

High Performance

Plastics Designed for Challenging Applications

High
Performance

High Performance Overview 9-2 to 9-3

PAI, Polyamide-imide 9-4 to 9-11

PBI, Polybenzimidazole 9-12 to 9-13

PBT, Polybutylene Terephthalate 9-14 to 9-19

PEEK, Polyether Ether Ketone 9-20 to 9-29

PEI, Polyetherimide 9-30 to 9-34

PET, Polyethylene Terephthalate 9-35 to 9-37

PI, Polyimide 9-38 to 9-41

PPO, Polyphenylene Oxide 9-43 to 9-47

PPS, Polyphenylene Sulfide 9-48 to 9-49

PPSU, Polyphenylsulfone 9-50 to 9-52

PSU, Polysulfone 9-53 to 9-55

PTFE, Polytetrafluoroethylene 9-56 to 9-65

PLASTICS GUIDE



WARNING: These products can potentially expose you to chemicals including, 4-Dioxane, Acetaldehyde, Acrylonitrile, Bisphenol-A, Carbon Black, Chromium, Cumene, Dichloromethane, Ethyl Acrylate, Ethylbenzene, Ethylene Glycol, Formaldehyde, Glass Fibers, Hexachlorobenzene, Lead, Methanol, Nickel, Polyvinyl Chloride, Silica-crystalline, Styrene, Tetrafluoroethylene, Titanium Dioxide, and Toluene, which are known to the state of California to cause cancer and/or birth defects or other reproductive harm. For more information, visit www.P65Warnings.ca.gov



High Performance

What is High Performance?

In modern industry, "performance" is a must. It can cover many aspects concerning quality, efficiency, durability, speed, throughput or resistance to external factors. The aim is to have applications that run smoothly, with minimum maintenance, at the best cost to performance ratio. Within our material portfolio, you will certainly find the high performance plastics you need for your applications.

High performance plastics typically have a permanent operating temperature of more than 302°F. It is this material class that brings the superior properties of polymers - such as sliding friction characteristics, weight saving and chemical resistance - to bear, especially at high permanent operating temperatures. Using special reinforcing materials such as glass fiber, glass beads or carbon fiber, heat distortion resistance and rigidity can be increased even further. Additives such as PTFE, and graphite considerably improve the sliding and friction characteristics, and the addition of metal fibers and carbon black provide improved electrical conductivity.

Industries and Applications

High performance plastics are plastics that meet higher requirements than standard or engineering plastics. Generally, they are used in smaller amounts for critical applications such as aerospace, defense, medical or industrial applications.

Differences between Crystalline and Amorphous?

Amorphous polymers and crystalline polymers both refer to classes of polymers distinguished by their molecular arrangement and properties. Amorphous polymers are characterized by their disordered, random molecular structure. This randomness results in them having no clear melting point, but instead, they soften over a range of temperatures. Crystalline polymers, on the other hand, have a more organized and repeating structure. This orderly alignment gives them a sharp melting point, where they transition from a solid to a melt.

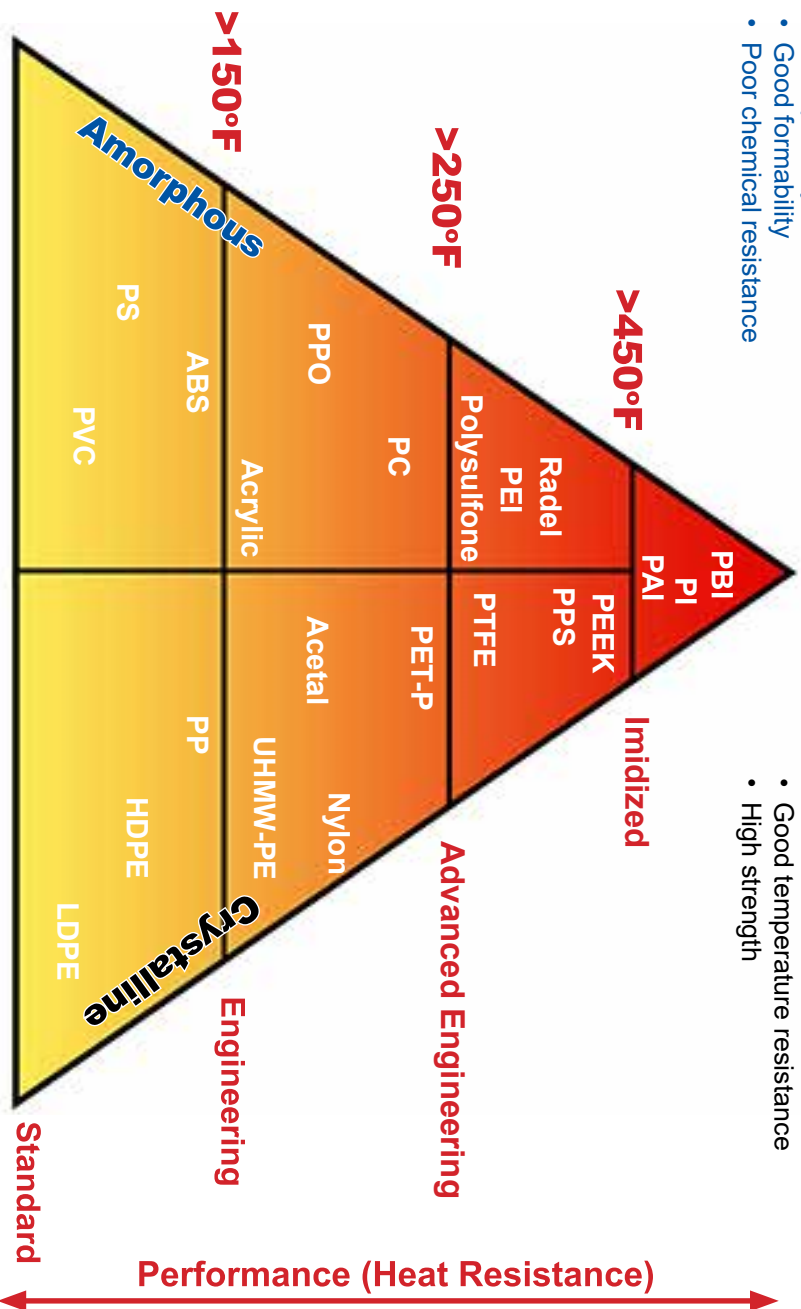
Please see the Polymer Pyramid on the following page for specific examples.

Amorphous

- Hot water and steam resistance
- Transparency
- Good formability
- Poor chemical resistance

Crystalline

- Bearing & wear performance
- Good chemical resistance
- Good temperature resistance
- High strength



PAI - Polyamide-Imide

Torlon® PAI

With its versatile performance capabilities and proven use in a broad range of applications, Torlon® polyamide-imide (PAI) shapes are offered in extruded, injection molded, and compression molded grades.

Torlon® PAI is the highest performing, melt processable plastic. It has superior resistance to elevated temperatures. It is capable of performing under severe stress conditions at continuous temperatures to 500°F (260°C). Parts machined from Torlon® stock shapes provide greater compressive strength and higher impact resistance than most advanced engineering plastics.

Typical Features:

- Maintains strength and stiffness to 500 °F (260 °C)
- Minimal expansion rate to 500 °F (260 °C)
- Excellent wear resistance in bearing grades
- Able to endure harsh thermal, chemical and stress conditions

Torlon® PAI's extremely low coefficient of linear thermal expansion and high creep resistance deliver excellent dimensional stability over its entire service range. Torlon® PAI is an amorphous material with a T_g (glass transition temperature) of 537°F (280°C). Torlon® PAI stock shapes are post-cured using procedures developed jointly by BP Amoco and Mitsubishi Chemical Group. This eliminates the need for additional curing by the end user in most situations. A post-curing cycle is sometimes recommended for components fabricated from extruded shapes where optimization of chemical resistance and/or wear performance is required.

For large shapes or custom geometries like tubular bar, compression molded Torlon® PAI shapes offer designers the greatest economy and flexibility. Another benefit of selecting a compression molded grade is that resins are cured, or "imidized" prior to molding which eliminates the need to post-cure shapes or parts fabricated from compression molded shapes.

Popular extrusion and injection molding grades of Torlon® PAI are offered as compression molded shapes. Typically, you can identify a compression molded grade as having a second digit of "5" in the product name.

Torlon® PAI Grades:

- | | |
|--------------------|--------------------|
| • Torlon® 4203 PAI | • Torlon® 4540 PAI |
| • Torlon® 4503 PAI | • Torlon® 5030 PAI |
| • Torlon® 4301 PAI | • Torlon® 5530 PAI |
| • Torlon® 4501 PAI | • Torlon® 7130 PAI |



PAI - Polyamide-Imide

Torlon® 4203 PAI & 4503 PAI

Torlon® 4203 PAI offers the best toughness and impact strength of all Torlon® PAI grades. This extruded grade is very popular for precision parts in high-tech equipment. In addition, its good electrical insulating ability provides numerous possibilities in the field of electrical components. Compression molded Torlon® 4503 PAI is similar in composition to Torlon® 4203 PAI, and is selected when larger shapes are required.

Torlon® 4503 PAI grade is commonly used for dies and patterns of formed metal parts or as thermal insulators. It is similar in composition to Duratron® T2503 PAI, and selected when larger shapes are required.

Product Applications:

- **High Temperature Electrical Connectors** - Torlon® 4203 PAI and Torlon® 5030 PAI provide outstanding electrical performance and high temperature stability.
- **Bearing Cages** - Torlon® 4203 and 4301 PAI's low expansion rate and excellent wear resistance enable manufacturers to increase bearing speeds and extend part life.
- **Can Mandrel** - Torlon® 4203 PAI's extraordinary compressive strength and abrasion resistance permit higher production rates, longer part life, and increased support of aluminum cans during printing.



Torlon® 4203 PAI pictured

Torlon® 4301 PAI & 4501 PAI

Torlon® 4301 PAI is primarily used for wear and friction parts. It offers a very low expansion rate, low coefficient of friction and exhibits little or no slip-stick in use. Torlon® 4301's flexural modulus of 1,000,000 psi, is higher than most other advanced engineering plastics. This grade excels in severe service wear applications such as non-lubricated bearings, seals, bearing cages and reciprocating compressor parts..

Torlon® 4501 PAI is well suited for general purpose wear and friction parts. It has a higher compressive strength and can therefore carry more load than Torlon® 4540. It is similar in composition to Torlon® 4301 PAI, and selected when larger shapes are required.

Product Applications:

- **Bearing Cages** - Torlon® 4203 and 4301 PAI's low expansion rate and excellent wear resistance enable manufacturers to increase bearing speeds and extend part life.



Torlon® 4301 PAI pictured

PAI - Polyamide-Imide

Typical Properties Comparison Torlon® PAI Grades

PROPERTY TESTED	ASTM	UNITS
MECHANICAL PROPERTIES		
Specific Gravity, 73°F	D792	g/cc
Tensile Strength, 73°F	D638	psi
Tensile Modulus, 73°F	D638	psi
Elongation (at break), 73°F	D638	%
Flexural Strength, 73°F	D790	psi
Flexural Modulus, 73°F	D790	psi
Shear Strength, 73°F	D732	psi
Compressive Strength, 73°F	D695	psi
Compressive Modulus, 73°F	D695	psi
Hardness, Rockwell M	D785	M
Hardness, Durometer, Shore "D"	D2240	D
Izod Impact (Notched)	D256A	ft-lb/in
Coefficient of Friction (Dry vs. Steel)	QTM 55007	Dynamic
Limiting PV (4:1 safety factor)	QTM 55007	psi-ft./min.
Wear Factor "k" x 10 ⁻¹⁰	QTM 55010	in ³ -min/lb-ft-hr
Relative Machinability	---	1=Easy, 10=Hard
THERMAL PROPERTIES		
Coefficient of Linear Thermal Expansion	E831	in/in-°F
Heat Deflection Temperature @ 264 psi	D648	°F
Melting Point (crystalline), Peak	D3418	°F
Continuous Service Temp in Air (Max)	Long Term	°F
Thermal Conductivity	F433	BTU-in/hr-ft ² -°F
ELECTRICAL PROPERTIES		
Dielectric Strength, Short Term	D149	kV/inch
Surface Resistance (EOS/ESD S11.11)	EOS/ESD	ohm/sq
Dielectric Constant, 10 ⁶ Hz	D150	---
Dissipation Factor, 10 ⁶ Hz	D150	---
Flammability @ 3.1 mm (1/8")	UL 94	---

The numbers supplied for the testing of this product came directly from the manufacturer of this material. These numbers should be used as a reference only, they are not to replace the actual testing of the material in your specific application. Test results may vary from application to application.



PAI - Polyamide-Imide

Typical Properties Comparison Torlon® PAI Grades

TORLON® 4203	TORLON® 4503	TORLON® 4301	TORLON® 4501
1.41	1.51	1.45	1.45
20,000	14,700	15,000	10,000
600,000	1,500,000	900,000	440,000
10.0 %	1.50 %	3.0 %	3.0 %
24,000	20,500	23,000	20,000
600,000	1,420,000	800,000	650,000
16,000	12,000	16,400	---
24,000	24,400	22,000	16,000
478,000	1,100,000	950,000	359,000
M 120	M 121	M 106	M 106
---	---	---	D 90
2.00	0.40	0.80	0.50
0.35	---	0.20	0.20
12,500	---	40,000	22,500
50	---	10	---
5	5	5	5
1.70 x 10 ⁻⁵	1.10 x 10 ⁻⁵	1.40 x 10 ⁻⁵	2.00 x 10 ⁻⁵
532°	410°	534°	534°
---	---	---	---
500°	480°	500°	500°
1.80	1.73	3.70	3.70
580	362	---	362
> 10 ¹⁶	> 10 ¹³	> 10 ¹³	> 10 ¹³
4.20	3.37	6.00	---
0.026	0.007	0.037	---
V-0	---	V-0	---

The numbers supplied for the testing of this product came directly from the manufacturer of this material. These numbers should be used as a reference only, they are not to replace the actual testing of the material in your specific application. Test results may vary from application to application.

High
Performance

PLASTICS GUIDE



PAI - Polyamide-Imide

Duratron® PAI

With its versatile performance capabilities and proven use in a broad range of applications, Duratron polyamide-imide (PAI) shapes are offered in extruded, injection molded, and compression molded grades.

Duratron® PAI is the highest performing, melt processable plastic. It has superior resistance to elevated temperatures. It is capable of performing under severe stress conditions at continuous temperatures to 500°F (260°C). Parts machined from Duratron stock shapes provide greater compressive strength and higher impact resistance than most advanced engineering plastics.

Duratron® PAI's extremely low coefficient of linear thermal expansion and high creep resistance deliver excellent dimensional stability over its entire service range. Duratron® PAI is an amorphous material with a T_g (glass transition temperature) of 537°F (280°C). Duratron® PAI stock shapes are post-cured using procedures developed jointly by BP Amoco and Mitsubishi Chemical Group. This eliminates the need for additional curing by the end user in most situations. A post-curing cycle is sometimes recommended for components fabricated from extruded shapes where optimization of chemical resistance and/or wear performance is required.

