Why?
What makes our functional polymers the choice for so many customers?

Performance Polymers Division

Product Information
Because...

It has to do with the valuable solutions we provide.

Our functional polymers are used in many applications for a wide range of industries. But it takes a deep understanding of target industries and their processing requirements to develop and propose products that meet our customers' needs precisely. Therein lies the value of our solutions.

Mitsui Chemicals, Inc.

Products of the Performance Polymers Division

- TPX™
- HI-ZEX MILLION™
- APEL™
- MIPELON™
- LUBMER™
- AURUM™
- MILEX™
Solution

Customers (Markets)

We create value for our customers in many ways.
New product development, cost savings... the list goes on.
TPX™ is a specially designed crystalline polyolefin with outstanding heat resistance, releasability and transparency. TPX™ expands the possibilities of advanced technologies.

### Characteristics

#### Releasability

Since TPX™ has a very low surface tension of only 24 mN/m, which is even lower than that of some fluorine resin, TPX™ shows an excellent releasability compared to a variety of materials.

<table>
<thead>
<tr>
<th>Material</th>
<th>Releasability (mN/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTFE</td>
<td>20</td>
</tr>
<tr>
<td>TPX™</td>
<td>24</td>
</tr>
<tr>
<td>HDPE</td>
<td>32</td>
</tr>
<tr>
<td>PP</td>
<td>34</td>
</tr>
<tr>
<td>PVC</td>
<td>39</td>
</tr>
<tr>
<td>PSu</td>
<td>41</td>
</tr>
<tr>
<td>PET</td>
<td>43</td>
</tr>
<tr>
<td>PC</td>
<td>43</td>
</tr>
<tr>
<td>PA66</td>
<td>46</td>
</tr>
</tbody>
</table>

### Heat resistance

Since TPX™ has a melting point in the range from 220°C to 240°C and a high visco softening point, it can be used at high temperatures.

#### Gas permeability

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

#### Food sanitation properties

Hygienic approved TPX™ grade (JPN Notification NO.370, The Voluntary Standards of the Japan Hygienic Olefin and Styrene Plastics Association, US FDA regulations and EU regulations) are also available and they are used for food wraps and microwave oven tableware.

#### 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, TPX™ does not hydrolyze in boiling water.

### Applications

- LED molds
- Release paper for synthetic leather
- Rubber hose mandrels and sheaths
- Food wraps and baking cartons
- Experimental apparatus
- Microwave oven tableware
**Cycloolefin Copolymer (COC)**

**APEL™**

APEL™ is an ideal transparent material for lens applications because of its outstanding optical properties. It is also used widely for medical and functional packaging use.

### Characteristics

#### Optical properties

APEL™ Cycloolefin Copolymer's light transmittance of 91%, and low birefringence make it ideal for use in the development of opto-electric applications.

**Performance comparison resins for optical applications**

![Graph showing refractive index and stress optical coefficient](image)

APEL™ has excellent optical characteristics. (High refractive index, Low birefringence)

#### Chemical resistance

In addition to excellent moisture impermeability, the Cycloolefin Copolymer displays an ability to resist acid, alkalis and alcohol among others.

#### Moisture barrier

APEL™ can be used to develop moisture barrier containers and for film applications due to its low permeability to water vapor and excellent humidity resistance.

**Gas barrier/permeability properties**

![Graph showing permeability comparison](image)

#### Dimensional stability

APEL™ exhibits excellent dimensional stability, with low mold shrinkage and low coefficient of linear expansion.

### Applications

- **Pick-up lenses for CD & DVD players**
- **Laser printer lenses**
- **Mobile phone camera lenses**
- **DVD lens unit**
- **Press through packaging (PTP)**
Ultra-high Molecular Weight Polyethylene

HI-ZEX MILLION™

HI-ZEX MILLION™ is an Ultra-high Molecular Weight Polyethylene, Mitsui Chemicals originally developed. The average molecular weight of HI-ZEX MILLION™, ranging from 500,000 to 6,000,000, is incomparably greater than the ordinary polyethylene. Because of its excellent properties, HI-ZEX MILLION™ is used in various fields; an electronic material, industrial material, medical equipment, and food manufacturing, etc.

Characteristics

Abrasian resistance

HI-ZEX MILLION™'s abrasion resistance is higher than that of such metals as carbon steel and brass, and is several to ten times as high as that of ordinary polyethylene.

