DOTMAR
ENGINEERING PLASTIC PRODUCTS

MATERIALS PROPERTIES APPLICATIONS



QUADRANT
ENGINEERING PLASTIC PRODUCTS

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COMPANY PROFILE

Dotmar Engineering Plastic Products was founded in 1967 and is currently the largest importer and distributor of thermoplastic stock shapes, polyurethane and conveyor components in Australia and New Zealand. Dotmar's distribution footprint extends to over 5,000 customers servicing over 100 diverse industry sectors.

Dotmar has built up its market-leading position by delivering a high level of customer service and applications advice, supported by a deep level of technical expertise. Dotmar is at the forefront of developing thermoplastic applications for commercial and industrial use and has built up a highly-skilled product development team supported by a network of mechanical engineers. Dotmar offers an extensive knowledge base in thermoplastics, polyurethane & conveyor products coupled with strong partnerships with world leading manufacturers.

Dotmar is focussed on three key areas of the business…

Materials Distribution → **Applications Development** → **Custom Manufacturing & Engineering**

Dotmar's focus is the technical application of thermoplastic materials in a number of exciting industries, ranging from pharmaceutical and materials handling to as far a field as architectural design. Dotmar excels in distribution, technical support, material selection and applications development.

So why choose the market leader…

- Offering the widest range of quality engineering thermoplastics
- Specialists in our field, offering the highest levels of material selection advice and technical support in the industry
- Largest distribution footprint in Australia and New Zealand
- Capital investment in inventory - commitment to continuous material supply and customer service delivery
- Long-standing partnerships with the world leaders in thermoplastics manufacturing

CONTENTS

ERTALON®/NYLATRON®

POLYAMIDES (PA)

Within the polyamides, commonly referred to as 'nylons', we distinguish different types. The most important ones are: PA 6 and PA 66.

The differences in physical properties which exist between these types are mainly determined by the composition and the structure of their molecular chains.

STANDARD GRADES

ERTALON® 6 SA natural (white) / black PA 6

This material offers an optimal combination of mechanical strength, stiffness, toughness, mechanical damping properties and wear resistance. These properties, together with a favourable electrical insulating ability, and a good chemical resistance make ERTALON 6 SA a 'general purpose' grade for mechanical construction and maintenance.

ERTALON® 66 SA natural (cream) / black PA 66

Material with a higher mechanical strength, stiffness, heat and wear resistance than ERTALON 6 SA. It also has a better creep resistance but its impact strength and mechanical damping ability are reduced. Well suited for machining on automatic lathes.

ERTALON® 66 SA-C natural (white) PA 66/6

ERTALON 66 SA-C, a modified polyamide 66, offers a well balanced combination of the remarkable properties of PA 6 and PA 66:

- toughness and impact strength (PA 6)
- stiffness and heat deflection resistance under load (PA 66)

ERTALON® 6 PLA natural (ivory) PA 6G

The characteristics of this cast nylon grade come very close to those of ERTALON 66 SA. Its production method (direct polymerization in the mould) offers the possibility of manufacturing large-sized stock shapes as well as custom castings which require only minimal machining.

SPECIAL GRADES

ERTALON® 4.6 (reddish brown) PA 66

Compared with the conventional nylons, ERTALON 4.6 (STANYL*) features a better retention of stiffness and creep resistance over a wide range of temperatures as well as a superior heat ageing resistance. Therefore, applications for ERTALON 4.6 are situated in the 'higher temperature area' (80-150˚C) where stiffness, creep resistance, heat ageing resistance, fatigue strength and wear resistance of PA 6, PA 66, POM and PETP fall short.

NYLATRON GSM (grey/black) PA 6G + MoS_2

NYLATRON GSM contains finely divided particles of molybdenum disulphide to enhance its bearing and wear behaviour without impairing the impact and fatigue resistance inherent to unmodified cast nylon grades. It is a very commonly used grade for gears, bearings, sprockets and sheaves.

NYLATRON GS (grey/black) PA 66 + MoS_2

The addition of MoS_2 renders this material somewhat stiffer, harder and dimensionally more stable than ERTALON 66 SA, but results in some loss of impact strength. The nucleating effect of the molybdenum disulphide results in an improved crystalline structure enhancing bearing and wear properties.

ERTALON® 6 XAU+ (black) PA 6G

ERTALON 6 XAU+ is a heat stabilised cast nylon 6 with a very dense and highly crystalline structure. It offers better technical properties than conventional extruded or cast nylons: superior resistance to creep and wear, better heat ageing performance and excellent machinability. ERTALON 6 XAU+ is particularly recommended for bearings and other mechanical parts subject to wear which are operating at temperatures above 60˚C.

