₂ Helical



TPX™ shows unique properties not available with any conventional resins.

Heat resistance

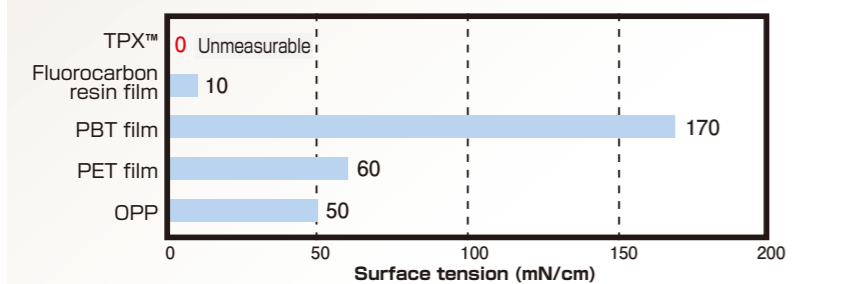
Since TPX™ has a melting point in the range from 220°C to 240°C and a high vicat softening point, it can be used at high temperatures. However, as heat distortion temperature almost same as polypropylene, please carefully consider if TPX™ would like to be used under a high-loaded environment.



Releasability and Non-compatibility

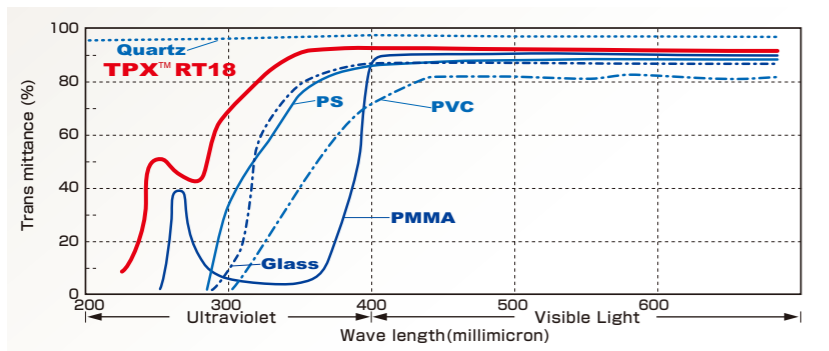
The surface tension of TPX™ is 24mN/m, which is the lowest after fluorine resin. Hence, TPX™ shows excellent releasability among various materials. TPX™ is used as release material in hardening process of thermosetting resins (urethane, epoxy etc.) Furthermore, since TPX™ shows incompatibility against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

Separating force from Epoxy



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 container caps and tubes, experimental apparatus and analytical cells.

Chemicals	Resin	TPX™	PMMA	PC	PS	PA
Concentrated sulfuric acid (98%)		A	C	C	A	D
Ammonia water		A	A	C	A	A
Sodium hydroxide (40%)		A	A	C	A	A
Sodium oxalate		A	A	A	A	—
Acetone		A	C	C	C	B
Methyl ethyl ketone		A	C	C	C	C
Ethanol		A	C	A	A	A
Toluene		C	E	C	E	—
Trichloroethylene		C	E	E	E	—
Brake oil		A	D	C	B	—

[25°C] A:Not attacked; B:Practically not attacked; C:Attacked (swelling); D:Attacked (cracked); E: Attacked (dissolve)

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.

Gas type	Resin	TPX™ (MX002)	HDPE	PP	PET
Moisture permeability (g · mm / m ² · 24hr · atm)		3.3	0.5	0.3	0.6
O ₂ permeability (cc · mm / m ² · 24hr · atm)		2000	125	110	0.8
N ₂ permeability (cc · mm / m ² · 24hr · atm)		495	45	17	—
CO ₂ permeability (cc · mm / m ² · 24hr · atm)		7000	250	310	—

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.

Dielectric property	Resin	TPX™	PTFE	ETFE	PE
Dielectric constant	10kHz	2.1	2.1	2.6	2.3
	1MHz	2.1	2.1	2.6	2.3
	10GHz	2.1	2.1	2.6	2.3
Dielectric dissipation factor (tan δ)	10kHz	< 0.0003	< 0.0003	0.0006	—
	1MHz	< 0.0003	< 0.0003	0.0015	—
	10GHz	0.0008	0.0005	0.0150	—

Low density

The density of TPX™ is the lowest (830 kg/m²) 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_D²⁰, 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

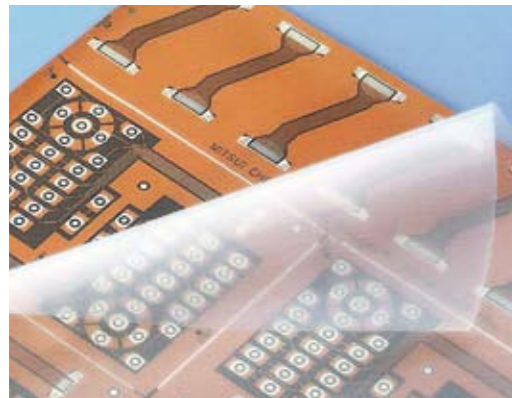
-  **Releasability**
-  **Heat resistance**
-  **Chemical resistance**