<table>
<thead>
<tr>
<th>Material</th>
<th>Sand Abrasion Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>HI-ZEX MILLION™</td>
<td>1</td>
</tr>
<tr>
<td>MC Nylon</td>
<td>4</td>
</tr>
<tr>
<td>Nylon 66</td>
<td>5</td>
</tr>
<tr>
<td>Fluoroplastics</td>
<td>5</td>
</tr>
<tr>
<td>Polyacetal</td>
<td>6</td>
</tr>
<tr>
<td>HDPE</td>
<td>10</td>
</tr>
<tr>
<td>Rigid PVC</td>
<td>10</td>
</tr>
<tr>
<td>Phenolic Laminates</td>
<td>18</td>
</tr>
<tr>
<td>Carbon Steel</td>
<td>7</td>
</tr>
<tr>
<td>Brass</td>
<td>27</td>
</tr>
<tr>
<td>Maple Tree</td>
<td>45</td>
</tr>
</tbody>
</table>

Impact resistance

HI-ZEX MILLION™'s impact resistance is higher than that of other resins and ordinary polyethylene, and it is maintained in extremely low temperature.

Self-lubrication

HI-ZEX MILLION™'s low coefficient of friction allows un lubricated sliding of parts in contact with metal surfaces without frictional seizing.

Lightweight property

HI-ZEX MILLION™'s density of 900-950kg/m³, is one of the lowest among engineering resins, can decrease the weight of the product.

Powder property

It has a narrower particle size distribution processed with the finest particle control technologies of Mitsui Chemicals.

Applications

- High-strength fiber
- Sliding tape
- Artificial limb material
**MIPELON™**

MIPELON™ is an Ultra-high Molecular Weight Polyethylene fine powder with a very small particle size: 25 to 30 microns.

**Characteristic**

**Fine-particle / Self-lubrication**

Abrasion resistance / Chemical resistance

The addition of MIPELON™ to various resins, rubber, greases, and coating materials results in improved self-lubrication, abrasion resistance and chemical resistance because of the characteristics of Ultra-high Molecular Weight Polyethylene. Sintered MIPELON™ makes an excellent porous products because of the fine spherical property.

**Applications**

- Additive for rubber
- Filters and other parts

---

**LUBMER™**

LUBMER™ is a specialty polyethylene developed by Mitsui Chemicals' original polymerization technology. LUBMER™ has excellent self-lubrication, abrasion resistance and moldability. LUBMER™ is used for a wide range of applications for automotive, electronic and industrial parts.

**Characteristics**

**Self-lubrication / Abrasion resistance**

By far better than ordinary polyethylene, polyacetal and nylon.

**Moldability**

LUBMER™ is a possible material for various molding including the injection molding, compatibility with self-lubrication and abrasion resistance.

**Lightweight property**

The weight of the product can be decreased.

**Applications**

- Glass-run channel
- Electronic parts, bearing
Specialty phenolic resin
MILEX™

MILEX™ is a specialty phenolic resin that has flexibility, heat-stabilization, low moisture absorption, and chemical resistance. Mitsui Chemicals continues to strive to provide valuable solutions with our Phenolic Resin in order to meet our customers’ needs.

Characteristics

Heat resistance / Impact resistance
It is the best material to meet the demand of miniaturization of the brake pad, because of its excellent heat resistance.

Excellent heat resistance

<table>
<thead>
<tr>
<th>Weight Retention Ratio (%)</th>
<th>XL-Series</th>
<th>Straight Novolac</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[Curing Condition]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molding: 150°C, 20min</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-Cure: 240°C, 1hr</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heat resistance / High strength
Heat resistance • Thermoplastic polyimide
AURUM™

AURUM™ is a new type of thermoplastic polyimide resin developed by Mitsui Chemicals. It has high heat resistance, mechanical strength, electrical properties, thermoplasticity, making injection molding and extrusion possible.

Characteristics

Heat resistance / high strength
Self-lubricating properties / Dimensional-stability
AURUM™ is a resin that has a glass transition temperature of 250°C, the highest in the world, with use up to 240°C.