** STANYL is a registered trade mark of DSM*

ERTALON® LFX (green) PA 6G + OIL

ERTALON LFX is an internally lubricated cast nylon 6 which is self-lubricating in the real meaning of the word. ERTALON LFX, specifically developed for unlubricated moving parts applications, yields a considerable enlargement of the application possibilities of nylons. This is because of its reduced coefficient of friction (-50%) and improved wear resistance (up to x 10).

ERTALON® 66-GF30 (black) PA66-GF30

Compared with virgin PA 66, this 30% glass fibre reinforced nylon grade offers increased strength, stiffness, creep resistance and dimensional stability whilst retaining an excellent wear resistance. It also allows higher max. service temperatures.

MAIN CHARACTERISTICS

- high mechanical strength, stiffness hardness and toughness
- good fatigue resistance
- high mechanical damping ability
- good sliding properties
- excellent wear resistance

APPLICATIONS

ERTALON and NYLATRON are used for a wide range of industrial components both for Original Equipment Manufacturing and maintenance.

Some examples: sleeve and slide bearings, wear pads, support and guide wheels, conveyor rollers, tension rollers, sleeves for wheels and rollers, pulleys and pulley-linings, cams, buffer blocks, hammer heads, scrapers, gear wheels, sprockets, seal-rings, feed screws, starwheels, cutting and chopping boards, insulators, etc.

ERTACETAL®

POLYACETAL (POM)

STANDARD GRADE

ERTACETAL® C natural (white) / black POM-C
ERTACETAL® H natural (white) POM-H

These are QUADRANT's virgin copolymer (POM-C) and homopolymer (POM-H) acetal grades. The acetal copolymer is more resistant against hydrolysis, strong alkalis and thermal-oxidative degradation than the acetal homopolymer. The latter, however, has higher mechanical strength, stiffness, hardness and creep resistance as well as a lower thermal expansion rate and very often it also presents a better wear resistance.

ERTACETAL is very well suited for machining on automatic lathes and is particularly recommended for mechanical precision parts.

ERTACETAL® scraper blades on a gelatine extruder

SPECIAL GRADE

ERTACETAL® H-TF (deep brown) POM-H

ERTACETAL H-TF is a DELRIN* AF Blend, a combination of TEFLON* fibres evenly dispersed in a DELRIN* acetal resin. Much of the strength that is inherent in ERTACETAL H is retained. Some properties are changed due to the addition of TEFLON* fibre which is softer, less stiff and slipperier than virgin acetal resin.

Compared with ERTACETAL C and H, this material offers superior sliding properties. Bearings made of ERTACETAL H-TF show low friction, long wear and are essentially free of stick-slip behaviour.

** DELRIN is a registered trade mark of Du Pont*
** TEFLON is a registered trade mark of Du Pont*

MAIN CHARACTERISTICS

- high mechanical strength, stiffness and hardness
- excellent resilience
- good creep resistance
- high impact strength, even at low temperatures
- very good dimensional stability
- good sliding properties
- excellent machinability
- physiologically inert (suitable for food contact)

APPLICATIONS

- gear wheels with small modulus
- cams
- heavily loaded bearings and rollers
- bearings and gears with small clearances
- valve seats
- snap fit assemblies
- all kinds of dimensionally stable precision parts for machine construction
- insulating components for electrical engineering
- parts which operate continuously in water of 60 - 80˚C (ERTACETAL C)

ERTACETAL® stock shapes

ERTALYTE®

POLYETHYLENE TEREPHTHALATE (PETP)

QUADRANT's stock shapes made of crystalline thermoplastic polyester, are marketed under the trade names ERTALYTE (virgin grade) and ERTALYTE TX (filled grade).

STANDARD GRADE

ERTALYTE® natural (white)/black PETP

The specific properties of this virgin PETP make it specially suitable for the manufacture of mechanical precision parts which have to sustain high loads and/or are subject to wear.

SPECIAL GRADE

ERTALYTE TX® (pale grey) PETP

ERTALYTE TX is a polyethylene terephthalate based compound incorporating a uniformly dispersed solid lubricant. Its specific Formulation yields a premium internally lubricated bearing-grade.

ERTALYTE TX has not only an excellent wear resistance but offers, in comparison with ERTALYTE an even lower coefficient of friction as well as higher Pressure-Velocity capabilities.