LED molds RT18



Rubber hose mandrels and sheaths
MX002, MX004, DX560M



Release films



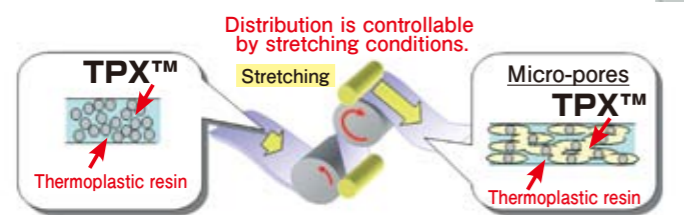
Release papers for synthetic leather
DX820
DX231
DX310



As resin modifier

-  **Non-compatibility**
-  **Heat resistance**










DX820



Synthetic papers DX820

As high-value-added product

RT18, MX004, MX0020, DX820, DX845

-  **Transparency**
-  **Heat resistance**
-  **Chemical resistance**
-  **Gas permeability**
-  **Steam resistance**
-  **Releasability**
-  **Low density**
-  **Low dielectric properties**
-  **Food sanitation**



Cosmetic container caps and tubes
MX004, RT18



Hollow fibers



Animal cages MX004(XB)
RT18(XB)



Experimental apparatus

As food container/packaging material

-  **Heat resistance**
 -  **Releasability**
 -  **Gas permeability**
 -  **Food sanitation**
- RT18, RT31, MX0020, DX820, MBZ230A



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				Grade	RT18, RT31 ^{※1} (RT18XB ^{※2} , RT31XB ^{※2})	DX845	DX231	DX820	MX004 (MX004XB ^{※2})	MX0020	MX002	DX310	MBZ230A	DX560M		
		物性項目	Test Condition	Unit	Test Method											
Basic Properties	Density			kg/m ³ lb/in ³	ASTM-D1505	833 0.030	833 0.030	232 0.030	832 0.030	833 0.030	834 0.030	834 0.030	834 0.030	1100 0.040	856 0.031	
	MFR		P=5kg, 260°C	g/10min	ASTM-D1238	26	9	100	180	25	21	21	100	49	330	
	Melting Point		peak temperature	°C °F	JIS-K7121 (DSC method)	232 449.6	232 449.6	232 449.6	232 449.6	228 442.4	224 435.2	224 435.2	226 438.8	233 451.4	221 429.8	
	Water Absorption			%	ASTM-D570	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	<0.01	
Thermal Properties	Vicat Softening Point			°C °F	ASTM-D1525	168 334.4	168 334.4	180 356.0	172 341.6	164 327.2	149 300.2	149 300.2	145 293.0	162 323.6	89 192.2	
	Heat Distortion Temperature		0.43MPa	°C °F	ASTM-D648	127 260.6	127 260.6	126 258.8	132 269.6	100 212.0	93 199.4	93 199.4	80 176.0	145 293.0	59 138.2	
	Expansion Coefficient			cm/cm°C cm/cm°F	ASTM-E831	1.17×10 ⁻⁴ 2.11×10 ⁻⁴	1.17×10 ⁻⁴ 2.11×10 ⁻⁴	1.17×10 ⁻⁴ 2.11×10 ⁻⁴	1.17×10 ⁻⁴ 2.11×10 ⁻⁴	1.17×10 ⁻⁴ 2.11×10 ⁻⁴	1.17×10 ⁻⁴ 2.11×10 ⁻⁴	1.17×10 ⁻⁴ 2.11×10 ⁻⁴	1.17×10 ⁻⁴ 2.11×10 ⁻⁴	1.28×10 ⁻⁴ 2.30×10 ⁻⁴	3.53×10 ⁻⁴ 6.35×10 ⁻⁴	
Mechanical Properties	23°C 73°F	Yield Stress		MPa PSI	ASTM-D638	30 4350	30 4350	29 4205	32 4640	25 3625	21 3045	21 3045	20 2900	27 3915	8 1160	
		Tensile Strength		MPa PSI	ASTM-D638	25 3625	25 3625	25 3625	25 3625	20 2900	10 1450	10 1450	10 1450	26 3770	9 1305	
		Elongation at Break		%	ASTM-D638	12	15	14	5	30	60	60	40	11	140	
		Tensile Modulus		MPa PSI	ASTM-D638	1900 275500	1900 275500	1860 269700	1950 282750	1300 188500	900 130500	900 130500	850 123250	2252 326540	280 40600	
	23°C 73°F	Flexural Modulus		MPa PSI	ASTM-D790	1600 232000	1600 232000	1550 224750	1700 246500	1050 152250	660 95700	660 95700	630 91350	1830 265650	240 34800	
		Flexural Strength		MPa PSI	ASTM-D790	45 6525	47 6815	43 6235	49 7105	32 4640	27 3915	27 3915	21 3045	70 10150	8 1160	
	23°C 73°F	Izod Impact Properties		with notch	J/m ft-ibs/in	ASTM-D256	30 0.56	30 0.56	18 0.34	19 0.36	27 0.51	32 0.60	32 0.60	25 0.47	73 1.37	NB NB
				without notch	kJ/m ² ft-ibs/in ²	ASTM-D256	9 4.3	10 4.8	8 3.8	8 3.8	23 10.9	129 61.3	129 61.3	127 60.3	35 16.6	NB NB
Rockwell Hardness		R scale	—	ASTM-D785	83	86	88	90	66	40	40	40	84	33		
Optical Properties	Haze			%	ASTM-D1003	0.7	0.7	1.7	2.1	0.7	0.7	1.3	1.7			
	Transmittance			%	ASTM-D1003	94	94	93	92	94	94	93	93			
	Refractive Index			—	ASTM-D542	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46			
Electrical Properties	Volume Resistivity			Ω · cm	ASTM-D257	>10 ¹⁶	>10 ¹⁶	>10 ¹⁶	>10 ¹⁶	>10 ¹⁶	>10 ¹⁶	>10 ¹⁶	>10 ¹⁶	>10 ¹⁶	>10 ¹⁵	
	Dielectric Breakdown Voltage			KV/mm V/mil	ASTM-D149	65 1650	65 1650	65 1650	65 1650	65 1650	65 1650	65 1650	65 1650	39 990	33 840	
	Dielectric Constant			—	ASTM-D150	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.5	2.2	
Moulding Properties	Spiral Flow		310 ~ 320°C Mould temp.73°C	cm	MCI Method-1	51	50			53	56	56		48		
	Moulding Shrinkage		Longitudinal	%	MCI Method-2	1.5	1.5			1.5	1.5	1.5		1.5		
			Transverse	%	MCI Method-2	1.2	1.2			1.1	1.1	1.1		1.1		
Processing Method	Injection Moulding			◎ : Highly recommended ○ : Possible × : Impossible	◎	○	○	○	◎	◎	◎	○	◎	○		
	Paper Coating Extrusion				×	×	◎	◎	×	×	×	◎	×	×		
	Film Extrusion				○	◎	×	×	◎	◎	◎	×	○	○		
	Mandrel Extrusion				○	○	×	×	◎	○	◎	×	×	◎		
	Fiber Extrusion				○	○	○	◎	○	○	○	○	×	×		
	Pipe Extrusion				○	○	×	×	○	○	○	○	×	○		
	Blow Moulding				×	○	×	×	○	○	○	×	×	○		