For large shapes or custom geometries like tubular bar, compression molded Duratron® PAI shapes offer designers the greatest economy and flexibility. Another benefit of selecting a compression molded grade is that resins are cured, or "imidized" prior to molding which eliminates the need to post-cure shapes or parts fabricated from compression molded shapes.

Popular extrusion and injection molding grades of Duratron® PAI are offered as compression molded shapes. Typically, you can identify a compression molded grade as having a second digit of "5" in the product name.

Typical Features:

- Maintains strength and stiffness to 500°F (260°C)
- Minimal expansion rate to 500°F (260°C)
- Excellent wear resistance in bearing grades
- Able to endure harsh thermal, chemical and stress conditions

Product Applications:

- Non-lubricated bearings
- Seals and valves
- Compressor parts
- Piston parts
- Bearing cages
- Electrical components
- High temperature seals



PAI - Polyamide-Imide

Duratron® PAI

Duratron® T4203 PAI

Duratron® T4203 PAI offers the best toughness and impact strength of all Duratron PAI grades. This extruded grade is very popular for precision parts in high-tech equipment. In addition, its good electrical insulating ability provides numerous possibilities in the field of electrical components. Compression molded Duratron® T4503 PAI is similar in composition to Duratron® T4203 PAI, and is selected when larger shapes are required.



Duratron® T4203 PAI pictured

Duratron® T4503 PAI

This grade is commonly used for dies and patterns of formed metal parts or as thermal insulators. It is similar in composition to Duratron® T2503 PAI, and selected when larger shapes are required.

Duratron® T4301 PAI

This Duratron® PAI is primarily used for wear and friction parts. It offers a very low expansion rate, low coefficient of friction and exhibits little or no slip-stick in use. Duratron® T4301's flexural modulus of 1,000,000 psi, is higher than most other advanced engineering plastics. This grade excels in severe service wear applications such as non-lubricated bearings, seals, bearing cages and reciprocating compressor parts.



Duratron® T4301 PAI pictured

Duratron® T4501 PAI

Duratron® T4501 PAI is well suited for general purpose wear and friction parts. It has a higher compressive strength and can therefore carry more load than Duratron® T4540. It is similar in composition to Duratron® T4301 PAI, and selected when larger shapes are required.

Duratron® T4540 PAI

This seal and bearing grade offers a very low coefficient of friction and good wear properties. It was developed specifically for use in rotating equipment. Its composition is the same as the former Duratron® T4340 PAI polyamide-imide and used when larger (especially tubular) shapes are required. Typical applications for Duratron® T4540 PAI include labyrinth seals, wear rings, bushings, and bearings of all types.

High
Performance

PLASTICS GUIDE



PAI - Polyamide-Imide

Typical Properties Comparison Duratron® PAI Grades

High
Performance

PROPERTY TESTED	ASTM	UNITS	DURATRON® T4203 PAI
MECHANICAL PROPERTIES			
Specific Gravity	D792	---	1.41
Tensile Strength	D638	psi	20,000
Tensile Strength at 300°F	D638	psi	15,000
Tensile Strength at 150°F	D638	psi	18,000
Tensile Modulus	D638	psi	600,000
Elongation (at break)	D638	%	10%
Flexural Strength	D790	psi	24,000
Flexural Modulus	D790	psi	600,000
Compressive Strength	D695	psi	24,000
Compressive Modulus	D695	psi	478,000
Hardness, Rockwell	D785	M (E)	120 (80)
Hardness, Durometer, Shore "D"	D2240	D	---
Izod Impact (Notched)	D256A	ft-lb/in	2.00
Coefficient of Friction (Dry vs. Steel)	QTM 55007	Dynamic	0.35
Limiting PV (4:1 safety factor)	QTM 55007	psi-ft./min.	12,000
Wear Factor "k" x 10 ⁻¹⁰	QTM 55010	in ³ -min/lb-ft-hr	35 x 10 ⁻¹⁰
THERMAL PROPERTIES			
Coefficient of Linear Thermal Expansion	E831	µin/in-°F	17.0
Deflection Temp. 264 psi	D648	°F (°C)	532° (278°)
Maximum Service Temp, Air	Long Term	°F (°C)	500° (260°)
Thermal Conductivity	F433	BTU-in/hr-ft ² -°F	1.80
ELECTRICAL PROPERTIES			
Dielectric Strength, Short Term	D149	kV/inch	580
Surface Resistance (EOS/ESD S11.11)	EOS/ESD	ohm	>=1.00e + 16
Dielectric Constant, 10 ⁶ Hz	D150	1 MHz	4.20
Dissipation Factor, 10 ⁶ Hz	D150	1MHz	0.026
CHEMICAL PROPERTIES			
Water Absorp Immersion, 24 hrs	D570(2)	%	0.40
Water Absorp Immersion, Saturation	D570(2)	%	1.70

The numbers supplied for the testing of this product came directly from the manufacturer of this material. These numbers should be used as a reference only, they are not to replace the actual testing of the material in your specific application. Test results may vary from application to application.

Continued on the next page

PLASTICS GUIDE



PAI - Polyamide-Imide

Typical Properties Comparison Duratron® PAI Grades

DURATRON® T4503 PAI	DURATRON® T4301 PAI	DURATRON® T4501 PAI	DURATRON® T4540 PAI
1.40	1.45	1.45	1.46
18,000	15,000	10,000	13,000
12,000	12,000	7,000	9,000
15,000	14,000	8,000	6,000
500,000	900,000	440,000	550,000
5%	3%	3%	3%
24,000	23,000	20,000	12,000
600,000	800,000	650,000	550,000
18,000	22,000	16,000	20,000
350,000	950,000	359,000	350,000
119 (80)	106 (70)	106 (70)	107 (66)
90	---	90	90
1.50	0.80	0.50	1.10
0.30	0.20	0.20	0.20
4,000	40,000	22,500	7,500
500 x 10 ⁻¹⁰	10 x 10 ⁻¹⁰	150 x 10 ⁻¹⁰	315 x 10 ⁻¹⁰
15.0	14.0	20.0	20.0
532° (278°)	534° (279°)	534° (279°)	534° (279°)
500° (260°)	500° (260°)	500° (260°)	500° (260°)
1.80	3.70	3.70	2.81
600	---	---	---
>=1.00e + 13	>=1.00e + 13	>=1.00e + 13	>=1.00e + 13
4.20	6.00	6.00	---
0.031	0.037	0.042	---
0.35	0.40	0.30	0.30
1.70	1.50	1.50	1.50

The numbers supplied for the testing of this product came directly from the manufacturer of this material. These numbers should be used as a reference only, they are not to replace the actual testing of the material in your specific application. Test results may vary from application to application.

Continued from previous page

High
Performance

PLASTICS GUIDE



PBI - Polybenzimidazole

Duratron® CU60 PBI

Duratron® CU60 PBI is the highest performance engineering thermoplastic available today. It offers the highest heat resistance and mechanical property retention over 400°F of any unfilled plastic. It has better wear resistance and load carrying capabilities at extreme temperatures than any other reinforced or unreinforced engineering plastic.

As an unreinforced material, Duratron® CU60 PBI is very “clean” in terms of ionic impurity and it does not outgas (except water). These characteristics make this material very attractive to semiconductor manufacturers for vacuum chamber applications. Duratron® CU60 PBI has excellent ultrasonic transparency which makes it an ideal choice for parts such as probe tip lenses in ultrasonic measuring equipment.

Duratron® CU60 PBI is also an excellent thermal insulator. Other plastics in melt do not stick to PBI. These characteristics make it ideal for contact seals and insulator bushings in plastic production and molding equipment.

Typical Features:

- Highest mechanical properties of any plastic above 400°F (204°C)
- Highest heat deflection temperature 800°F (427°C), with a continuous service capability of 750°F (399°C) in inert environments, or 650°F (343°C) in air with short term exposure potential to 1,000°F (538°C)
- Lowest coefficient of thermal expansion and highest compressive strength of all unfilled plastics.

Product Applications:

- High heat insulator bushings
- Electrical connectors
- Ball valve seats
- Clamp rings



Engineering Notes:

Duratron® CU60 PBI is extremely hard and can be challenging to fabricate. Polycrystalline diamond tools are recommended when fabricating production quantities. Duratron® tends to be notch sensitive. All corners should be radiused (0.040" min.) and edges chamfered to maximize part toughness. High tolerance fabricated components should be stored in sealed containers (usually polybags with desiccant) to avoid dimensional changes due to moisture absorption. Components rapidly exposed to temperatures above 400°F (204°C) should be "dried" prior to use or kept dry to avoid deformation from thermal shock.

PBI - Polybenzimidazole

Typical Properties for Duratron® CU60 PBI

PROPERTY TESTED	ASTM	UNITS	DURATRAN® PBI
MECHANICAL PROPERTIES			
Specific Gravity	D792	---	1.30
Tensile Strength	D638	psi	20,000
Tensile Modulus	D638	psi	850,000
Elongation (at break)	D638	%	3
Flexural Strength	D790	psi	32,000
Flexural Modulus	D790	psi	950,000
Compressive Strength	D695	psi	50,000
Compressive Modulus	D695	psi	900,000
Hardness, Rockwell	D785	M (R)	125 (-)
Hardness, Durometer, Shore "D"	D2240	D	94
Izod Impact (Notched)	D256A	ft-lb/in	0.50
Coefficient of Friction (Dry vs. Steel)	QTM 55007	Dynamic	0.24
Limiting PV (4:1 safety factor)	QTM 55007	psi-fpm	37,500
Wear Factor "k" x 10 ⁻¹⁰	QTM 55010	in ³ -min/lb-ft-hr	60
THERMAL PROPERTIES			
Coefficient of Linear Thermal Expansion	E831	10E-4/°F	.13
Deflection Temp. 264 psi	D648	°F	800°
Cont. Service in Air (Max)	Long Term	°F	600°
Thermal Conductivity	F433	BTU-in/hr-ft ² -°F	2.8
ELECTRICAL PROPERTIES			
Dielectric Strength, Short Term	D149	Volts/mil	550
Surface Resistance (EOS/ESD S11.11)	EOS/ESD	Ohm/Sq	1E+13
Dielectric Constant, 10 ⁶ Hz	D150	1 MHz	3.20
Dissipation Factor, 10 ⁶ Hz	D150	1MHz	.003
CHEMICAL PROPERTIES			
Water Absorp Immersion, 24 hrs	D570(2)	%	0.40
Water Absorp Immersion, Satur.	D570(2)	%	5.00

The numbers supplied for the testing of this product came directly from the manufacturer of this material. These numbers should be used as a reference only, they are not to replace the actual testing of the material in your specific application. Test results may vary from application to application.

High
Performance

PLASTICS GUIDE

PBT - Polybutylene Terephthalate

Hydex® 4101 and Hydex® 4101L

Hydex® 4101 and Hydex® 4101L (internally lubricated) represent a family of stock shape plastics with elevated performance over PET-P, Acetal and Nylon. Hydex® 4101 is a PBT Polyester with an outstanding set of properties that include; wear resistance, chemical resistance and toughness. Hydex® 4101L (Lubricated) is an enhanced version with improved wear, PV range and lubricity over Hydex® 4101. In direct comparison to other commonly used plastics, Hydex® 4101 and Hydex® 4101L have:

Product Applications:

- Bearings
- Bushings, Cams
- Cam rollers
- Conveyor components
- Conveyor wheels
- Dispensing components
- Filler components
- Fixturing blocks
- Food pistons
- Wear strips
- Impellers
- Manifolds
- Pump parts
- Scraper blades
- Timing screws
- Valve bodies & Gears

Food Processing Industry:

- Bakery
- Beverages / Soft drinks
- Candy / Confectionery
- Canned foods
- Dairy
- Frozen foods
- Ice cream
- Juices
- Meat & Meat by-products
- Poultry processing
- Processed & Snack foods



PBT - Polybutylene Terephthalate

Advantages of Hydrex® 4101/4101L vs other materials

Improved Wear and Chemical Resistance versus Acetal

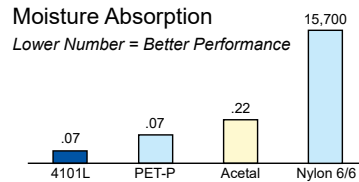
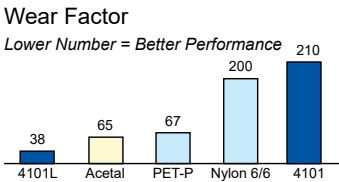
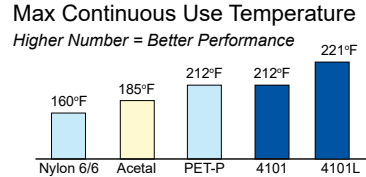
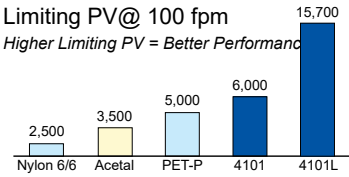
- Hydex® 4101 and 4101L are compatible with chemicals having a pH range of 2.0 - 9.0, Acetal's range is 4.0 - 9.0.
- Hydex® 4101 and 4101L can with stand repeated "CIP" chemical washdown without affecting material performance. Acetal degrades upon repeated contact with aqueous chlorine solutions.
- Hydex® 4101L has 30% higher limiting PV than Delrin® AF.
- Hydex® 4101L has about two times better wear factor than Acetal.
- Hydex® 4101L is approved for direct food contact, Delrin® AF is not.

Superior Dimensional Stability over Nylon

- Hydex® 4101 and 4101L have moisture absorption of 0.07%.
- Nylon has moisture absorption 15 times greater than Hydex®, and can exhibit significant dimensional changes in use.

Best Wear and Lubricity when compared to PET-P

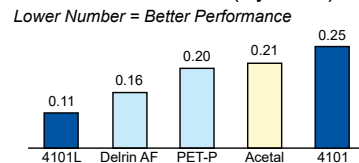
- Hydex® 4101 and 4101L have 20% greater impact strength than PET-P.
- Hydex® 4101L has about 50% better wear factor than PET-P.
- Hydex® 4101L has more than twice the LPV performance than PET-P.
- Hydex® 4101L has about 50% lower coefficient of friction than PET-P.



Chemical Resistance

HYDEX 4101 HYDEX 4101L	>	pH Range	2.0 - 9.0
PET-P	>	pH Range	2.0 - 9.0
Acetal	>	pH Range	4.0 - 9.0
Nylon 6/6	>	pH Range	2.0 - 10.0

Coefficient of Friction (Dynamic)



High
Performance

PLASTICS GUIDE

PBT - Polybutylene Terephthalate

Hydex® 4101 and Hydex® 4101L

Hydex® 4101 & 4101L Sheet

Standard Thickness (inches) :	1/2 3/4 1 1-1/2 2 2-1/2 3 3-1/2 4
Standard Sheet Size (inches) :	12 x 24 and 12 x 48 (1/2" to 4" thick) 24 x 24 and 24 x 48 (1/2" to 2" thick)
Standard Sheet Tolerances :	Thickness 1/2 to 7/8 +.025" / -0 Thickness 1 to 4 +.050" / -0 Width +.125" / -0 Length +.500" / -0
Standard Sheet Color :	Natural and Black

Sheets / Slabs can be ground down to intermediate sizes

Hydex® 4101 & 4101L Rod

Standard Diameter (inches) :	1/4 1/2 3/4 1 1-1/4 1-1/2 2 2-1/4 2-1/2 3 3-1/2 4 4-1/2 5 5-1/2 6
Standard Rod Length (feet) :	1/4 to 1 dia 5 and 10 ft +.002" / -0 1-1/8 to 2 dia 4 and 8 ft +.005" / -0 2-1/8 to 2-1/2 dia 2 and 4 ft +.025" / -0 2-5/8 to 6 dia 2 and 4 ft Oversize
Standard Rod Color :	Natural and Black

Rods can be ground down to any intermediate diameter, pricing is based on next larger diameter rod plus grinding charge.