High heat resistance

<table>
<thead>
<tr>
<th>Temp (°C)</th>
<th>AURUM™ (225°C amorphous)</th>
<th>MILEX™ (PL Series)</th>
<th>ARLEN™ (A220)</th>
<th>PPS (Sf40%)</th>
<th>PABD (Sf30%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>20,000</td>
<td>15,000</td>
<td>10,000</td>
<td>5,000</td>
<td>0</td>
</tr>
<tr>
<td>50</td>
<td>15,000</td>
<td>10,000</td>
<td>7,500</td>
<td>3,750</td>
<td>0</td>
</tr>
<tr>
<td>100</td>
<td>10,000</td>
<td>7,500</td>
<td>5,000</td>
<td>2,500</td>
<td>0</td>
</tr>
<tr>
<td>150</td>
<td>7,500</td>
<td>5,000</td>
<td>3,750</td>
<td>1,875</td>
<td>0</td>
</tr>
<tr>
<td>200</td>
<td>5,000</td>
<td>3,750</td>
<td>2,500</td>
<td>1,250</td>
<td>0</td>
</tr>
<tr>
<td>250</td>
<td>3,750</td>
<td>2,500</td>
<td>1,875</td>
<td>937</td>
<td>0</td>
</tr>
</tbody>
</table>

Applications

Epoxy curing agent for IC encapsulation
Binder for brake pads

Mechanical parts
Electronic / Electric-parts
Automotive structural parts
# Table of Physical Properties of Grades

Physical Properties (Figures are just representative values, but not specification values. SI units are used.)

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>METHOD (ASTM)</th>
<th>TPX™</th>
<th>APEL™</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>RT18</td>
<td>MX004</td>
</tr>
<tr>
<td>Basic properties</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Filler content</td>
<td>%</td>
<td>—</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>—</td>
<td>D792</td>
<td>0.83</td>
<td>0.83</td>
</tr>
<tr>
<td>Water absorption</td>
<td>%</td>
<td>D570</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Molding shrinkage (MD)</td>
<td>%</td>
<td>D855</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>(TD)</td>
<td>%</td>
<td>D955</td>
<td>1.2</td>
<td>1.1</td>
</tr>
<tr>
<td>Light transmittance</td>
<td>%</td>
<td>D792</td>
<td>94</td>
<td>94</td>
</tr>
<tr>
<td>Mechanical properties</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tensile properties</td>
<td>MPa</td>
<td>D638</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>Elongation</td>
<td>%</td>
<td>D638</td>
<td>12</td>
<td>30</td>
</tr>
<tr>
<td>Flexural strength</td>
<td>MPa</td>
<td>D790</td>
<td>45</td>
<td>32</td>
</tr>
<tr>
<td>Flexural modulus</td>
<td>MPa</td>
<td>D790</td>
<td>1,600</td>
<td>1,050</td>
</tr>
<tr>
<td>Compressive strength</td>
<td>MPa</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Compressive elasticity modulus</td>
<td>MPa</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Izod impact strength (with notch)</td>
<td>J/m</td>
<td>D256</td>
<td>30</td>
<td>27</td>
</tr>
<tr>
<td>Rockwell hardness (R/M scale)</td>
<td>—</td>
<td>D785</td>
<td>83</td>
<td>66</td>
</tr>
<tr>
<td>Thermal properties</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melting point</td>
<td>°C</td>
<td>—</td>
<td>232</td>
<td>228</td>
</tr>
<tr>
<td>Glass transition point</td>
<td>°C</td>
<td>—</td>
<td>22</td>
<td>14</td>
</tr>
<tr>
<td>Deflection temp. under load (1.8MPa)</td>
<td>°C</td>
<td>D648</td>
<td>90</td>
<td>80</td>
</tr>
<tr>
<td>Coefficient of linear expansion (MD)</td>
<td>x10^-5/°C</td>
<td>D696</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>(TD)</td>
<td>x10^-5/°C</td>
<td>D696</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Specific heat</td>
<td>J/(g·°C)</td>
<td>C351</td>
<td>1.96</td>
<td>1.96</td>
</tr>
<tr>
<td>Thermal conductivity</td>
<td>W/(m·°C)</td>
<td>C177</td>
<td>0.17</td>
<td>0.17</td>
</tr>
<tr>
<td>Combustibility</td>
<td>—</td>
<td>UL94</td>
<td>HB</td>
<td>HB</td>
</tr>
<tr>
<td>Electrical properties</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface resistivity</td>
<td>Ω</td>
<td>D257</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Dielectric constant (10^9Hz)</td>
<td>—</td>
<td>D150</td>
<td>2.1</td>
<td>2.1</td>
</tr>
<tr>
<td>Dielectric dissipation factor (10^9Hz)</td>
<td>—</td>
<td>D150</td>
<td>0.0001&gt;</td>
<td>0.0001&gt;</td>
</tr>
</tbody>
</table>