MAIN CHARACTERISTICS

- high mechanical strength, stiffness and hardness
- very good creep resistance
- low and constant coefficient of friction
- excellent wear resistance (comparable with the one of nylons)
- very good dimensional stability (better than polyacetal)
- physiologically inert (suitable for food contact)

APPLICATIONS

- heavily loaded bearings: bushings, thrust washers, guides, etc...
- dimensionally stable parts for mechanisms of precision: bushings, slideways, gears, rollers, pump components, etc...
- insulating components for electrical engineering

ERTALYTE® camrollers on can filling machine

QUADRANT PC 1000

POLYCARBONATE (PC)

QUADRANT PC 1000 natural (clear, translucent) PC

QUADRANT is marketing non-UV-stabilised polycarbonate stock shapes under the trade name QUADRANT PC 1000. It is a 'non-optical' industrial quality.

APPLICATIONS

- components for precision engineering
- safety glazing
- insulating parts for electrical engineering
- articles in contact with foodstuffs
- components for medical and pharmaceutical devices

MAIN CHARACTERISTICS

- high mechanical strength
- good creep resistance
- very high impact strength, even at low temperatures
- stiffness retention over a wide range of temperatures
- very good dimensional stability
- translucent
- physiologically inert (suitable for food contact)

+: measured on dry test specimens
++: measured on test specimens in equilibrium with the standard atmosphere 23°C/50% RH (mostly derived from literature)

(1) According to method 1 of ISO 62 and done on discs ø 50 x 3mm.
(2) The figures given for these properties are for the most part derived from raw material supplier data and other literature.
(3) Values for this property are only mentioned for amorphous materials and not for semi-crystalline ones.
(4) Only for short time exposure (a few hours) in applications where no or only a very low load is applied to the material.
(5) Temperature resistance over a period of 5,000/20,000 hours. After these periods of time, there is a decrease in tensile strength of about 50% as compared with the original value. The temperature values given here are thus based on the thermal-oxidative degradation which takes place and causes a reduction in properties.
Note, however, that, as for all thermoplastics, the maximum allowable service temperature depends in many cases essentially on the duration and the magnitude of the mechanical stresses to which the material is subjected.

(6) Impact strength decreasing with decreasing temperature, the minimum allowable service temperature is practically mainly determined by the extent to which the material is subjected to impact. The values given here are based on unfavourable impact conditions and may consequently not be considered as being the absolute practical limits.
(7) These estimated ratings, derived from raw material supplier data, are not intended to reflect hazards presented by the materials under actual fire conditions. There are no UL-yellow cards available for these stock shapes.
(8) The figures given for the properties of dry material (+) are for the most part average values of tests run on test specimens machined out of rods ø 40 - 60 mm. Considering the very low water absorption of ERTACETAL, ERTALYTE and PC 1000, the values for the mechanical and electrical properties of these materials can be considered as being practically the same for dry (+) and moisture conditioned (++) test specimens.
(9) Test speed: Type 1 B
(10) Test speed: 20mm/min (5 mm/min for ERTALON 66-GF30, ERTACETAL H-TF and ERTALYTE TX).
(11) Test speed: 1mm/min.
(12) Test specimens: cylinders (ø 12 x 30 mm)
(13) Pendulum used: 15 J.
(14) 10 mm thick test specimens.
(15) Electrode configuration: 25/75mm coaxial cylinders; in transformer oil according to IEC 296; 1 mm thick natural coloured test specimens. It is important to know that the electric strength of black extruded material (ERTALON 6 SA, ERTALON 66 SA, ERTACETAL and ERTALYTE) can be as low as 50% of the value for natural material. Possible microporosity in the centre of polyacetal stock shapes also significantly reduces the electric strength.
(16) The property-values given below do not apply to the ERTALYTE sheets.

° This table is a valuable help in the choice of a material. The data listed here fall within the normal range of product properties, but they **should not be used to establish material specification limits** nor used alone as the basis of design.

It has to be noted that ERTALON 66-GF30 is a fibre reinforced, and consequently anisotropic material (properties differ when measured parallel and perpendicular to the extrusion direction).