High
Performance

PLASTICS GUIDE



PBT - Polybutylene Terephthalate

Typical Properties for Hydex® 4101 & 4101L

PROPERTY TESTED	CONDITION	UNITS	HYDEX® 4101	HYDEX® 4101L
PHYSICAL PROPERTIES				
Chemical Designation	---	---	PBT	PBT
Filler	---	---	n/a	n/a
Density	---	g/cm	1.31	1.36
MECHANICAL PROPERTIES				
Tensile Modulus	@ 73°F	psi	425,000	380,000
Tensile Strength at Yield	@ 73°F	psi	9,400	7,200
Tensile Strength at Break	@ 73°F	psi	---	---
Shear Strength	@ 73°F	psi	---	---
Elongation at Yield	@ 73°F	psi	6	---
Elongation at Break	@ 73°F	%	50	40
Flexural Modulus	@ 73°F	%	420,000	390,000
Flexural Strength	@ 73°F	psi	12,000	14,000
Compressive Modulus	@ 73°F	psi	---	---
Compressive Strength	@ 73°F, 10% strain	psi	---	---
Izod Impact, Notched	@ 73°F	ft.-lb./in.	0.7	0.7
Rockwell Hardness	@ 73°F	M (R) Scale	---	---
Coefficient of Friction	Static	---	0.19	0.08
Coefficient of Friction	Dynamic, 40 psi	---	0.25	0.11
Wear (K) Factor	---	in-min/lb-ft-hr	210 x 10 ⁻¹⁰	38 x 10 ⁻¹⁰
Limiting PV	---	psi-fpm	6,000	15,700
THERMAL PROPERTIES				
Vicat Softening Point	---	°F	---	---
Melting Temperature	---	°F	437°	---
Heat Deflection Temperature	@ 66 psi	°F	310°	---
Heat Deflection Temperature	@ 264 psi	°F	200°	195°
Service Temperature	Intermittent	°F	---	---
Service Temperature	Long Term	°F	221°	221°
Thermal Expansion (CLTE)	---	in./in./ °F	6.1 x 10 ⁻⁵	---
Thermal Conductivity	---	BTU-in./hr.-ft.-°F	---	---
MISC PROPERTIES				
Moisture Absorption	24 hrs. @ 73°F	%	0.07	0.07
Moisture Absorption	Saturation @ 73°F	%	---	---
Flammability	UL 94	---	HB	---
Food Grade	---	---	Yes	Yes

The numbers supplied for the testing of this product came directly from the manufacturer of this material. These numbers should be used as a reference only, they are not to replace the actual testing of the material in your specific application. Test results may vary from application to application.

High
Performance

PLASTICS GUIDE

PBT - Polybutylene Terephthalate

Hydex® UD Blue - Ultra Detectable grade of PBT

Hydex® 4101 UD Blue has been specifically designed for the demanding environment of the food processing industry. For several years, the industry has been moving towards materials used in equipment design that are detectable in some way; either visually, by metal or x-ray detection, in order to improve food safety, and reduce the possibility of product contamination. Hydex® 4101 UD Blue offers visibility for all three detection types with one material. The product's specially formulated fillers are detectable to both x-ray and metal detection systems, and its blue coloration is visible to optical inspection systems.

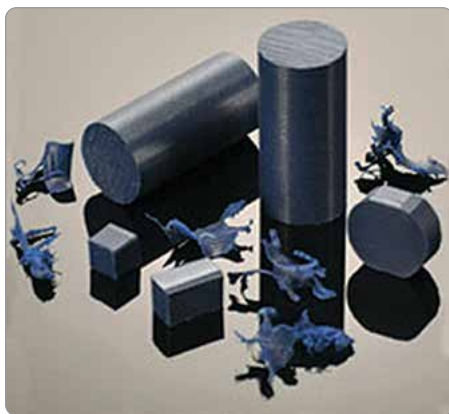
In addition, as part of the polyester family, HYDEX® 4101 UD Blue exhibits the very good physical properties typical of the family, as well as excellent resistance to chlorine and caustic cleaning solutions.

Typical Features:

- Resistant to cleaning agents
- Food grade blue color
- Good chemical resistance
- Good dimensional stability
- Good impact strength
- Metal detectable
- X-ray opaque

Product Applications:

- Food processing pump impellers
- Filler valve parts
- Food forming plates



Ensinger 

Hydex® 4101 UD Blue

Standard Thickness (inches) :	3/4" and 1" thick
Standard Sheet Size (inches) :	24" x 48"
Standard Diameter (inches) :	1", 1-1/2", 2" and 3" dia
Standard Rod Lengths (inches) :	120" long (10 feet)
Hydex 4101 UD Blue Color :	Food Grade Blue

PBT - Polybutylene Terephthalate

Typical Properties for Hydrex® UD Blue

PROPERTY TESTED	CONDITION	UNITS	HYDEX® UD BLUE
PHYSICAL PROPERTIES			
Chemical Designation	---	---	PBT
Filler	---	---	Detectable
Density	---	g/cm	1.59
MECHANICAL PROPERTIES			
Tensile Modulus	@ 73°F	psi	550,000
Tensile Strength at Yield	@ 73°F	psi	9,300
Tensile Strength at Break	@ 73°F	psi	---
Shear Strength	@ 73°F	psi	---
Elongation at Yield	@ 73°F	psi	---
Elongation at Break	@ 73°F	%	3.53
Flexural Modulus	@ 73°F	%	556,150
Flexural Strength	@ 73°F	psi	15,250
Compressive Modulus	@ 73°F	psi	346,360
Compressive Strength	@ 73°F, 10% strain	psi	13,760
Izod Impact, Notched	@ 73°F	ft.-lb./in.	0.58
Rockwell Hardness	@ 73°F	M (R) Scale	92
Coefficient of Friction	Static	---	---
Coefficient of Friction	Dynamic, 40 psi	---	---
Wear (K) Factor	---	in-min/lb-ft-hr	---
Limiting PV	---	psi-fpm	---
THERMAL PROPERTIES			
Vicat Softening Point	---	°F	---
Melting Temperature	---	°F	437°
Heat Deflection Temperature	@ 66 psi	°F	393°
Heat Deflection Temperature	@ 264 psi	°F	275°
Service Temperature	Intermittent	°F	---
Service Temperature	Long Term	°F	221°
Thermal Expansion (CLTE)	---	in./in./ °F	4.05 x 10 ⁻⁵
Thermal Conductivity	---	BTU-in./hr.-ft.°F	---
MISC PROPERTIES			
Moisture Absorption	24 hrs, @ 73°F	%	---
Moisture Absorption	Saturation @ 73°F	%	---
Flammability	UL 94	---	---
Food Grade	---	---	Yes

The numbers supplied for the testing of this product came directly from the manufacturer of this material. These numbers should be used as a reference only, they are not to replace the actual testing of the material in your specific application. Test results may vary from application to application.

High
Performance

PLASTICS GUIDE



PEEK - Polyetheretherketone

PEEK (Polyetheretherketone) is a high-performance engineering plastic known for its durability in hostile environments. PEEK offers broad chemical resistance that makes it a great alternative to fluoropolymers when higher strength is needed; maintaining dimensional stability and excellent mechanical strength. PEEK offers superior wear resistance and can be used continuously to 480°F (250°C). It can also be used with hot water or steam without permanent loss in physical properties. PEEK carries a V-0 flammability rating in thinner gauges and exhibits very low smoke and toxic gas emission when exposed to flame. PEEK is available in unfilled, bearing grade and glass and carbon filled grades.

PEEK has proven success in challenging environments in the aerospace, oil & gas, pharmaceutical/medical, food processing and semiconductor industries. Our inventory is coded for full traceability with manufacturer material certifications. It is available in sheet, rod, tube, film, machined and molded parts. PEEK shapes are made from a variety of resins including Victrex™, KetaSpire® and VESTAKEEP®.

Common Trade Names:

- Ketron® (Mitsubishi Chemical Group)
- SustaPEEK® (Rochling Sustaplast)
- GEHR PEEK™ (GEHR Plastics, Inc.)
- ZL-1500 (ZL Engineering)

Typical Features:

- Excellent chemical resistance
- Excellent wear and abrasion resistance
- Very low moisture absorption
- FDA compliant grades
- Unaffected by continuous exposure to hot water or steam - autoclavable

Product Applications:

- Valve seats
- Pump gears
- High purity seals
- Wafer carriers
- Bushings & bearings
- Electrical connectors
- Screw and impellers
- Gears and wear blades
- Medical instruments
- Lab & analytical equipment

PEEK Availability

Standard Thickness (inches) :	1/4" up to 4" thick
Standard Sheet Size (inches) :	24" x 48" 12" x 48" 48" x 96"
Standard Diameter (inches) :	1/4" up to 6" diameter
Standard Rod Length (inches) :	48" and 96" lengths
Standard Color :	Natural (Tan) and Black



PEEK - Polyetheretherketone

PEEK Grades & Descriptions

PEEK 1000

This general purpose grade is unreinforced and offers the highest elongation and toughness of all PEEK grades. The newly available black PEEK 1000 is ideal for instrument components where aesthetics are important, as well as for seal components where ductility and inertness are important.

PEEK GF30 (30% Glass Reinforced)

The addition of glass fibers significantly reduces the expansion rate and increases the flexural modulus of PEEK. This grade is ideal for structural applications that require improved strength, stiffness or stability, especially at temperatures above 300°F (150°C).

PEEK CA30 (30% Carbon Fiber Reinforced)

The addition of carbon fibers enhances the compressive strength and stiffness of PEEK, and dramatically lowers its expansion rate. It offers designers optimum wear resistance and load carrying capability in a PEEK based product. This grade provides more thermal conductivity than unreinforced PEEK - increasing heat dissipation from bearing surfaces improving bearing life and capability.

PEEK HPV (Bearing Grade)

Carbon fiber reinforced with graphite and PTFE lubricants, our newest grade of PEEK offers the lowest coefficient of friction and the best machinability for all PEEK grades. An excellent combination of low friction, low wear, high LPV, low mating part wear and easy machining, make it ideal for aggressive service bearings.

PEEK IM (Injection Molded Grade)

Injection Molded PEEK advanced polymers shapes are ideal for machined back-up rings and v-seals. PEEK offers excellent chemical and wear resistance across a broad range of operating temperatures. In addition to the widely used PEEK 1000 grade, several specific grades are available that incorporate glass or carbon fibers, or wear resistant additives that increase the wear life of machined parts.

PEEK LSG (Life Science Grade)

This series of PEEK materials were developed specifically for Life Sciences applications and are pre-qualified biocompatible materials, helping to save precious time and money. Approved for both the United States Pharmacopeias (USP) and ISO 10993-1 by successfully passing a series of biocompatibility tests these products are implantable for up to 24 hours.



High
Performance

PLASTICS GUIDE

PEEK - Polyetheretherketone

Typical Properties Comparison PEEK grades

High
Performance

PROPERTY TESTED	ASTM	UNITS
PHYSICAL PROPERTIES		
Specific Gravity	D792	g/cc
Water Absorption, Immersion, 24 hours	D570(2)	%
Water Absorption, Immersion, at Saturation	D570(2)	%
MECHANICAL PROPERTIES		
Hardness Rockwell R (Shore D)	D785 (D2240)	---
Tensile Strength	D638	psi
Tensile Strength at 65°C (150°F)	D638	psi
Elongation at Break	D638	%
Tensile Modulus	D638	psi
Flexural Strength	D790	psi
Flexural Modulus	D790	psi
Compressive Strength, 10% Deformation	D695	psi
Compressive Modulus	D695	psi
Shear Strength	D732	psi
Izod Impact (Notched)	D256 Type A	ft.-lb./in.
Coefficient of Friction, Dynamic (Dry vs. Steel)	QTM 55007	---
Wear Factor "k" x 10 ⁻¹⁰	QTM 55010	in ³ -min./ft.-lb.-hr.
Limiting PV (with 4:1 safety factor applied)	QTM 55007	psi-ft./min.
ELECTRICAL PROPERTIES		
Surface Resistivity per Square	EOS/ESD S11.11	ohm
Dielectric Strength (Short Term)	ASTM D149	kV/in.
THERMAL PROPERTIES		
Coefficient of Linear Thermal Expansion	E831	μin./in.-°F
Thermal Conductivity	F433	BTU-in./hr.-ft ² -°F
Melting Point (Crystalline, Peak)	D3418	°F
Maximum Service Temp., Air (Long Term)	---	°F
Deflection Temp at 1.8 MPa (264 psi)	D648	°F
Flammability, UL94 (1/8", est. rating)	---	---
COMPLIANCE PROPERTIES		
3A-Dairy	---	---
Canada AG	---	---
FDA	---	---
NSF	---	---
USDA	---	---
USP Class VI	---	---

Note: Values listed are typical and are meant only as a guide to aid in design only. As always we highly recommend testing any new material in the application first before converting over to new material based on guide data information alone. Applications and usage vary and Alro does not guarantee any results as this data is for information only.



PEEK - Polyetheretherketone

Typical Properties Comparison PEEK grades

KETRON® PEEK 1000	KETRON® PEEK CA30	KETRON® PEEK GF30	KETRON® PEEK HPV	KETRON® PEEK IM
1.31	1.42	1.59	1.44	1.31
0.10	0.15	0.15	0.05	0.10
0.50	0.50	0.50	0.30	0.50
126 (85)	125 (91)	124 (88)	M85	127 (88)
16,000	16,000	7,400	11,000	16,000
12,000	12,000	5,000	9,000	---
40%	3%	1%	2%	40%
630,000	140,000	850,000	850,000	600,000
25,000	23,000	12,000	27,500	23,000
600,000	1,000,000	900,000	1,100,000	600,000
20,000	28,000	19,000	20,000	20,000
500,000	580,000	500,000	500,000	425,000
8,000	11,000	---	10,000	---
0.60	1.40	1.00	0.70	0.40
0.32	0.24	---	0.21	0.32
375×10^{-10}	102×10^{-10}	---	100×10^{-10}	375×10^{-10}
8,500	17,000	---	20,000	8,500
$\geq 1.00e + 13$	$\geq 1.00e + 05$	$\geq 1.00e + 13$	$\leq 10,000$	$\geq 1.00e + 13$
480	---	550	---	480
26.0	23.0	14.0	17.0	26.0
1.75	6.37	2.98	1.70	1.75
644°	644°	654°	644°	654°
480°	480°	480°	482°	480°
320°	450°	450°	383°	320°
V-0	V-0	V-0	V-0	V-0
Yes	No	No	No	No
No	No	No	No	No
Yes	No	No	No	No
No	No	No	No	No
Yes	No	No	No	No
No	No	No	No	No

Note: Values listed are typical and are meant only as a guide to aid in design only. As always we highly recommend testing any new material in the application first before converting over to new material based on guide data information alone. Applications and usage vary and Alro does not guarantee any results as this data is for information only.