MCI Method-1 Moulding Temp. : 310 ~ 330°C (depending on the grade)
MCI Method-2 Moulding Temp. : 260 ~ 280°C (depending on the grade)
Note: Figures shown here are representative values but not specified values.

※ 1 RT31, RT31XB : Low odor grade
※ 2 RT18XB, RT31XB, MX004XB : Blue tint grade

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 up the roughness of a mold due to its high flow ability. From this reason, the mold should be polished as fine as possible. A proper thickness of the plating is 0.015 to 0.02mm. As TPX™ is usually injected at nearby 300°C, the gas is occasionally generated and it results in the cloudy and rusty surface on a mold. It is recommended that a mold is swept with cloth and covered with anti-corrosion agent after molding.

Example of Injection Molding Condition

Injection Machine	Clamp Force Capacity: 70ton	
Screw Diameter	φ 32mm	
Mold shape	Casserole Dish 136 × 136 × 58 (max thickness 3mm)	
Gate	Pin Gate	
Pre-Drying	Not Required	
Cylinder Temperature (°C)	C1	270
	C2	280
	C3	300
	C4	300
	Nozzle	290
Injection Pressure (MPa)	P1	30
	P2	40
	Pressure keeping	30
Injection speed (%)	V1	30
	V2	40
Injection time (s)	t1+t2	3
	Dwell Pressure	2
Coling Time(s)	20	
Cylinder Temperature	40	

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 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 an extruder with a diameter of less than 60mmφ.

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.

Example of Extruding Condition (T-Die Cast)

Extruder	T-Die Cast Extruder (3-Layered)	
Die	Multi Manifold Die	
Pre-Drying	Not Required	
Die Rip Gap	0.5mm	
Air Gap	30mm	
Cylinder Temperature (°C)	C1	280
	C2	290
	C3	290
	C4	290
	Adaptor	290
Die	290	
Casting Roll Temperature (°C)	50	
Pull-Up Speed (m/min)	20	
Film Thickness (mm)	50	



TPX™