PROPERTIES		TEST METHODS ISO/(IEC)	UNITS	ERTALON 6SA	ERTALON 66SA	ERTALON 66SA-C	ERTALON 4.6
Colour		-	-	natural (white)/black	natural (white)/black	natural (white)	reddish brown
Density			1183	1.14	1.14	1.14	1.18
Water absorption:							
• after 24/96 h immersion in water of 23°C (1)		62	mg	86/168	40/72	65/120	90/180
		62	%	1.28/2.50	0.60/1.07	0.97/1.79	1.30/2.60
• at saturation in air of 23°C / 50% RH		-	%	2.6	2.4	2.5	2.8
• at saturation in water of 23°C		-	%	9	8	8.5	9.5
THERMAL PROPERTIES (2)							
Melting temperature		-	°C	220	255	240	295
Glass transition temperature (3)		-	°C	-	-	-	-
Thermal conductivity at 23°C		-	W/(K.m)	0.28	0.28	0.28	0.30
Coefficient of linear thermal expansion:							
• average value between 23 and 60°C		-	m/(m.K)	90 x 10^{-6}	80 x 10^{-6}	85 x 10^{-6}	80 x 10^{-6}
• average value between 23 and 100°C		-	m/(m.K)	105 x 10^{-6}	95 x 10^{-6}	100 x 10^{-6}	90 x 10^{-6}
Temperature of deflection under load:							
• method A: 1.8 MPa	+	75	°C	70	85	75	160
Max. allowable service temperature in air:							
• for short periods (4)		-	°C	160	180	170	200
• continuously: for 5000/20000 h (5)		-	°C	85/70	95/80	90/75	155/135
Min. service temperature (6)				-40	-30	-30	-40
Flammability (7):							
• "Oxygen Index"		4589	%	25	26	24	24
• according to UL 94 (3/6mm thickness)		-	-	HB / HB	HB / V-2	HB / HB	HB / HB
MECHANICAL PROPERTIES at 23°C (8)							
Tension test (9):							
• tensile stress at yield / tensile strength at break (10)	+	527	MPa	76 / -	90 / -	86 / -	100 / -
	++	527	MPa	45 / -	55 / -	50 / -	55 / -
• tensile strain at break (10)	+	527	%	> 50	> 40	> 50	25
	++	527	%	> 100	> 100	> 100	> 100
• tensile modulus of elasticity (11)	+	527	MPa	3250	3450	3300	3300
	++	527	MPa	1400	1650	1450	1300
Compression test (12):							
• compressive stress at 1 / 2 / 5 % nominal strain (11)	+	604	MPa	24/46/80	25/49/92	24/47/88	23/45/94
Creep test in tension (9):							
• stress to produce 1% strain in 1000 h ($\sigma_{1/1000}$)	+	899	MPa	18	20	19	22
	++	899	MPa	7	8	7.5	7..5
Charpy impact strength - Unnotched (13)	+	179/1eU	kJ/m^2	no break	no break	no break	no break
Charpy impact strength - Notched	+	179/1eU	kJ/m^2	5.5	4.5	5	8
Izod impact strength - Notched	+	180/2A	kJ/m^2	5.5	4.5	5	8
	++	180/2A	kJ/m^2	15	11	13	25
Ball indentation hardness (14)	+	2039-1	N/mm^2	150	160	155	165
Rockwell hardness (14)	+	2039-2	-	M 85	M 88	M 87	M 92
ELECTRICAL PROPERTIES at 23°C							
Electric strength (15)	+	(243)	kV/mm	25	27	26	25
	++	(243)	kV/mm	16	18	17	15
Volume resistivity	+	(93)	Ohm.cm	>10^{14}	>10^{14}	>10^{14}	>10^{14}
	++	(93)	Ohm.cm	>10^{12}	>10^{12}	>10^{12}	>10^{12}
Surface resistivity	+	(93)	Ohm	>10^{13}	>10^{13}	>10^{13}	>10^{13}
	++	(93)	Ohm	>10^{12}	>10^{12}	>10^{12}	>10^{12}
Relative permittivity: • at 100 Hz	+	(250)	-	3.9	3.8	3.8	3.8
	++	(250)	-	7.4	7.4	7.4	7.4
• at 1 MHz	+	(250)	-	3.3	3.3	3.3	3.4
	++	(250)	-	3.8	3.8	3.8	3.8
Dielectric dissipation factor tanδ: • at 100 Hz	+	(250)	-	0.019	0.013	0.013	0.009
	++	(250)	-	0.13	0.13	0.13	0.13
• at 1 MHz	+	(250)	-	0.021	0.020	0.020	0.019
	++	(250)	-	0.06	0.06	0.06	0.06
Comparative tracking index (CTI)	+	(112)	-	600	600	600	400
	++	(112)	-	600	600	600	400

Note: 1 g/cm^3 = 1000 kg/m^3 ; 1 N/mm^2 = 1 MPa; 1 kV/mm = 1 MV/m.