High
Performance

PLASTICS GUIDE



PEEK - Polyether Ether Ketone

SustaPEEK® XDT - X-ray Detectable PEEK

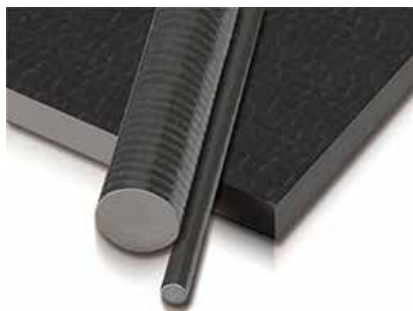
SustaPEEK® XDT offers the best balance of properties of all thermoplastic materials. In addition to outstanding mechanical properties, chemical resistance and thermal performance, SustaPEEK® XDT can withstand long term continuous temperatures of 480°F as well as exposure to hot water or steam with low moisture absorption which makes it the material of choice for high-temperature applications in the food processing industry.

Repeated handling, cleaning and normal wear and tear of plastic components parts on processing machinery increases the risk of a fragment breaking off and contaminating the product, especially with ongoing pressure to increase production line speeds. Quality checks are performed at process control points typically with either metal or x-ray detection systems. In many cases, x-ray systems are required or preferred due to the food (such as meat products) and the fact that the system can effectively detect contamination post-packaging.

SustaPEEK® XDT has been proven to be detected in a particle as small as a 3mm cube on production lines running as fast as 250 feet-per-minute. Together with the recently developed Polystone® M XDT (UHMW-PE) and Sustarin® C XDT (Acetal), Rochling now provides three of the most commonly used engineering plastics in the food processing industry in these special x-ray detectable grades.

Typical Features:

- Excellent chemical resistance
- Very low moisture absorption
- Outstanding rigidity at high temperatures
- Inherently good wear and abrasion resistance
- Unaffected by continuous exposure to hot water or steam
- X-ray detectable as small as 3mm cube



SustaPEEK® XDT

Standard Thickness (inches) :	3/8" up to 4" thick
Standard Sheet Size (inches) :	Please inquire for sizes
Standard Diameter (inches) :	1/2" up to 6" diameter
Standard Rod Length (inches) :	Please inquire for lengths
Standard Color :	Dark Gray

PEEK - Polyether Ether Ketone

Typical Properties for SustaPEEK® XDT

PROPERTY TESTED	ASTM	UNITS	SUSTAPEEK XDT
MECHANICAL PROPERTIES			
Specific Gravity	D792	---	1.32
Water Absorption (24 hrs)	D570	%	0.10
Water Absorption at Saturation	D570	%	0.50
Flammability	UL94	---	V-0
Tensile Strength	D638	psi	16,000
Elongation	D638	%	20
Modulus	D638	psi	500,000
Flexural Strength	D790	psi	25,000
Flexural Modulus	D790	psi	600,000
Izod Impact, Notched	D256	ft.-lb./in.	1.20
Rockwell Hardness	D785	M scale	M105
Heat Deflection Temp @ 264 psi	D648	°F	320°
Coefficient of Linear Thermal Expansion	D696	in./in./°F	2.6 x 10 ⁻⁵
Dielectric Strength	D149	V/mil	480
Volume Resistivity	D257	ohm-cm	10 ¹⁵
Dielectric Constant	D150	---	3.30

High
Performance



PLASTICS GUIDE



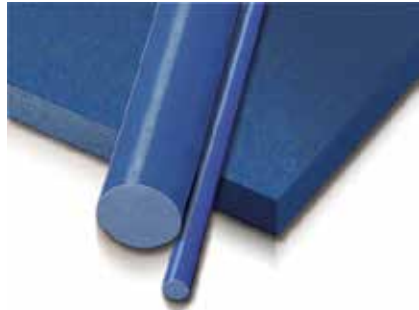
PEEK - Polyether Ether Ketone

TecaPEEK® UD Blue - Ultra Detectable PEEK

TecaPEEK® UD Blue is an "Ultra Detectable" PEEK designed specifically for high temperature applications in the food industry. It has the advantage of detect-ability by all 3 of the food product inspection technologies used in the food industry – optical, metal and x-ray detect-ability. Detection of particulate matter in food products is very important in food safety. It also offers the typical high performance advantages of excellent temperature, chemical, and wear resistance. All the components of TecaPEEK® UD Blue are FDA compliant.

Typical Features:

- Optical, Metal and X-ray detectable
- Excellent chemical resistance
- Very low moisture absorption
- Inherently good wear and abrasion resistance
- Unaffected by continuous exposure to hot water or steam
- FDA compliant



Product Applications:

- Valve seats
- Pump parts
- Filler valves
- Bushings & bearings
- Scraper blades
- Filler nozzles

TecaPEEK® UD Blue

Standard Thickness (inches) :	1/4" up to 2" thick
Standard Sheet Size (inches) :	24" x 48"
Standard Diameter (inches) :	1/2" up to 4" diameter
Standard Rod Length (inches) :	120" (10 foot)
Standard Color :	Blue

PEEK - Polyether Ether Ketone

Typical Properties for TecaPEEK® UD Blue

PROPERTY TESTED	ASTM	UNITS	TECAPEEK UD BLUE
MECHANICAL PROPERTIES			
Modulus of Elasticity (tensile test), 73°F	D638	psi	772,200
Tensile Strength, 73°F	D638	psi	12,750
Elongation at Yield, 73°F	D638	%	3.43%
Elongation at Break, 73°F	D638	%	4.13%
Flexural Strength, 73°F	D790	psi	21,230
Modulus of Elasticity (flexural test), 73°F	D790	psi	728,400
Compression Strength at 10% strain, 73°F	D695	psi	21,235
Compression Modulus, 73°F	D695	psi	536,730
Impact Strength (Izod), 73°F	D256	ft.-lb./in.	0.79
Rockwell Hardness, M Scale, 73°F	D785	M scale	M 101
THERMAL PROPERTIES			
Melting Temperature	---	°F	644°
Service Temperature, Long Term	---	°F	500°
Service Temperature, Short Term	---	°F	572°

This information reflects the current state of our knowledge and is intended only to assist and advise. It is given without obligation or liability. It does not assure or guarantee chemical resistance, quality of products or their suitability in any legally binding way. Values are not minimum or maximum values, but guidelines that can be used for comparative purposes in material selection. They are within the normal range of product properties and do not represent guaranteed property values. Testing under individual application circumstances is always recommended. Data is obtained from extruded shapes materials unless otherwise noted. References to FDA compliance refer to the resins from which the products were made unless otherwise noted. All trade and patent rights should be observed. All rights reserved. Data sheet values are subject to periodic review, the most recent update can be found at www.ensinger-inc.com.



High
Performance

PLASTICS GUIDE



PEEK - Polyether Ether Ketone

SustaPEEK MG - Medical Grade PEEK

SustaPEEK MG (polyetheretherketone) offers the best balance of properties of all thermoplastic materials. In addition to outstanding mechanical properties, chemical resistance and thermal performance, SustaPEEK can withstand long term continuous temperatures of 480°F as well as exposure to hot water or steam with low moisture absorption.

SustaPEEK MG comes in 6 different colors, Natural, Black, Green, Red, Blue and Yellow.

Typical Features:

- Intrinsic flame retardancy
- Outstanding rigidity at high temperatures
- Continuous use temperature of 480°F
- Excellent hydrolysis resistance
- Excellent chemical resistance
- Good dimensional stability
- FDA compliant

Product Applications:

- Semiconductor applications
- Medical devices and instruments
- Surgical instruments
- Analytical instruments
- Pump rotors and housings
- Automotive thrust washers

Material Certifications:

- ASTM D6262
- FDA compliant
- USP Class VI & ISO 10993-5 compliant



SustaPEEK MG

Standard Thickness (inches) : 1/4" up to 2" thick (standard increments)

Standard Sheet Size (inches) : 24 x 48

Standard Diameter (inches) : 1/4" up to 6" diameter

Standard Rod Length : Varies by diameter, please inquire

Standard Colors : Natural, Black, Green, Red, Blue & Yellow



PEEK - Polyether Ether Ketone

Ketron® PEEK LSG - Life Science Grade

Ketron® PEEK LSG natural / black stock shapes are produced from batches of Victrex PEEK. The composition of the resin used for the production of the Ketron® PEEK LSG stock shapes complies with the regulations that apply in the Member States of the European Union (Directive 2002/72/EC, as amended) and in the United States of America (FDA) for plastic materials and articles intended to come into contact with foodstuffs.

Ketron® PEEK LSG stock shapes have also been successfully type tested for their compliance with both United States Pharmacopeia (USP) and ISO 10993-1 guideline requirements for Biocompatibility Testing of Materials, and they come with full traceability from resin to stock shape.

These features, added to an excellent sterilizability by means of steam, dry heat, ethylene oxide, plasma and gamma irradiation, make Ketron® PEEK LSG stock shapes very suitable for applications in the medical, pharmaceutical and biotechnology markets.

Typical Features:

- Intrinsic flame retardancy
- Outstanding rigidity at high temperatures
- Excellent hydrolysis resistance
- Continuous use temperature of 480°F
- Excellent chemical resistance
- Good dimensional stability
- FDA compliant



Product Applications:

- Medical devices and instruments
- Surgical instruments
- Analytical instruments
- Pump rotors and housings
- Aircraft interior components
- Automotive thrust washers
- Semiconductor applications

Ketron® PEEK LSG

Standard Thickness (inches) : 1/4" up to 2" thick (standard increments)

Standard Sheet Size (inches) : 24 x 48

Standard Diameter (inches) : 1/4" up to 6" diameter

Standard Rod Length : 4 ft or 8 ft, varies by diameter

PEI - Polyetherimide

Ultem™ PEI

Ultem™ PEI is an amorphous, high performance polymer known for its high strength and long term heat resistance. Its continuous use temperature of 340° F (170° C) is higher than that of general use plastics such as Nylon and Acetal. Ultem™ is inherently flame retardant, UL 94-V-0 rated, with low smoke output and is also RoHS compliant. PEI has excellent dimensional stability and is chemical resistant.

Ultem™ is commonly used in the electronics' market because of its good arc resistance and one of the highest dielectric strengths of any thermoplastic material. It is also a prime material for medical applications because of its ability to withstand multiple autoclave steam sterilization cycles. Ultem™ has exceptional mechanical, thermal, and electrical properties. Natural Ultem™ 1000 (unreinforced) is a translucent amber material. The addition of glass fiber reinforcement to PEI elevates the performance with the addition of higher tensile properties and higher thermal properties.

Common Trade Names:

- Duratron® U (Mitsubishi Chemical Group)
- SustaPEI® (Rochling)
- TecaPEI™ (Ensinger)
- Semitron® ESd PEI (Mitsubishi Chemical Group)
- ZL® 1000 PEI (ZL Plastics)



Typical Features:

- Extremely strong and stiff
- High dielectric strength
- Outstanding heat resistance
- Resistant to hydrolysis when exposed to hot water or steam
- Can tolerate repeated sterilization cycles in an autoclave
- UV resistant
- Easy to machine and finish
- Inherent flame resistance with low smoke evolution
- FDA & USDA Class VI compliant grades

Products Applications:

- Medical instruments and devices
- Semiconductor process equipment
- Analytical instruments
- Aerospace components
- Burn-in test sockets
- Electrical connectors
- Automotive components
- Insulators
- Electrical fittings & housings
- Structural probes
- Manifolds
- Valves & Clamps

PEI - Polyetherimide

Typical Properties for Ultem™ PEI grades

PROPERTY TESTED	ASTM	UNITS	ULTEM PEI 1000	ULTEM PEI 2300
MECHANICAL PROPERTIES				
Specific Gravity	D792	---	1.28	1.51
Tensile Strength	D638	psi	17,000	17,000
Tensile Modulus	D638	psi	500,000	800,000
Elongation (at break)	D638	%	60	3
Flexural Strength	D790	psi	20,000	27,000
Flexural Modulus	D790	psi	500,000	850,000
Compressive Strength	D695	psi	22,000	32,000
Compressive Modulus	D695	psi	480,000	---
Hardness, Rockwell	D785	M (R)	112 (125)	114 (127)
Hardness, Durometer, Shore "D"	D2240	D	86	---
Izod Impact (Notched)	D256A	ft-lb/in	0.500	1.00
Coefficient of Friction (Dry vs. Steel)	QTM 55007	Dynamic	0.42	---
Limiting PV (4:1 safety factor)	QTM 55007	psi-ft/min.	1,875	---
Wear Factor "k" x 10 ⁻¹⁰	QTM 55010	in ³ -min/lb-ft-hr	2,900 x 10 ⁻¹⁰	---
THERMAL PROPERTIES				
Coefficient of Linear Thermal Expansion	E831	µin/in-°F	31.0	11.0
Deflection Temp. 264 psi	D648	°F	400	410
Cont. Service in Air (Max)	Long Term	°F	---	340
Thermal Conductivity	F433	BTU-in/hr-ft ² -°F	1.23	1.56
ELECTRICAL PROPERTIES				
Dielectric Strength, Short Term	D149	kV/in.	830	770
Surface Resistance (EOS/ESD S11.11)	EOS/ESD	Ohm	>=1.00e +13	>=10.0e +12
Dielectric Constant, 10 ⁶ Hz	D150	1 MHz	3.15	3.70
Dissipation Factor, 10 ⁶ Hz	D150	1MHz	.0013	.002
CHEMICAL PROPERTIES				
Water Absorp Immersion, 24 hrs	D570(2)	%	0.25	0.18
Water Absorp Immersion, Satur.	D570(2)	%	1.25	0.90

The numbers supplied for the testing of this product came directly from the manufacturer of this material. These numbers should be used as a reference only, they are not to replace the actual testing of the material in your specific application. Test results may vary from application to application.

High
Performance

PLASTICS GUIDE



PEI - Polyetherimide

Ultem™ PEI

Ultem™ PEI is available in a variety of grades to best suit the application at hand. The following list of grades is a quick overview, please inquire with your Alro representative on availability and any minimums that may apply.

- Ultem™ 1000 - Natural unfilled or black
- Ultem™ 2300 - 30% glass filled with improved strength and rigidity; exceptional strength -to- weight ratio. This is the most common grade of filled Ultem but custom runs of 10% and 20% are available with a minimum order requirement.
- Static Dissipative
- Conductive
- Medical
- FDA compliant colors available on a custom basis.

Chemical Resistance:

Complete specific information about the chemical resistance of thermoplastic polymers is impossible to present because of the great number of chemical media and the wide range of exposure combinations and conditions. In general Ultem™ displays excellent property retention and resistance to environmental stress cracking when exposed to most commercial automotive and aircraft fluids, fully halogenated hydrocarbons, alcohols and weak aqueous solutions. Exposure to partially halogenated hydrocarbons and strong alkaline environments should be avoided.