Remarks

*1 Mitsui Chemicals method
*2 As measured at 10^9Hz
<table>
<thead>
<tr>
<th>HI-ZEX MILLION™</th>
<th>MILEX™</th>
<th>AURUM™</th>
</tr>
</thead>
<tbody>
<tr>
<td>240S</td>
<td>320MU</td>
<td>630M</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.94</td>
<td>0.93</td>
<td>0.93</td>
</tr>
<tr>
<td>1.9</td>
<td>1.9</td>
<td>0.1</td>
</tr>
<tr>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.06</td>
<td>&lt;0.1</td>
<td>0.23</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.74</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.85</td>
<td>0.66</td>
<td>0.66</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>41</td>
<td>39</td>
</tr>
<tr>
<td>410</td>
<td>350</td>
<td>260</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>182</td>
<td>162</td>
<td></td>
</tr>
<tr>
<td>785</td>
<td>590</td>
<td>590</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14,700</td>
<td>12,800</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>245</td>
<td>220</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,900</td>
<td>2,250</td>
<td>21,500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,200</td>
<td>3,900</td>
<td></td>
</tr>
<tr>
<td>No failure</td>
<td>No failure</td>
<td>No failure</td>
</tr>
<tr>
<td>136</td>
<td>136</td>
<td>136</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>300&lt;</td>
<td>170&lt;</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>3.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.5</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.5</td>
<td>4.7</td>
<td>4.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.01</td>
<td>0.92</td>
<td></td>
</tr>
<tr>
<td>No failure</td>
<td>No failure</td>
<td>No failure</td>
</tr>
<tr>
<td>0.42</td>
<td>0.42</td>
<td>0.42</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.17</td>
<td>0.49</td>
<td></td>
</tr>
<tr>
<td>Equal to HB</td>
<td>Equal to HB</td>
<td>HB</td>
</tr>
<tr>
<td>E(15)&lt;</td>
<td>E(15)&lt;</td>
<td>E(15)&lt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>2.3</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.8</td>
<td>5.5</td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.002</td>
<td>0.002</td>
<td>0.002</td>
</tr>
<tr>
<td>Molecular weight:</td>
<td></td>
<td>5,750,000</td>
</tr>
<tr>
<td>2,100,000</td>
<td>3,600,000</td>
<td></td>
</tr>
<tr>
<td>3,600,000</td>
<td>5,750,000</td>
<td></td>
</tr>
<tr>
<td>Filler: Glass fiber</td>
<td>All of above figures are for material in non-crystalline state. Filler: Carbon fiber Critical oxygen index: 47%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*3 As measured at 0.45 MPa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*4 Testing method: JIS K 8911</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*5 Mitsubishi Chemicals method</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*6 Testing method: JIS K 7208</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*7 Melting point at crystallization of crystallizable grade Critical PV value of JCL3030 (brass self-lubricating):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>With oil lubrication = 12.3 (MPa-m/s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without oil lubrication = 3.3 (MPa-m/s)</td>
<td>(Substrate: SUS304)</td>
<td></td>
</tr>
</tbody>
</table>
Overseas & Domestic Sites

We are leveraging Mitsui Chemicals’ collective strengths, developing our functional polymer business on a global scale.

MITSUI CHEMICALS, INC.

Performance Polymers Division
Shiodome City Center, 1-5-2,
Higashi-Shimbashi, Minato-ku, Tokyo 105-7117
PHONE +81-3-6253-3696 FAX +81-3-6253-4221

Please see our website for details.

Mitsui Chemicals Search

The information contained in this brochure is, to the best of our knowledge, accurate and reliable, but all suggestions are made without warranty, either express or implied. The Values using laboratory test specimens prepared in Mitsui Chemicals, Inc. laboratories and are not to be used as product specifications. Nothing herein shall be construed as permission or as recommendation for uses which infringe valid patents or as extending a license under valid patents. Because the conditions and methods of use on the part of our customers are beyond our control, Mitsui Chemicals, Inc., disclaims any liability incurred in connection with the use of our products.