ERTALON 66-GF30	ERTALON 6 PLA	ERTALON 6 XAU+	ERTALON LFX	NYLATRON MC 901	NYLATRON GSM	NYLATRON GS	ERTACETAL C	ERTACETAL H	ERTACETAL H-TF	ERTALYTE (16)	ERTALYTE TX	QUADRANT PC 1000
black	natural (ivory)/black	black	green	blue	grey-black	grey-black	natural (white)/black	natural (white)/black	deep brown	natural (white)/black	pale grey	natural (clear, translucent)
1.29	1.15	1.15	1.135	1.15	1.16	1.15	1.41	1.43	1.50	1.39	1.44	1.20
30/56	44/83	47/89	44/83	49/93	52/98	46/85	20/37	18/36	16/32	6/13	5/11	13/23
0.39/0.74	0.65/1.22	0.69/1.31	0.66/1.24	0.72/1.37	0.76/1.43	0.68/1.25	0.24/0.45	0.21/0.43	0.18/0.36	0.07/0.16	0.06/0.13	0.18/0.33
1.7	2.2	2.2	2	2.3	2.4	2.3	0.20	0.20	0.17	0.25	0.23	0.15
5.5	6.5	6.5	6.3	6.6	6.7	7.8	0.85	0.85	0.72	0.50	1.47	0.35
255	220	220	220	220	220	255	165	175	175	255	255	-
-	-	-	-	-	-	-	-	-	-	-	-	150
0.30	0.29	0.29	0.28	0.29	0.30	0.29	0.31	0.31	0.31	0.29	.029	0.21
50×10^{-6}	80×10^{-6}	80×10^{-6}	80×10^{-6}	80×10^{-6}	80×10^{-6}	80×10^{-6}	110×10^{-6}	95×10^{-6}	105×10^{-6}	60×10^{-6}	65×10^{-6}	65×10^{-6}
60×10^{-6}	90×10^{-6}	90×10^{-6}	90×10^{-6}	90×10^{-6}	90×10^{-6}	90×10^{-6}	125×10^{-6}	110×10^{-6}	120×10^{-6}	80×10^{-6}	85×10^{-6}	65×10^{-6}
150	80	80	75	80	80	85	105	115	105	75	75	130
240	170	180	165	170	170	180	140	150	150	160	160	135
120/110	105/90	120/105	105/90	105/90	105/90	95/80	115/100	105/90	105/90	115/100	115/100	125/115
-20	-30	-30	-20	-30	-30	-20	-50	-50	-20	-20	-20	-60
-	25	25	-	25	25	26	15	15	-	25	25	25
HB / HB	HB / HB	HB / HB	HB / HB	HB / HB	HB / HB	HB / HB	HB / HB	HB / HB	HB / HB	HB / HB	HB / HB	HB / HB
- / 100	85 / -	83 / -	70 / -	81 / -	78 / -	92 / -	68 / -	78 / -	- / 55	90 / -	- / 76	70 / -
- / 75	55 / -	55 / -	45 /	50 / -	50 / -	55 / -	68 / -	78 / -	- / 55	90 / -	- / 76	70 / -
5	25	25	25	35	25	20	35	35	10	15	7	> 50
12	> 50	> 50	> 50	> 50	> 50	> 50	35	35	10	15	7	> 50
5900	3500	3400	3000	3200	3300	3500	3100	3600	3200	3700	3450	2400
3200	1700	1650	1450	1550	1600	1675	3100	3600	3200	3700	3450	2400
28/55/90	26/51/92	26/51/92	22/43/79	24/47/86	25/49/88	25/49/92	19/35/67	22/40/75	20/37/69	26/51/103	24/47/95	18/35/72
26	22	22	18	21	21	21	13	15	13	26	23 7	1
18	10	10	8	9	9	9	13	15	13	26	23	17
≥50	no break	no break	≥50	no break	no break	no break	≥150	≥200	≥30	≥50	≥30	no break
6	3.5	3.5	4	3.5	3.5	4	7	10	3	2	2.5	9
6	3.5	3.5	4	3.5	3.5	4	7	10	3	2	2.5	9
11	7	7	7	7	7	9	7	10	3	2	2.5	9
165	165	1 65	145	160	160	165	140	160	140	170	160	120
M 76	M 88	M 87	M 82	M 85	M 84	M 88	M 84	M 88	M 84	M 96	M 94	M 75
30	25	29	22	25	24	26	20	20	20	22	21	28
20	17	19	14	17	16	17	20	20	20	22	21	28
$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{15}$	$>10^{15}$	$>10^{15}$
$>10^{13}$	$>10^{12}$	$>10^{12}$	$>10^{12}$	$>10^{12}$	$>10^{12}$	$>10^{12}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{15}$	$>10^{15}$	$>10^{15}$
$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{14}$	$>10^{14}$	$>10^{15}$
$>10^{12}$	$>10^{12}$	$>10^{12}$	$>10^{12}$	$>10^{12}$	$>10^{12}$	$>10^{12}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{14}$	$>10^{14}$	$>10^{15}$
3.9	3.6	3.6	3.5	3.6	3.6	3.8	3.8	3.8	3.6	3.4	3.4	3
6.9	6.6	6.6	6.5	6.6	6.6	7.4	3.8	3.8	3.6	3.4	3.4	3
3.6	3.2	3.2	3.1	3.2	3.2	3.3	3.8	3.8	3.6	3.2	3.2	3
3.9	3.7	3.7	3.6	3.7	3.7	3.8	3.8	3.8	3.6	3.2	3.2	3
0.012	0.012	0.015	0.015	0.012	0.012	0.013	0.003	0.003	0.003	0.001	0.001	0.001
0.19	0.14	0.15	0.15	0.14	0.14	0.13	0.003	0.003	0.003	0.001	0.001	0.001
0.014	0.016	0.017	0.016	0.016	0.016	0.020	0.008	0.008	0.008	0.014	0.014	0.008
0.04	0.05	0.05	0.05	0.05	0.05	0.06	0.008	0.008	0.008	0.014	0.014	0.008
475	600	600	600	600	600	600	600	600	600	600	600	350 (225)
475	600	600	600	600	600	600	600	600	600	600	600	350 (225)