CHEMICAL RESISTANCE	
CHEMICAL	RESULT
Inorganic Acids	no effect
Alkalines	no effect
Alcohols	no effect
Ester	partly soluble, swells
Ketones	partly soluble, swells
Aliphatic Hydrocarbons	no effect
Aromatic Hydrocarbons	partly soluble, swells
Chlorinated Hydrocarbons	dissolves

Machining Recommendations:

Because of its exceptional combination of physical properties, Ultem™ can be readily machined with conventional metalworking tools. The resin permits high cutting speeds and feed rates for the production of precision parts with virtually no tool wear. Carbide tipped tools should be used when machining Ultem™ 2000 Series resins. The following guidelines are recommended for best results.



PEI - Polyetherimide


Ultem™ PEI

Ultem™ PEI Sheet

Standard Thickness (inches) :	1/32	1/16	3/32	1/8		
	3/16	1/4	3/8	1/2		3/4
	1	1-1/2	2	3		4
Standard Sheet Size (inches) :	1/32 to 3/16 24 x 48					
	1/4 to 4 12 x 24 and 24 x 24					
	1/4 to 2 24 x 24 and 24 x 48					
Standard Color(s) :	Natural (Amber)					

Material over 1/8" thick supplied as extruded - not finished

Ultem™ PEI Rod

Standard Diameter (inches) :	3/16	1/4	5/16	3/8	7/16	1/2	
	9/16	5/8	3/4	7/8	1	1-1/8	
	1-1/4	1-3/8	1-1/2	1-5/8	1-3/4		
	2	2-1/4	2-1/2	3	3-1/2	4	
	4-1/2	5	5-1/2	6			
Standard Rod Length (feet) :	1/4 to 1 5 ft and 10 ft						
	1-1/8 to 2 4 ft and 8 ft						
	2-1/8 to 6 2 ft and 4 ft						
Standard Color(s) :	Natural (Amber)						

Rods can be ground to any intermediate diameter, price is based on next larger diameter size plus grinding charge.

High
Performance

PLASTICS GUIDE

PEI - Polyetherimide

SustaPEI MG (Ultem™) - Medical Grade

SustaPEI (Ultem™ 1000) is an amorphous polyetherimide and is one of the most commonly used high performance materials. It offers excellent thermal performance and high mechanical strength and stiffness. It is inherently flame retardant, possesses good resistance to acids and is capable of operating continuously in steam and hot water.

SustaPEI MG comes in 5 different colors, Natural (Amber), Gray, Black, Blue & Green.

Typical Features:

- Capable of withstanding multiple autoclave cycles
- High strength & rigidity at elevated temperatures
- Continuous use temperature of 340°F
- Low thermal expansion
- High dielectric strength
- Inherently flame retardant
- Hydrolysis resistant
- Highly resistant to acid solutions



Product Applications:

- Fluid handling manifolds & connectors
- Electrical / electric components
- Semiconductor components
- Analytical instrumentation
- Medical devices

Material Certifications:

- ASTM D5205
- Meets FDA 210 CFR 177.1595
- USP Class VI & ISO 10993 compliant

SustaPEI MG

Standard Thickness (inches) :	1/4" up to 4" thick (standard increments)
Standard Sheet Size (inches) :	24 x 48
Standard Diameter (inches) :	3/8" up to 6" diameter
Standard Rod Length :	Varies by diameter, please inquire
Standard Colors :	Natural (Amber), Gray, Black, Blue & Green

PET - Polyethylene Terephthalate

PET is a strong, stiff, semicrystalline performance plastic with excellent machining characteristics, chemical resistance, and bearing and wear properties. PET is often used for food processing machinery applications where low moisture absorption, low thermal expansion, resistance to staining, or resistance to cleaning chemicals is required. It is suitable for making precision mechanical part which are capable of sustaining high loads and enduring wear conditions. PET's continuous service temperature is 210 F (100 C) and its melting point is almost 150 F higher than acetal.

PET is FDA compliant in natural and black. Natural PET is also USDA, 3A-Dairy and Canada AG compliant.

High
Performance

Common Trade Names:

- Ertalyte® (Mitsubishi Chemical Group)
- Ertalyte® TX (Mitsubishi Chemical Group)
- Sustadur® (Rochling Plastics)
- TecaPET (Ensinger Plastics)
- ZL® 1400 (ZL Plastics)
- ZL® 1400T (ZL Plastics)



Typical Features:

- Good for both wet and dry environments
- High strength and rigidity - ideal for close tolerance parts
- Good wear resistance and excellent dimensional stability
- Excellent stain resistance
- Better resistance to acids than Nylon or Acetal

Product Applications:

- Cutting manifolds
- Food equipment components
- Carousel
- Resistant to many CIP (Clean in Place) wash down chemicals
- Filter track
- Locating disk and ring
- Distribution valves

PLASTICS GUIDE

PET - Polyethylene Terephthalate

Available Grades

Enhanced internally lubricated grades are available for improved wear. They are also FDA compliant and exhibit a lower wear rate and coefficient of friction than unmodified polyesters. Internally lubricated PET excels under high pressure and velocity conditions. It is also suited for applications involving soft metal and plastic mating surfaces. For instance, Ertalyte® TX reduces MRO costs, eliminates the need for lubrication, and is commonly used for applications where food compliancy, chemical resistance, and low wear are critical. Applications include rollers and wheels without bearings, liner bearings, wear and slide pads, dynamic seals, scraper blades, thrust washers, valve seats, journal bearings, and dosing piston and valve.

Ertalyte® and Ertalyte® TX

Ertalyte® PET-P Sheet :	1/4" to 4" thick, 24" x 48" or 24" x 39" sheets
Ertalyte® TX Sheet :	.315" to 3.94" thick, 24" x 39" sheets
Ertalyte® PET-P Rod :	.375" to 8.27" Diameter, various lengths
Ertalyte® TX Rod :	10 mm to 160 mm Diameter, various lengths
Ertalyte® PET-P Tube :	.787" to 7.87" OD, .472" to 6.30" ID
Ertalyte® TX Tube :	.787" to 7.87" OD, .472" to 6.30" ID



PET - Polyethylene Terephthalate

Typical Properties for Ertalyte® PET-P & TX

PROPERTY TESTED	ASTM	UNITS	ERTALYTE® PET-P	ERTALYTE® TX
MECHANICAL PROPERTIES				
Specific Gravity, 73°F	D792	---	1.41	1.44
Tensile Strength, 73°F	D638	psi	12,400	10,500
Tensile Modulus, 73°F	D638	psi	460,000	500,000
Elongation (at break), 73°F	D638	%	20	5
Flexural Strength, 73°F	D790	psi	18,000	14,000
Flexural Modulus, 73°F	D790	psi	490,000	360,000
Shear Strength, 73°F	D732	psi	8,000	8,500
Compressive Strength	D695	psi	15,000	15,250
Compressive Modulus	D695	psi	420,000	400,000
Hardness, Rockwell M	D785	M	M93	M94
Hardness, Rockwell R	D785	R	R125	---
Hardness, Durometer	D2240	D	D87	---
Izod Impact (Notched)	D256A	ft-lb/in	0.5	0.4
Coefficient of Friction (Dry vs. Steel)	QTM 55007	Dynamic	.20	.19
Limiting PV (4:1 safety factor)	QTM 55007	psi-fpm	2,800	6,000
Wear Factor "k" x 10 ⁻¹⁰	QTM 55010	in ³ -min/lb-ft-hr	60	35
Relative Machinability	---	1 = easy	2	2
THERMAL PROPERTIES				
Coefficient of Linear Thermal Expansion	E831	in/in/°F	3.3 x 10 ⁻⁵	4.5 x 10 ⁻⁵
Deflection Temp. 264 psi	D648	°F	240°	180°
Melting Point (Crystalline) Peak	D3418	°F	491°	491°
Cont. Service in Air (Max)	long term	°F	210°	210°
Thermal Conductivity	F433	BTU-in/hr-ft ² -°F	2.0	1.9
ELECTRICAL PROPERTIES				
Dielectric Strength, Short Term	D149	volts/mil	385	385
Surface Resistance (EOS/ESD S11.11)	EOS/ESD	Ohm/Sq	> 10 ¹³	> 10 ¹³
Dielectric Constant, 10 ⁶ Hz	D150	---	---	3.60
Dissipation Factor, 10 ⁶ Hz	D150	---	---	0.02
Flammability @ 3.1mm (1/8")	UL 94	---	HB	HB

The numbers supplied for the testing of this product came directly from the manufacturer of this material. These numbers should be used as a reference only, they are not to replace the actual testing of the material in your specific application. Test results may vary from application to application.

High
Performance

PLASTICS GUIDE



PI - Polyimide

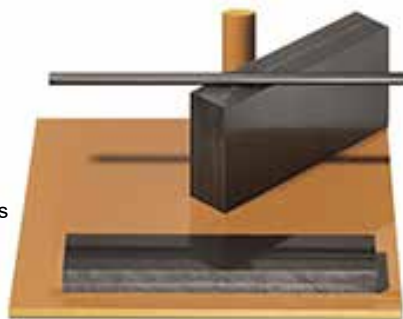
Tecasint™ - High Temperature Polyimides

The trend towards space and weight saving in modern mechanical and plant engineering applications results in higher density performance and consequently in increased thermal and wear resistance expectations in the material used. The characteristic profile of polyimides addresses these stringent demands with outstanding success.

Tecasint™ from Ensinger is a range of non-melting high-temperature polyimides which are characterized by the following properties:

Typical Features:

- High strength over a wide temperature range from -454° F to +572° F
- Glass transition temperature, depending on type, between +260° F to +400° F
- Extremely good long-term thermal stability
- Excellent resistance to wear under high surface area pressure, high sliding speeds
- Good cryogenic properties
- Inherently flame retardant (UL 94 VO)
- Minimal thermal expansion
- Outstanding durability
- High pressure and creep strength
- High purity, low outgassing in vacuum
- Good chemical resistance to acids, fats and solvents
- Excellent electrical insulation properties
- Good thermal insulation
- High radiation resistance



The fields of application are many and varied: the mechanical engineering, automotive and gear manufacturing industries appreciate the outstanding sliding properties of the graphite/PTFE-modified Tecasint™ product types. In vacuum technology, or for use in dry gas atmospheres, the unreinforced or MoS2-modified product types (for sliding applications) are used. Its electrical insulating effect at high temperatures makes Tecasint™ also ideally suited for applications in the electrical and electronics industry. Tecasint™ has a very low ion content and is used in particular for applications in the field of ultra-clean-room technology, for example in the production of wafers.

PI - Polyimide

Tecasint™ - High Temperature Polyimides

Tecasint™ 1000

Extremely good dimensional stability. Good sliding properties and wear resistance as well as excellent radiation resistance.

Tecasint™ 2000

Enhanced thermal resistance. Lower moisture absorption. Enhanced sliding friction behaviour. High creep strength. Very good machining properties. Higher degree of toughness. Ideally suited for the direct forming method.

Tecasint™ 3000

Extreme thermostability. High degree of toughness. Easy to machine. Low water absorption. Currently only using the direct forming method. Semi-finished products in the development stage.

Tecasint™ 4000

Extreme toughness, minimal water absorption. Good tribological properties. Maximum stability against oxidation through air exposure. Improved chemical resistance.

Tecasint™ 5000

Non-melting high temperature polyamidiimide (PAI). Extremely good dimensional stability and load capacity up to +300°C.

Tecasint™ 8000

PTFE material reinforced with organic HT plastics (PI powder). Reduced creep under load. Excellent sliding and friction properties. High chemical resistance and very good machining properties. Suitable for mating partners in soft materials (stainless steel, brass, aluminium, bronze).

Tecasint™ PI

Standard Thickness (mm) :	5 mm up to 100 mm thick
Standard Sheet Size (mm) :	5 mm to 55 mm 300 mm x 1,000 mm 5 mm to 55 mm 395 mm x 795 mm 60 mm and up 300 mm x 1,000 mm
Standard Diameter (mm) :	6 mm up to 100 mm diameter
Standard Rod Length (mm) :	6 mm to 12 mm 395 mm long 12.7 to 15 mm 395 & 795 mm long 16 mm and up 395, 795 and 1,000 mm long
Standard Color :	Varies by grade, please inquire

PI - Polyimide

Duratron® D7000 PI

Duratron® D7000 PI is an exceptional value for applications where thermal requirements exclude Duratron® PAI and do not require the extraordinary thermal resistance of Duratron® PBI. Duratron® PI is available in several grades for structural and wear applications and in the broadest range of shapes - particularly thick sheets, larger sheets geometries and heavy-wall tubes. It offers good mechanical performance for applications that demand higher temperature resistance.

Duratron® D7000 PI machinable shapes are ideal starting points for designs that reduce weight, extend length of service before maintenance or replacement and reduce overall cost by increasing process uptime. Duratron® PI materials are just one of the solutions in the machinable plastics industry's broadest product line.

Typical Features:

- Good performance at elevated temperature (>600°F)
- Good chemical resistance
- Easily machined from a broad range of shapes - rod, sheet, tubular forms
- High strength, tough and dimensionally stable



Product Applications:

- Valve and pump seats, seals, and wear surfaces
- Structural and wear parts for semiconductor and electronics manufacturing
- Fixtures and handling parts for glass and plastics manufacturing
- Metal replacement for aerospace components, lightweight, lubrication-free

Duratron® D7000 PI

Standard Thickness (inches) :	1/4" to 1" (1/8" increments) 1-1/4" to 3" (in 1/4" increments)
Standard Sheet Size (inches) :	24 x 48, 28 x 57, 36 x 48, 48 x 120
Standard Diameter (inches) :	1" up to 13" diameter
Standard Lengths (inches) :	24" or 48", depending on diameter



PI - Polyimide

Typical Properties for Duratron® D7000 PI

PROPERTY TESTED	ASTM	UNITS	DURATRON® D7000 PI
MECHANICAL PROPERTIES			
Specific Gravity	D792	---	1.37
Tensile Strength	D638	psi	17,500
Tensile Strength at 300°F	D638	psi	12,000
Tensile Strength at 150°F	D638	psi	16,000
Tensile Modulus	D638	psi	540,000
Elongation (at break)	D638	%	6%
Flexural Strength	D790	psi	25,000
Flexural Modulus	D790	psi	550,000
Compressive Strength	D695	psi	27,000
Compressive Modulus	D695	psi	380,000
Hardness, Rockwell	D785	R	128
Hardness, Durometer, Shore "D"	D2240	D	90
Izod Impact (Notched)	D256A	ft-lb./in.	1.00
Coefficient of Friction (Dry vs. Steel)	QTM 55007	Dynamic	0.29
Limiting PV (4:1 safety factor)	QTM 55007	psi-ft./min.	15,000
Wear Factor "k" x 10 ⁻¹⁰	QTM 55010	in ³ -min/lb-ft-hr	150 x 10 ⁻¹⁰
THERMAL PROPERTIES			
Coefficient of Linear Thermal Expansion	E831	µin/in-°F	22.50
Deflection Temp. 264 psi	D648	°F (°C)	670° (354°)
Maximum Service Temp, Air	Long Term	°F (°C)	500° (260°)
Thermal Conductivity	F433	BTU-in/hr-ft ² -°F	1.50
ELECTRICAL PROPERTIES			
Dielectric Strength, Short Term	D149	kV/inch	395
Surface Resistance (EOS/ESD S11.11)	EOS/ESD	ohm	>=1.00e + 13
Dielectric Constant, 10 ⁶ Hz	D150	1 MHz	3.20
Dissipation Factor, 10 ⁶ Hz	D150	1MHz	<= 0.0050
CHEMICAL PROPERTIES			
Water Absorp Immersion, 24 hrs	D570(2)	%	0.70
Water Absorp Immersion, Satur.	D570(2)	%	3.80

The numbers supplied for the testing of this product came directly from the manufacturer of this material. These numbers should be used as a reference only, they are not to replace the actual testing of the material in your specific application. Test results may vary from application to application.

High
Performance

PLASTICS GUIDE

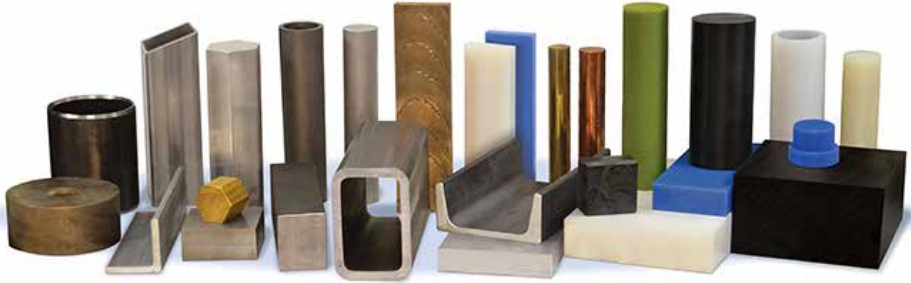




Alro Online Store

MyAlro.com

Aluminum • Alloys • Carbon Steel • Stainless Steel • Red Metals • Plastics



Did you know Alro also offers online shopping and e-business solutions for all of our customers? Visit the Alro Online Store from your computer or mobile device 24 hours a day. Set up your company account and purchase metals and plastics from our vast inventory.

Alro utilizes systems technology to achieve the benefits of e-Business in raw material procurement processes.

- **Business to Business (B2B)** – Helps reduce purchasing transaction costs.
- **Web Ordering (MyAlro.com)** – Helps with material selection, quoting and estimating.
- **Automated Inventory Replenishment (APOS)** – helps reduce Kan Ban replenishment costs
- **Summary Billing** – helps reduce admin costs of processing raw material payables
- **Advance Shipping Notices** – helps reduce receiving time

Alro computers retrieve business information from customers/vendors computers via the internet. During the process we pickup and deliver electronic business documents. This process typically does not require any programming on the part of our customers, as Alro systems are designed to accept virtually any customer document format. Some examples of these documents are as follows:

- | | | |
|-------------------|--------------------------------------|---------------------|
| • Purchase orders | • POD - Electronic Proof of Delivery | • CAD drawings |
| • Invoices | • ACH Payment notifications | • Burn prints |
| • Quotes | • Mill Certifications | • Material releases |



PPO - Polyphenylene Oxide

NORYL® PPO

NORYL® modified PPO is a strong, tough engineering plastic with outstanding mechanical, thermal, and electrical properties. Low moisture absorption and low thermal expansion make NORYL® one of the most dimensionally stable thermoplastics available.

NORYL® is widely used for electrical housings and structural components since it has excellent insulating properties, flame resistance, and dimensional stability over a wide range of service temperatures. NORYL® is often selected for fluid handling applications since it has low moisture absorption and excellent strength and stiffness. NORYL® is easy to fabricate, paint, and glue.

High
Performance

Typical Features:

- Excellent dimensional stability
- Low moisture absorption
- High dielectric strength
- Good impact resistance
- Excellent flammability rating
- Easy to fabricate, paint & glue
- Good strength and stiffness over a wide service range temperature

Product Applications:

- Manifolds
- Pump, valve & fittings
- Housings and covers
- Electrical components

Specific Applications:

- **NORYL® EN185** resin combines a heat deflection temperature of 180°F at 264 psi with excellent impact resistance even in thin walls. NORYL® EN185 resin is typically used in electronics housings, beverage cases, and for transportation component applications.
- **NORYL® EN212** resin extends the range of extruded thermoplastic applications to high-temperature environments that require both toughness and UL approval for use in communications and electronics housings.
- **NORYL® EN265** resin is ideal for higher temperature electrical housing applications where flame retardance is needed. Listed UL 94V-1 with a thermal index (continuous use) temperature of 105°C, the material provides high mechanical strength, toughness and low water absorption.
- **NORYL® ENG265** resin is suitable for higher temperature applications where UL 94V-1 flame retardance is not required.



PLASTICS GUIDE

PPO - Polyphenylene Oxide

Typical Properties Comparison for NORYL® Grades

High
Performance

PROPERTY TESTED	ASTM	UNITS
PHYSICAL PROPERTIES		
Tensile Strength at Yield, Type I, .125"	D638	psi
Tensile Elongation at Break, Type 1, .125"	D638	%
Flexural Strength at Break, .125"	D790	psi
Flexural Modulus, .125"	D790	psi
Izod Impact, Notched, at 73°F	D256	ft.•lbs./in.
Izod Impact, Notched, at -40°F	D256	ft.•lbs./in.
Gardner Impact at 73oF	D3029	ft.•lbs.
Gardner Impact at -40oF	D3029	ft.•lbs
Hardness, Rockwell	D785	R
Specific Gravity, solid	D792	1 = Water
Water Absorption, 24 hours, 73oF	D570	%
Mold Shrinkage, flow, .125"	D955	in./in. E-3
THERMAL PROPERTIES		
Heat Deflection Temp. @ 66 psi, .250"	D648	°F
Heat Deflection Temp. @ 264 psi, .250"	D648	°F
Coefficient of Thermal Expansion, flow x E-5 -40°F to 200°F	E831	in./in.-°F
Thermal Index, Electrical Properties	UL 746B	°C
Thermal Index, Mech. Prop. w/Impact	UL 746B	°C
Thermal Index, Mech. Prop. w/o Impact	UL 746B	°C
ELECTRICAL PROPERTIES		
Dielectric Strength, in Oil	D149	V/mil
Dielectric Constant, 60 Hz	D150	---
Dissipation Factor, 60 Hz	D150	---
FLAME CLASS RATING*		
UL 94 HB Flame Class Rating	UL 94	in
UL 94 V-1 Flame Class Rating	UL 94	in
UL 94 V-0 Flame Class Rating	UL 94	in

* This rating is not intended to reflect hazards presented by this or any other material under actual fire conditions.

Note: Values listed are typical and are meant only as a guide to aid in design only. As always we highly recommend testing any new material in the application first before converting over to new material based on guide data information alone. Applications and usage vary and Alro does not guarantee any results as this data is for information only.

Two page chart, continued on the next page



PPO - Polyphenylene Oxide

Typical Properties Comparison for NORYL® Grades

NORYL® EN185	NORYL® EN212	NORYL® EN265	NORYL® ENG265
6,200	6,900	9,200	7,500
50.0	45.0	25.0	30.0
9,500	11,000	15,000	12,000
315,000	345,000	380,000	320,000
8.0	5.5	3.5	3.5
3.0	2.5	2.5	2.5
18	19	11	19
10	5	3	4
113	115	119	119
1.08	1.08	1.08	1.06
0.07	0.07	0.07	0.06
---	5 - 7	5 - 7	5 - 7
200°	230°	---	279°
180°	210°	254°	260°
4.10	3.80	3.30	3.30
50	95	110	105
50	80	105	90
50	95	110	105
630	400	500	500
2.80	2.65	2.69	2.65
0.0004	0.0007	0.0007	0.0004
---	---	---	0.058
0.058	0.060	0.058	---
---	0.240	0.240	---

* This rating is not intended to reflect hazards presented by this or any other material under actual fire conditions.

Note: Values listed are typical and are meant only as a guide to aid in design only. As always we highly recommend testing any new material in the application first before converting over to new material based on guide data information alone. Applications and usage vary and Alro does not guarantee any results as this data is for information only.

Two page chart, continued on from previous page

High
Performance

PLASTICS GUIDE

PPO - Polyphenylene Oxide

NORYL® PPO

NORYL® Sheet / Plate

Standard Thickness (inches) :	1/8	1/4	3/8	1/2	5/8
	3/4	1	1-1/4	1-1/2	
	1-3/4	2	2-1/2	3	
Standard Sheet Size (inches) :	12 x 48	24 x 48			
	48 x 48	48 x 96			
Standard Sheet Tolerances :	Thickness +/- 10%				
Standard Sheet Color :	Black				



NORYL® Rod

Standard Diameter (inches) :	1/8	3/16	3/8	1/4	1/2	5/8	3/4
	7/8	1	1-1/4	1-3/8	1-1/2	1-3/4	
	2	2-1/2	3	3-1/2	4	5	6
Standard Rod Length (feet) :	1/16 to 1 dia +.005" / -0						
	1-1/4 to 2 dia +.010" / -0						
	2-1/4 to 3 dia +.030" / -0						
	3 dia and Up Oversized, as extruded						
Standard Rod Color :	Black						



High
Performance

PLASTICS GUIDE



PPO - Polyphenylene Oxide

SustaPPO MG (Noryl®) - Medical Grade

SustaPPO (modified polyphenylene oxide) is manufactured from Noryl® resin. This material has very low moisture absorption and exceptional dimensional stability making it suitable for electrical insulating applications. SustaPPO is a lightweight engineering plastic that withstands most acids bases and has excellent flame resistance.

SustaPPO MG comes in 5 different colors, Gray, Brown, Blue, Yellow and Green.

Typical Features:

- Continuous use temperature of 220°F
- Long term dimensional stability
- Excellent impact strength
- Resistance to acids and bases
- Low moisture absorption
- High dielectric strength
- Excellent hydrolytic stability

Product Applications:

- Electrical / electric components
- Pump and valve parts
- Manifolds and housings
- Analytical instrumentation
- Medical devices



Material Certifications:

- ASTM D4349
- FDA compliant
- ISO 10993 compliant

SustaPPO MG

Standard Thickness (inches) :	3/8" up to 2" thick (standard increments)
Standard Sheet Size (inches) :	24 x 48
Standard Diameter (inches) :	3/8" up to 6" diameter
Standard Rod Length :	Varies by diameter, please inquire
Standard Colors :	Gray, Brown, Blue, Yellow and Green

PPS - Polyphenylene Sulfide

Techtron® PPS & HPV

PPS (polyphenylene sulfide) products offer the broadest resistance to chemicals of any advanced engineering plastic. They have no known solvents below 392°F (200°C) and offer inertness to steam, strong bases, fuels and acids. Minimal moisture absorption and a very low coefficient of linear thermal expansion, combined with Quadrant's proprietary stress relieving processes, make these PPS products ideally suited for precise tolerance machined components. In addition, PPS products exhibit excellent electrical characteristics and are inherently flame retardant.

Techtron® PPS

Unlike reinforced PPS products, Techtron® PPS is easily machined to close tolerances. It is ideal for structural applications in corrosive environments or as a PEEK replacement at lower temperatures. Techtron® PPS is off white in color.

Techtron® HPV

Techtron® HPV exhibits excellent wear resistance and a low coefficient of friction. It overcomes the disadvantages of virgin PPS caused by a high coefficient of friction, and of glass fibre reinforced PPS which can cause premature wear of the counterface in moving-part applications.

Typical Features:

- Excellent wear and frictional behavior
- Excellent chemical and hydrolysis resistance
- Very good dimensional stability
- Good electrical insulating and dielectric properties
- Excellent resistance against high energy radiation
- Inherent low flammability

Product Applications:

- Pump housings
- Lantern rings
- Retaining rings
- Chip nests
- HPLC



Techtron® PPS

Standard Thickness (inches) :	1/4" up to 4" thick
Standard Sheet Size (inches) :	1/4" to 2" 24 x 48 2-1/4" to 4" 12 x 48
Standard Diameter (inches) :	3/16" up to 6" diameter
Standard Rod Length :	96" (8 ft) or 120" (10 ft) long
Standard Color :	Natural (off white)

PPS - Polyphenylene Sulfide

Typical Properties for Techtron® PPS & HPV

PROPERTY TESTED	ASTM	UNITS	PPS	HPV
MECHANICAL PROPERTIES				
Specific Gravity	D792	---	1.35	1.43
Tensile Strength	D638	psi	13,500	10,900
Tensile Modulus	D638	psi	500,000	540,000
Elongation at Break	D638	%	15%	5%
Flexural Strength	D790	psi	21,000	10,500
Flexural Modulus	D790	psi	575,000	535,000
Shear Strength	D732	psi	9,000	---
Compressive Strength, 10% Def.	D695	psi	21,500	15,500
Compressive Modulus	D695	psi	430,000	342,000
Hardness, Rockwell	D785	R/M	R 125	M 84
Hardness, Durometer	D2240	D scale	D 85	---
Izod Impact, Notched .125"	D256 "A"	ft.·lb./in.	0.60	1.40
Coefficient of Friction (D vs S)	QTM 55007	Dynamic	0.40	0.20
Limiting PV (4:1 Safety)	QTM 55007	psi-fpm	3,000	8,750
Wear Factor "k" x 10 ⁻¹⁰	QTM 55010	in ³ -min/lb-ft-hr	2,400	62
THERMAL PROPERTIES				
Coefficient of Linear Thermal Expansion	E831	10E-4/°F	0.28	0.33
Deflection Temp. at 264 psi	D648	°F	250°	240°
Melting Point (crystalline), peak	D3418	°F	540°	536°
Cont. Service in Air (max)	Long Term	°F	425°	430°
Thermal Conductivity	F433	BTU-in./hr.·ft ² -°F	2.00	2.10
ELECTRICAL PROPERTIES				
Dielectric Strength, short term	D149	Volts/mil	540	500
Surface Resistance	EOS/ESD	ohm/sq	1E +13	1E +13
Dielectric Constant, 10 ⁶ Hz	D150	---	3.00	---
Dissipation Factor, 10 ⁶ Hz	D150	---	0.0013	---
Flammability @ 3.1mm	UL94	---	5 (V-0)	5 (V-0)
FDA Compliant	---	---	Yes	Yes

High
Performance

PLASTICS GUIDE



PPSU - Polyphenylsulfone

Radel® R - PPSU

Stock shapes extruded from Radel® R resins offer a superior combination of high performance properties that include excellent thermal stability, outstanding toughness and good environmental stress cracking resistance. These properties make Radel® R stock shapes attractive for a variety of demanding applications.

Radel® polyphenylsulfone (PPSU) delivers the highest performance of our sulfone polymers, offering better impact resistance and chemical resistance than polysulfone (PSU) and polyetherimide (PEI). The high heat resistance and excellent hydrolytic stability of Radel® PPSU make it an excellent choice for hot water fittings and medical devices requiring repeated steam sterilization.

Radel® R series products are targeted at a number of industries and applications. The initial target market is the medical industry. Radel® R is used in applications for surgical tools and instruments because of its resistance to autoclave sterilization damage. A second market for Radel® R is electronics because of its temperature resistance and dielectric properties.