TECHTRON® HPV PPS

POLYPHENYLENE SULPHIDE (PPS)

TECHTRON®HPV PPS (deep blue) PPS

TECHTRON® HPV PPS is a reinforced, internally lubricated semicrystalline polymer developed to close the gap both in performance and price between the standard thermoplastic materials (eg. PA, POM, PETP, ...) and the high end Advanced Engineering Plastic Products (eg. PBI, PI, PAI, PEEK, ...).

Machined parts of TECHTRON®1000 PPS

MAIN CHARACTERISTICS

- very high max. allowable service temperature in air (220°C continuously going up to 260˚C for short periods of time)
- high mechanical strength, stiffness and hardness, also at elevated temperatures
- excellent chemical and hydrolysis resistance
- excellent wear and frictional behaviour
- excellent dimensional stability
- excellent resistance to high energy radiation (Gamma-rays and X-rays)
- very good UV resistance
- inherent low flammability
- good electrical insulating and dielectric properties

APPLICATIONS

TECHTRON®HPV PPS is recommended for use in demanding applications requiring at the same time high temperature resistance, low creep, resistance to wear and to hostile chemical environments; or in other words where many other engineering plastics such as PA, POM, PETP, PEI 1000, PPSU 1000 and PSU 1000 fall short. In less demanding high-tech applications, TECHTRON®HPV PPS can also offer a very good, economic alternative to PEEK, PAI or PI.

SYMALIT PVDF

POLYVINYLIDENE FLUORIDE (PVDF)

SYMALIT PVDF natural (white) PVDF

SYMALIT PVDF is highly crystalline unreinforced fluoropolymer combining good mechanical, thermal and electrical properties with excellent chemical resistance. It also shows excellent resistance to high energy radiation.

Additionally, the composition of the raw material used for the production of SYMALIT PVDF stock shapes complies with the EU/FDA regulations concerning plastics materials intended to come into contact with foodstuffs.

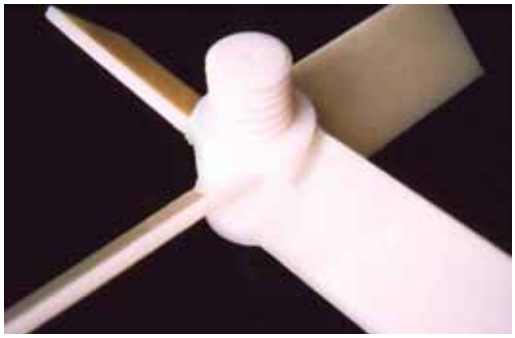
SYMALIT PVDF is a versatile engineering material especially suitable for the manufacture of components for the petro-chemical, chemical, metallurgical, foot, paper, textile, pharmaceutical and nuclear industries.

APPLICATIONS

Its property profile makes SYMALIT PVDF a versatile engineering material, specially suitable for the manufacture of components for the petro-chemical, chemical, metallurgical, pharmaceutical, food, paper, textile and nuclear industries.

MAIN CHARACTERISTICS

- high maximum allowable service temperatures in air (150°C for Symalit PVDF)
- excellent chemical and hydrolysis resistance
- outstanding UV - and weather resistance
- good mechanical strength, stiffness and creep resistance
- good sliding properties and wear resistance
- inherent low flammability
- good electrical insulating properties



Machined parts of SYMALIT PVDF

KETRON® PEEK • KETRON® PEEK-HPV • KETRON® PEEK-GF30 • KETRON® PEEK-CA30

POLYETHERETHERKETONE (PEEK)

There are 4 different grades.

KETRON® PEEK 1000 natural (brown/grey)/blk PEEK-1000

KETRON PEEK-1000 stock shapes are produced from virgin poly-etheretherketone resin and offer the highest toughness and impact strength of all KETRON PEEK grades. Both KETRON PEEK-1000 natural and black can be sterilised by all conventional sterilisation methods (steam, dry heat, ethylene oxide and gamma irradiation). Additionally, the composition of the raw materials used for the production of KETRON PEEK-1000 natural stock shapes complies with the directives of the European Union and the American FDA regulations with respect to food compatibility as well as to the USP-standard class VI (United States Pharmacopoeia) with respect to biocompatibility. These features make this grade very popular in medical, pharmaceutical and food processing industries.

KETRON® PEEK 1000 gears for pneumatic hand drill

KETRON® PEEK-HPV (black) PEEK HPV

The addition of PTFE, graphite and carbon fibres results in a KETRON PEEK "Bearing Grade". Its excellent tribological properties (low friction, long wear, high PV-limits) make this grade the ideal material for wear and friction applications.

KETRON® PEEK-GF30 natural (brown/grey) PEEK-GF30

This 30% glass fibre reinforced grade offers a higher stiffness, strength and creep resistance than KETRON PEEK-1000 and has a much better dimensional stability. This grade is ideal for structural applications supporting high static loads for long periods of time at elevated temperatures. The use of KETRON PEEK-GF30 is not recommended for sliding parts since the glass fibres tend to abrade the mating surface.

KETRON® PEEK-CA30 (black) PEEK-CA30

This 30% carbon fibre reinforced grade combines even better mechanical properties (higher E-modulus, mechanical strength and creep resistance...) than KETRON PEEK-GF30 with an optimum wear resistance. Moreover, the carbon fibres provide 3.5 times higher thermal conductivity than unreinforced PEEK - dissipating heat from the bearing surface faster.

KETRON® PEEK 1000 protection cap for oil measuring probe

MAIN CHARACTERISTICS

- very high max. allowable service temperature in air (250°C continuously going up to 310°C for short periods of time)
- high mechanical strength, stiffness and hardness, also at elevated temperatures
- excellent chemical and hydrolysis resistance
- excellent wear and frictional behaviour
- very good dimensional stability
- outstanding UV resistance
- excellent resistance to high energy radiation (gamma-rays and X-rays)
- inherent low flammability and very low levels of smoke evolution during combustion

APPLICATIONS

Applications include gears, pump components, valve seats and bearings, and can be found in the aerospace, nuclear, chemical, automotive and electrical industries, as well as in all kinds of military equipment.

PEI 1000
PPSU 1000
PSU 1000

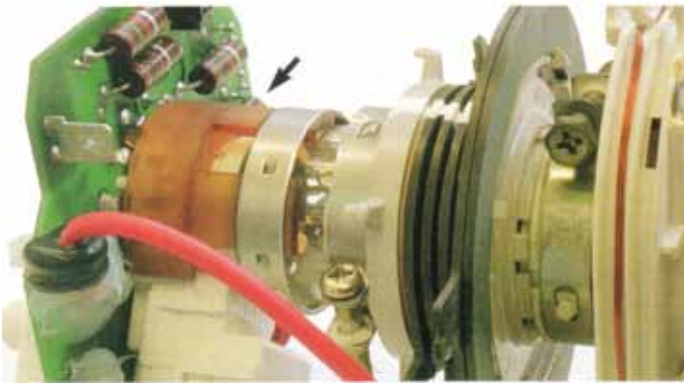
POLYETHERIMIDE (PEI)
POLYPHENYLSULPHONE (PPSU)
POLYSULPHONE (PSU)

These unreinforced amorphous thermoplastic materials have a lot of features in common and all offer a combination of excellent mechanical, thermal and electrical properties.

The price/performance ratio of these materials slots between the conventional engineering plastics and premium materials like PEEK.