Typical Features:

- High HDT of 405°F (207°C)
- Superior toughness and impact strength
- Inherently flame retardant
- Transparent
- Exceptional long-term hydrolytic stability
- Better chemical resistance than PSU and PEI
- Withstands over 1,000 cycles of steam sterilization without any significant loss of properties

Product Applications:

- Acid tank/ lineup
- Battery cases
- Cutting boards
- Fume hoods
- Machined parts
- Metal plating barrels
- Orthopedic appliances
- Plating modules

Radel® R PPSU

Standard Thickness (inches) :	1/32" up to 2" thick
Standard Sheet Size (inches) :	24" x 48"
Standard Diameter (inches) :	1/4" up to 8" diameter
Standard Rod Length (inches) :	48" and 96", varies by diameter
Standard Color :	Off White

PPSU - Polyphenylsulfone

Typical Properties for Radel® R PPSU

PROPERTY TESTED	ASTM	UNITS	RADEL R 5500
PHYSICAL PROPERTIES			
Specific Gravity	D792	lb./in ³	0.0466
Water Absorption, immersion, 24 hrs	D570(2)	%	0.37
Water Absorption, immersion	D570(2)	%	1.10
MECHANICAL PROPERTIES			
Hardness, Rockwell, R	D785	---	120
Hardness, Shore D	D2240	---	80
Tensile Strength, Ultimate	D638	psi	11,000
Elongation at Break	D638	%	30%
Tensile Modulus	D638	psi	340,000
Flexural Modulus	D790	psi	345,000
Flexural Yield Strength	D790	psi	15,500
Compressive Strength	D695	psi	13,400
Compressive Modulus	D695	psi	280,000
Shear Strength	D732	psi	9,000
Izod Impact, Notched .125"	D256, Type A	ft.•lb./in.	2.50
ELECTRICAL PROPERTIES			
Surface Resistivity per Square	EOS/ESD S11.11	ohm	Min 1e+013
Dielectric Constant @ 1MHz	D150	---	3.44
Dielectric Strength, Short Term	D149	V/mil	360
Dissipation Factor, 1 MHz	D150	---	0.0017
THERMAL PROPERTIES			
Coefficient of Therm Exp, Linear 68°F	E831	µin/in-°F	31
Thermal Conductivity	F433	BTU-in./hr.•ft ² -°F	2.40
Maximum Service Temp., Air	Long Term	°F	300°
Deflection Temp at 1.8 MPa (264 psi)	D648	°F	405°
Glass Temperature	D3418	°F	---
Flammability, UL 94, .125" thick	Est. Rating	---	V-0

The numbers supplied for the testing of this product came directly from the manufacturer of this material. These numbers should be used as a reference only, they are not to replace the actual testing of the material in your specific application. Test results may vary from application to application.

High
Performance

PLASTICS GUIDE



PPSU - Polyphenylsulfone

Sustason PPSU MG (Radel®) - Medical Grade

Sustason PPSU (polyphenolsulfone) is produced from Radel® R resin. It is an amorphous product that offers improved chemical resistance and thermal stability over most amorphous thermoplastics. Sustason PPSU has the added advantage of superior impact resistance over polycarbonate. It is preferred over all other amorphous thermoplastics, including PEI (Ultem®), where added thermal performance impact resistance and a high number of steam sterilization cycles is desired.

Typical Features:

- Excellent thermal stability
- High impact resistance
- Resistance to hydrolysis
- Continuous use temperature of 320°F
- Outstanding steam autoclaving resistance
- FDA and USP Class VI compliant
- Custom colors available by request

Product Applications:

- Sizing trials for joint implants
- Dental handles and instruments
- Medical device components
- Lab animal cages

Material Certifications:

- ASTM D6394
- FDA compliant
- USP Class VI & ISO 10993 compliant



Sustason PPSU MG

Standard Thickness (inches) :	3/8" up to 2" thick (standard increments)
Standard Sheet Size (inches) :	24 x 48
Standard Diameter (inches) :	3/8" up to 6" diameter
Standard Rod Length :	Varies by diameter, please inquire
Standard Colors :	Natural, Gray, Black and Blue

PSU - Polysulfone

Polysulfone is a transparent, heat resistant, ultra-stable high performance amorphous engineering thermoplastic. It has low flammability and smoke emission. The material also has good impact and electrical properties. Polysulfone can be processed on conventional equipment, however, the material must be dried before processing. It can be compounded with fillers like glass beads, glass fiber, or TFE.

Made from UDEL® polysulfone resin, these stock shapes remain stable, resisting creep and deformation under continuous load and elevated temperatures. They have high tensile strength and, as temperatures increase, flexural modulus remains high. Polysulfone products will withstand exposure to soap, detergent solutions and some hydrocarbon oils, even at elevated temperatures under moderate stress levels.

Typical Features:

- Hot water & steam performance to 300°F (150°C)
- Excellent mechanical & electrical properties
- Dimensionally stable
- Low outgassing levels
- Radiation stability
- Easily machined
- FDA compliant
- Transparent grades available



Product Applications:

- Float switches
- Membrane cartridge filter system
- Solenoid valve body
- Dairy connector
- Manifolds
- Distributor valves
- Medical equipment components
- Steam cleaning equipment inserts

Polysulfone - PSU

Standard Thickness (inches) :	3/8" up to 4" thick
Standard Sheet Size (inches) :	3/8" to 4" 12 x 24 and 12 x 48
	3/8" to 2" 24 x 24 and 24 x 48
Standard Diameter (inches) :	1/4" up to 6" diameter
Standard Rod Length :	1/4" to 1" 5 ft and 10 ft
	1-1/8" to 2" 4 ft and 8 ft
	2-1/8" to 2-1/2" 2 ft and 4 ft
	2-5/8" to 6" 2 ft and 4 ft
Standard Color :	Natural (amber)

All Polysulfone material supplied as extruded, not finished

PSU - Polysulfone

Typical Properties for Polysulfone

PROPERTY TESTED	ASTM	UNITS	PSU 1000
PHYSICAL PROPERTIES			
Specific Gravity	D792	g/cc	1.24
Water Absorption, immersion, 24 hrs	D570(2)	%	0.30
Water Absorption, immersion	D570(2)	%	0.60
MECHANICAL PROPERTIES			
Hardness, Rockwell M, (R)	D785	---	82 (128)
Hardness, Shore D	D2240	---	80
Tensile Strength, Ultimate	D638	psi	10,200
Elongation at Break	D638	%	30%
Tensile Modulus	D638	psi	390,000
Flexural Modulus	D790	psi	400,000
Flexural Yield Strength	D790	psi	15,000
Compressive Strength	D695	psi	13,000
Compressive Modulus	D695	psi	375,000
Shear Strength	D732	psi	9,000
Izod Impact, Notched .125"	D256, Type A	ft. •lb./in.	1.30
ELECTRICAL PROPERTIES			
Surface Resistivity per Square	EOS/ESD S11.11	ohm	Min 1e+013
Dielectric Constant @ 1MHz	D150	---	3.14
Dielectric Strength, Short Term	D149	V/mil	425
Dissipation Factor, 1 MHz	D150	---	0.0008
THERMAL PROPERTIES			
Coefficient of Therm Exp, Linear 68°F	E831	µin/in-°F	31
Thermal Conductivity	F433	BTU-in./hr. •ft ² -°F	1.80
Maximum Service Temp., Air	Long Term	°F	300°
Deflection Temp at 1.8 MPa (264 psi)	D648	°F	340°
Glass Temperature	D3418	°F	374°
Flammability, UL 94, .125" thick	Est. Rating	---	HB

Note: Values listed are typical and are meant only as a guide to aid in design only. As always we highly recommend testing any new material in the application first before converting over to new material based on guide data information alone. Applications and usage vary and Alro does not guarantee any results as this data is for information only.



PSU - Polysulfone

Sustason PSU MG - Medical Grade

Sustason PSU (polysulfone) is a semi-transparent amorphous thermoplastic with an amber tint. It is a logical progression from standard transparent plastics such as polycarbonate when improved chemical or higher temperature resistance is required by an application. Sustason PSU can be used continuously in hot water and steam sterilization and has excellent chemical resistance to acidic salt solutions.

Sustason PSU MG comes in 2 different colors, White and Natural (Amber).

Typical Features:

- Excellent electrical properties
- Continuous use temperature of 300°F
- Heat deflection temperature of 345°F
- Water, food and medical compliance
- Stiffness, strength & dimensional stability
- Maintains its properties over a wide temp range
- Autoclavable

Product Applications:

- Electrical / electric components
- Inspection glasses
- Manifolds and housings
- Medical devices

Material Certifications:

- ASTM D6394
- FDA compliant
- USP Class VI & ISO 10993 compliant



Sustason PSU MG

Standard Thickness (inches) :	3/8" up to 2" thick (standard increments)
Standard Sheet Size (inches) :	24 x 48
Standard Diameter (inches) :	3/8" up to 6" diameter
Standard Rod Length :	Varies by diameter, please inquire
Standard Colors :	White and Natural (Amber)

PTFE/TFE - Polytetrafluoroethylene

PTFE or TFE - polytetrafluoroethylene is a very dense material having a density of 2.13 - 2.19 grams/cc. PTFE is well known for its chemical resistance. It is insoluble in all organics with the exception of a few exotics. Electrical properties are excellent. Impact strength is high but its resistance to wear, tensile strength and creep resistance are low in comparison to other engineering materials. PTFE has one of the lowest coefficients of friction of any solid.

In industrial applications, owing to its low friction, PTFE is used for applications where sliding action of parts is needed: plain bearings, gears, slide plates, etc. In these applications, it performs significantly better than nylon and acetal; it is comparable to ultra-high-molecular-weight polyethylene (UHMWPE). Although UHMWPE is more resistant to wear than PTFE, for these applications, versions of PTFE with mineral oil or molybdenum disulfide embedded as additional lubricants in its matrix are being manufactured. Its extremely high bulk resistivity makes it an ideal material for fabricating long-life electrets, useful devices that are the electrostatic analogues of magnets.

Mechanical properties can be improved by adding fillers such as glass fibers, bronze, carbon, and graphite. PTFE has an extremely low coefficient of friction. Very few materials will stick to it. It has useful properties from cryogenic temperatures up to 260°C (550°F).

Common Trade Names:

- Dyneon® (3M)
- Enflon® (Enflo)
- Neoflon® (Daikin)
- Polyflon® (Polyflon Company)
- Teflon® (DuPont)

Typical Features:

- Excellent electrical properties
- High impact strength
- Great chemical resistance
- Wide range of temperatures
- Extremely low coefficient of friction

Product Applications:

- Bushings and bearings
- Conveyor rollers
- Doctor blades
- Gaskets and seals
- Coil separators
- Conductor, layer, ground insulation
- Tank liners and washers
- Lab splash pans



PTFE/TFE - Polytetrafluoroethylene

Typical PTFE Enhanced Fillers

TFE fluorocarbon resin performs well in many applications without fillers. In fact, fillers can lessen its outstanding electrical and chemical properties. In mechanical applications, however compounds of PTFE and inorganic fillers offer improved wear resistance, reduce creep and initial deformation and increased stiffness and conductivity. Hardness is increased and the coefficient of thermal expansion is decreased. Compounds can therefore make it possible to gain the advantages of PTFE in applications where the unfilled resin cannot be used.

Glass Fiber - Glass in the form of short fibers is the most widely used filling material. The most popular compounds are 15% or 25% glass (by weight). It is sometimes combined with graphite or MoS₂. Glass has little effect on most of the electrical properties of PTFE. It resists acids and oxidation, but it can be attacked by alkali.

Carbon - A typical carbon filler is high-purity coke powder. It is often used in combination with graphite in concentrations of 25% to 35% by weight. Compounds of PTFE and carbon have excellent wear resistance, both dry and in water. They are compatible with most chemicals and can carry heavy loads under rubbing contact.

Graphite - This crystalline form of carbon is used alone or in combination with glass or amorphous carbon. A typical compound is 15% graphite by weight. The addition of graphite helps reduce the wear of soft metal mating parts and improves frictional and wear properties when mixed with other fillers. Like other forms of carbon, it serves well in corrosive environments.

Bronze - Round or irregularly-shaped bronze particles are often used at 60% by weight, or 55% with 5% MoS₂. Compounds of bronze and PTFE are creep-resistant and easily machined. They deliver good wear performance, low friction and relatively high thermal conductivity.

MoS₂ - Used in concentrations of approximately 5% by weight in compounds with glass or bronze. MoS₂ can increase surface hardness and lower coefficient of friction and wear rate.

PTFE MATERIAL	VIRGIN	RE-PROCESSED	VIRGIN PTFE / TFE				
FILLER	none	none	Glass Fiber	Bronze	Graphite	Carbon	Glass, MoS ₂
Filler Content by Weight	0%	0%	25%	40%	10%	10%	23% 2%
PHYSICAL PROPERTIES							
Specific Gravity	2.16	2.16	2.22	3.30	2.13	2.13	2.16
Tensile Strength Break (psi)	3,000	1,500	2,500	2,300	2,700	2,800	2,500
Elongation @ Break	200%	75%	50%	60%	60%	50%	50%
Shore Hardness	54	56	63	65	57	62	64
Deformation Under Load (% @ 1200 psi)	6.20%	6.00%	4.90%	3.60%	4.00%	3.70%	2.70%
Limiting PV @ 100 FPM (psi x fpm)	2,200	1,500	11,000	12,000	15,000	15,000	12,000

High Performance

PLASTICS GUIDE



PTFE/TFE - Polytetrafluoroethylene

High
Performance

Virgin PTFE Sheet

Standard Thickness (inches) :	1/16	3/32	1/8	3/16	1/4	
	3/8	1/2	5/8	3/4	1	1-1/4
	1-1/2	1-3/4	2	3	4	
Standard Sheet Size (inches) :	24 x 24	36 x 36	48 x 48			
Standard Sheet Color :	Natural (White)					



Note: PTFE is also available in thin gage films starting at 0.010" thick, please call for inquiries on thin gage PTFE film, fabric and tape.

Virgin PTFE Rod

Standard Diameter (inches) :	1/8" up to 5" diameter (Extruded)
Standard Rod Length :	6 feet and 12 feet (Extruded)
Standard Tolerances :	1/8" to 1" dia +.002"/-.000"
	1-1/8" to 2" dia +.010"/-.000"
	2-1/8" and over +.002"/-.000"

Standard Diameter (inches) :	1-1/2" up to 12" diameter (Molded)
Standard Rod Length (inches) :	12" long (Molded)

PTFE Heavy Wall Tube

Standard Diameters (inches) :	3/16" up to 1" O.D.
	1/16" up to 7/8" I.D.
Standard Wall Thickness :	.063" thick wall
Standard Length :	Random coil lengths, 25 ft or longer
Standard Tube Color :	Natural (White)




PTFE/TFE - Polytetrafluoroethylene

Thin Wall PTFE Tubing

With its high lubricant performance, high melting temperature, biocompatibility, and super precision extruded tolerances, PTFE Thin Wall Tubing is the best choice for your demanding application. It is chemically resistant to all common solvents, acids and bases, and lowest coefficient of friction of all polymers. PTFE also has excellent dielectric insulation properties.

Paste extruded PTFE tubing can be used in a temperature range from -200°C (-392°F) up to 250°C(482°F) in static conditions. These can be used in an extremely wide range of applications: Biomedical, Aerospace, Electrical, Electronics, Household Appliances, CPI and Automotive. Market demand of superior quality PTFE tubing is increasing more and more. GAPI production systems and control can ensure the highest quality and consistency in terms of properties and performance.

PTFE Thin Wall Tubing can be supplied in different colours and with special fillers. Special dimensions and tolerances can be produced on request.



SIZE (inches) O.D.	TOLERANCE (inches) O.D. (+/-)	SIZE (inches) I.D.	SIZE (inches) WALL	TOLERANCE (inches) WALL (+/-)	BURST PRESSURE PSI @ 75°F(*) Pounds/Foot
1/16	.004	1/32	.016	.003	1595
3/16	.008	1/16	.062	.001	3220
1/8	.005	1/16	.031	.005	1610
5/32	.005	3/32	.031	.005	1050
3/16	.008	1/8	.031	.005	795
1/4	.008	1/8	.062	.010	1595
1/4	.008	5/32	.047	.007	955
1/4	.008	3/16	.031	.005	530
5/16	.010	3/16	.063	.010	1065
5/16	.010	1/4	.031	.005	395
3/8	.010	1/4	.062	.010	800
3/8	.010	5/16	.031	.005	320
7/16	.020	5/16	.062	.010	635
7/16	.010	3/8	.031	.005	265
1/2	.010	3/8	.062	.010	530
1/2	.010	7/16	.031	.005	225
9/16	.010	1/2	.031	.005	200
5/8	.010	1/2	.062	.010	400
5/8	.010	9/16	.031	.005	176
11/16	.020	5/8	.031	.005	155
3/4	.020	11/16	.031	.005	145
13/16	.020	11/16	.062	.010	290

(*) The burst pressure values indicated in this chart are theoretical and indicated only as a guideline for the designers. For critical applications it will be strictly necessary to make appropriate tests.

High
Performance

PLASTICS GUIDE



PTFE/TFE - Polytetrafluoroethylene

Fluorosint® - Enhanced PTFE Materials

Fluorosint's unique properties are the result of a proprietary process in which synthetically manufactured mica is chemically linked to PTFE. This bonding results in properties not normally attainable in reinforced PTFE. Fluorosint® grades offer an excellent combination of low frictional properties and dimensional stability.

Mitsubishi Chemical Advanced Materials developed the Fluorosint range of enhanced PTFE materials to fill the performance gaps where unfilled and low-tech, filled PTFE based polymers underperform. Each Fluorosint material was specifically developed to excel in demanding bearing and seal applications. While each of these materials possess the chemical resistance and compliance of PTFE, each material offers some special benefits that give the designer clear performance advantages.

Fluorosint® 207

Fluorosint® 207's unmatched dimensional stability, excellent creep resistance and white color uniquely position this material to serve FDA regulated applications. It is non-permeable in steam and complies with the FDA's regulation 21 CFR 175.300. Its relative wear rate is 1/20 the rate of PTFE below 300°F (150°C) making it an excellent choice for aggressive service bearings and bushings.

Typical Features:

- Chemical resistance parallels PTFE
- Continuous use temperature to 500°F (260°C)
- Compared to other PTFE –based products :
 - Higher load carrying capabilities
 - 1/9 the deformation under the load
 - Lower coefficient of thermal expansion



Product Applications:

- Seals
- Appliances
- Bearings
- Mixers
- Pumps
- Valve seats

Fluorosint® 207

Standard Thickness (inches) :	1/4" up to 3" thick
Standard Sheet Size (inches) :	12" x 12"
Standard Diameter (inches) :	1/2" up to 8-3/4" diameter
Standard Rod Length (inches) :	Please inquire, varies by diameter
Standard Tube Diameter (inches) :	1-1/4" up to 12" OD, inquire on wall thickness
Standard Tube Length (inches) :	Please inquire, varies by diameter
Fluorosint® 207 Color :	White and Light Gray



PTFE/TFE - Polytetrafluoroethylene

Fluorosint® - Enhanced PTFE Materials

Fluorosint® 500

Fluorosint® 500 has nine times greater resistance to deformation under load than unfilled PTFE. Its coefficient of linear thermal expansion approaches the expansion rate of aluminum, and is 1/5 that of PTFE - often eliminating fit and clearance problems. It is 1/3 harder than PTFE, has better wear characteristics and maintains low frictional properties. Fluorosint® 500 is also non-abrasive to most mating materials.

High
Performance

Typical Features:

- Chemical resistance parallels PTFE
- Continuous use temperature to 500°F (260°C)
- Compared to other PTFE -based products :
 - Higher load carrying capabilities
 - 1/9 the deformation under the load
 - Lower coefficient of thermal expansion



Product Applications:

- Split and one-piece seals
- Valve seats
- Shrouds
- Slide bearings
- Wear strips
- Sacrificial, abradable seals
- Thrust washers

Fluorosint® 500

Standard Thickness (inches) :	1/4" up to 3" thick
Standard Sheet Size (inches) :	12" x 12"
Standard Diameter (inches) :	1/2" up to 8-3/4" diameter
Standard Rod Length (inches) :	Please inquire, varies by diameter
Standard Tube Diameter (inches) :	1-1/4" up to 12" OD, inquire on wall thickness
Standard Tube Length (inches) :	6" or 12", varies by diameter
Fluorosint® 500 Color :	Tan / Gray

PLASTICS GUIDE

PTFE/TFE - Polytetrafluoroethylene

Fluorosint® - Enhanced PTFE Materials

Fluorosint® HPV

FDA compliant Fluorosint® HPV is a high performance bearing grade of Fluorosint® - optimized for high PV and very low "K", or wear factor. Fluorosint® HPV was developed for bearing applications where other, low-tech PTFE formulations exhibit premature wear or simply cannot perform. FDA compliance gives food and pharmaceutical equipment manufacturers new design options and all benefit from its excellent load bearing and wear characteristics.

Product Applications:

- Bearings
- Wear guides
- Thrust washers
- Commercial food equipment
- High performance seals

FLUOROSINT® HPV



Fluorosint® MT-01

Fluorosint® MT-01 is an extreme service grade developed specifically for applications where the benefits of PTFE-based materials also require strength, stiffness and stability. Fluorosint® MTR-01 delivers high mechanical performance at elevated temperature and as a result is often specified in seat, seal and wear applications where extreme conditions are present.

Product Applications:

- High temperature seals
- Linear guides
- Wear bands
- Ovens and dryers

FLUOROSINT® MT-01



Fluorosint® HPV & MT-01

Standard Thickness (inches) :	1/4" up to 3" thick (HPV only)
Standard Sheet Size (inches) :	12" x 12" (HPV only)
Standard Diameter (inches) :	1/2" up to 8-3/4" diameter
Standard Rod Length (inches) :	Please inquire, varies by diameter
Standard Tube Diameter (inches) :	1-1/4" up to 12" OD, inquire on wall thickness
Standard Tube Length (inches) :	Please inquire, varies by diameter
Fluorosint® HPV Color :	Light Tan & Gray
Fluorosint® MT-01 Color :	Dark Gray

PTFE/TFE - Polytetrafluoroethylene

Fluorosint® - Enhanced PTFE Materials

Fluorosint® HPV

Fluorosint® 135 is a polytetrafluoroethylene (PTFE) material uniquely designed to provide the lowest coefficient of friction and deformation of seals, bearings and washer applications. Engineered for superior performance and value, Fluorosint® 135's machinability and stability offers the best protection against wear and breakdown. Even at extreme temperatures and pressures, Fluorosint® 135 continues to protect and reduce the risk of malfunction due to corrosive chemicals.

Typical Features:

- Lowest wear rate
- Lowest coefficient of linear thermal expansion
- Lowest coefficient of friction
- Lowest deformation
- Counter surface has little effect on performance
- No excessive run in period
- Extremely chemically inert



Product Applications:

- Compressor, pump and valve wear parts
- Seals, bearings, thrust washers and seals
- Insulating blocks and fixtures in diagnostic equipment
- Compressor piston rings, rider bands & packing sets
- Lubricated or non-lube dry running applications
- Typical air, hydrogen nitrogen refrigerant gas service
- Service temperatures of 450°F / 232°C

Fluorosint® 135

Standard Thickness (inches) :	1/4" up to 3" thick
Standard Sheet Size (inches) :	12" x 12"
Standard Diameter (inches) :	1/2" up to 8-3/4" diameter
Standard Rod Length (inches) :	Please inquire, varies by diameter
Standard Tube Diameter (inches) :	1-1/4" up to 12" OD, inquire on wall thickness
Standard Tube Length (inches) :	6" or 12", varies by diameter
Fluorosint® 135 Color :	Dark Gray

High
Performance

PLASTICS GUIDE

PTFE/TFE - Polytetrafluoroethylene

Typical Properties Comparison Fluorosint® Grades

High
Performance

PLASTICS GUIDE

PROPERTY TESTED	ASTM	UNITS	FLUOROSINT® 207
PHYSICAL PROPERTIES			
Specific Gravity	D792	g/cc	2.30
Water Absorp. Immersion, 24 hrs	D570(2)	%	0.030
Water Absorp. Immersion, Saturation	D570(2)	%	0.20
Deformation	2000 psi, 122°F	%	1.1
MECHANICAL PROPERTIES			
Hardness, Rockwell R	D785	---	50
Hardness, Shore D	D2240	---	65
Tensile Strength	D638	psi	1,500
Tensile Strength at 300°F	D638	psi	500
Tensile Strength at 150°F	D638	psi	1,000
Tensile Modulus	D638	psi	250,000
Elongation (at break)	D638	%	50%
Flexural Strength	D790	psi	2,000
Flexural Modulus	D790	psi	350,000
Compressive Strength	10% Def.; D695	psi	3,800
Compressive Modulus	D695	psi	225,000
Shear Strength	D732	psi	1,700
Izod Impact, Notched	D256, Type A	ft.-lb./in.	1.00
Coefficient of Friction, Dynamic (Dry vs. Steel)	QTM 55007	---	0.10
Wear Factor "k" x 10 ⁻¹⁰	QTM 55010	in ³ -min/lb-ft-hr	85 x 10 ⁻¹⁰
Limiting PV (4:1 safety factor)	QTM 55007	psi-ft./min.	8,000
ELECTRICAL PROPERTIES			
Surface Resistivity per Square	EOS/ESD S11.11	ohm	>= 1.00e + 13
Dielectric Constant (at10 ⁶ Hz)	D150	Freq at 1e+6 Hz	2.65
Dielectric Strength	Short Term; D149	kV/in.	200
Dissipation Factor (at 10 ⁶ Hz)	D150	Freq at 1e+6 Hz	0.0080
THERMAL PROPERTIES			
Coefficient Therm Exp, Linear	E831	µin/in-°F	57.0
Thermal Conductivity	---	BTU-in/hr-ft ² -°F	3.05
Melting Point	D3418	°F (°C)	621° (327°)
Maximum Service Temp, Air	Long Term	°F (°C)	500° (260°)
Deflection Temp at 1.8 MPa (264 psi)	D648	°F (°C)	210° (99°)
Flammability, UL94	1/8" (Est Rating)	---	V-0

The numbers supplied for the testing of this product came directly from the manufacturer of this material. These numbers should be used as a reference only, they are not to replace the actual testing of the material in your specific application. Test results may vary from application to application.

Two page chart, continues on the next page



PTFE/TFE - Polytetrafluoroethylene

Typical Properties Comparison Fluorosint® Grades

FLUOROSINT® 500	FLUOROSINT® HPV (PTFE)	FLUOROSINT® MT-01 (PTFE)	FLUOROSINT® 135
2.32	2.06	2.27	1.91
0.10	0.15	0.10	0.10
0.30	0.43	---	0.30
5.0	3.2	0.20	---
55	44	74	80
70	61	---	74
1,100	1,450	2,100	1,300
500	500	500	---
1,000	1,000	1,500	---
300,000	210,000	326,000	370,000
30%	65%	40%	3%
2,200	2,500	4,000	2,500
500,000	165,000	485,000	300,000
4,000	3,000	3,400	7,000
250,000	110,000	250,000	200,000
2,100	2,500	2,600	2,500
0.90	1.80	---	0.50
0.15	0.15	0.18	<= 0.15 (dynamic) <= 0.20 (static)
600 x 10 ⁻¹⁰	38 x 10 ⁻¹⁰	200 x 10 ⁻¹⁰	32 x 10 ⁻¹⁰
8,000	20,000	4,500	14,300
>=1.00e + 13	>=1.00e + 13	>=1.00e + 6	>=1.00e + 05
2.85	---	---	---
275	---	---	---
0.0080	---	---	---
25.0	49.0	30.0	25.0
5.30	---	---	---
621° (327°)	621° (327°)	---	621° (327°)
500° (260°)	500° (260°)	600° (316°)	500° (260°)
270° (132°)	180° (82°)	200° (93°)	220° (104°)
V-0	V-0	V-0	V-0

High
Performance

PLASTICS GUIDE

The numbers supplied for the testing of this product came directly from the manufacturer of this material. These numbers should be used as a reference only, they are not to replace the actual testing of the material in your specific application. Test results may vary from application to application.

Two page chart, continued from previous page

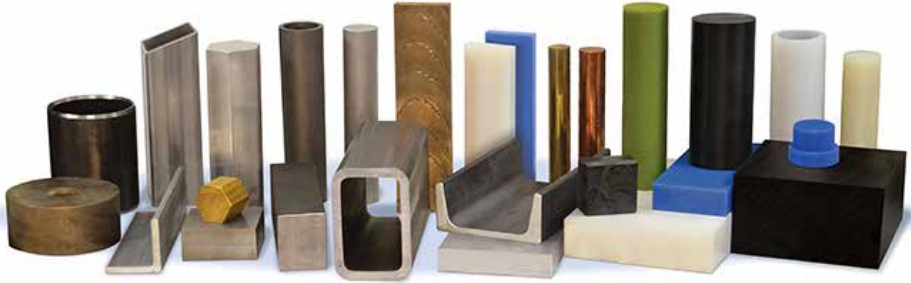




Alro Online Store

MyAlro.com

Aluminum • Alloys • Carbon Steel • Stainless Steel • Red Metals • Plastics



Did you know Alro also offers online shopping and e-business solutions for all of our customers? Visit the Alro Online Store from your computer or mobile device 24 hours a day. Set up your company account and purchase metals and plastics from our vast inventory.

Alro utilizes systems technology to achieve the benefits of e-Business in raw material procurement processes.

- **Business to Business (B2B)** – Helps reduce purchasing transaction costs.
- **Web Ordering (MyAlro.com)** – Helps with material selection, quoting and estimating.
- **Automated Inventory Replenishment (APOS)** – helps reduce Kan Ban replenishment costs
- **Summary Billing** – helps reduce admin costs of processing raw material payables
- **Advance Shipping Notices** – helps reduce receiving time

Alro computers retrieve business information from customers/vendors computers via the internet. During the process we pickup and deliver electronic business documents. This process typically does not require any programming on the part of our customers, as Alro systems are designed to accept virtually any customer document format. Some examples of these documents are as follows:

- | | | |
|-------------------|--------------------------------------|---------------------|
| • Purchase orders | • POD - Electronic Proof of Delivery | • CAD drawings |
| • Invoices | • ACH Payment notifications | • Burn prints |
| • Quotes | • Mill Certifications | • Material releases |