PEI 1000 natural (amber, translucent) PEI

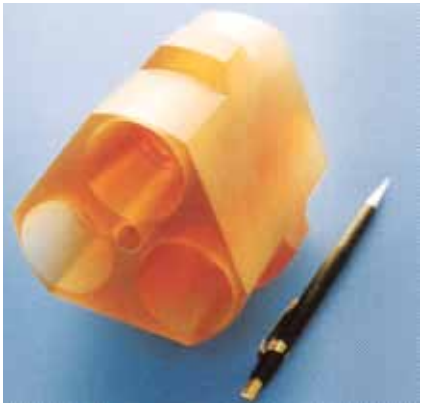
PEI 1000 stock shapes are produced from ULTEM® resin. This advanced polymer features a combination of outstanding thermal, mechanical and electrical properties, together with very low flammability and low levels of smoke evolution during combustion making it extremely suitable for electrical/electronic insulators and a variety of structural components requiring high strength and rigidity at elevated temperatures. Thanks to the good hydrolysis resistance of polyetherimide and because the raw material used for the production of PEI 1000 stock shapes is USP Class VI compliant, medical devices and analytical instrumentation are obviously important application fields.



PEI 1000 clamp on video display unit

PSU 1000 natural (yellow, translucent) PSU

PSU 1000 stock shapes are produced from non-UV-stabilised polysulphone resin. It offers excellent radiation stability, low ionic impurity levels and good chemical and hydrolysis resistance. Compared to PEI 1000, it has a lower property profile, often replacing polycarbonate whenever higher temperature resistance and improved chemical resistance are required. PSU 1000 is commonly used in food processing equipment (milk machines, pumps, valves, filtration plates, heat exchangers) and for medical components subject to cleaning and sterilisation.



Machined part of PSU 1000

PPSU 1000 (black) PPSU

PPSU 1000 stock shapes are produced from RADEL® R resin. This material offers a better impact strength and chemical resistance than PSU 1000 and PEI 1000. PPSU 1000 also has superior hydrolysis resistance as measured by steam autoclaving cycles to failure. In fact, this material has virtually unlimited steam sterilisability. This factor makes it an excellent choice for medical devices which are subjected to repeated steam autoclaving. Additionally, the raw material used for the production of PPSU 1000 stock shapes is USP Class VI compliant making it a very popular material for medical and pharmaceutical industries (eg. sterilisation trays, dental and Surgical instrument handles, orthopaedic implant trials and fluid handling coupling and fitting applications).

Applications

Parts machined from these materials are used in the electrical industries (coil bobbins, insulating bushings, housings), in process equipment (milking machines, pumps, valves, filtration plates, heat exchangers) and in the food processing / medical industries (components subject to repeated cleaning and sterilization).

**ULTEM is a registered trade mark of General Electric Co. USA*
**RADEL is a registered trade mark of Amoco Polymers*

Main characteristics

- high maximum allowable service temperatures in air (180°C, 170°C and 150°C continuously for PPSU 1000, PEI 1000 and PSU 1000 respectively)
- high mechanical strength and stiffness over a wide temperature range
- excellent hydrolysis resistance (suitable for repeated steam sterilisation)
- physiologically inert (suitable for food contact)
- very good dimensional stability
- translucent non-optical quality (except for PPSU 1000 which is black)
- good UV resistance
- very good resistance against high energy radiation (Gamma-rays and X-rays)
- good electrical insulating and dielectric properties

PHYSICAL PROPERTIES (Indicative values°)

PROPERTIES	Test methods ISO / (IEC)	Units	KETRON PEEK-1000	KETRON PEEK-HPV	KETRON PEEK-GF30	KETRON PEEK-CA30	TECHTRON HPV PPS	PPSU 1000	PEI 1000	PSU 1000	SYMALIT PVDF
Colour	-	-	natural (brownish grey)/ black	black -	brownish grey	black -	deep blue -	black -	natural (amber, translucent)	natural (yellow, translucent)	natural (white)
Density	1183	g/cm³	1.31	1.45	1.51	1.41	1.43	1.29	1.27	1.24	1.79
Water absorption:											
• after 24/96 h immersion in water of 23°C (1)	62	mg	5 / 10	4 / 9	-	-	1 ./ 2	26 / 55	20 / 41	23 / 44	1 / 3
	62	%	0.06/0.12	0.05/0.11	-	-	0.01/0.03	0.35/0.72	0.26/0.54	0.32/0.61	0.01/0.03
• at saturation in air of 23°C / 50% RH	-	%	0.20	0.14	0.14	0.14	0.03	0.60	0.75	0.40	0.05
• at saturation in water of 23°C	-	%	0.45	0.30	0.30	0.30	0.09	1.20	1.35	0.85	0.05
THERMAL PROPERTIES											
Melting Point	-	°C	340	340	340	340	280	-	-	-	175
Glass transition temperature (2)	-	°C	-	-	-	-	-	220	215	190	-
Thermal conductivity at 23°C	-	W/(K.m)	0.25	0.24	0.43	0.92	0.30	0.35	0.22	0.26	0.19
Coefficient of linear thermal expansion:											
• average value between 23 and 100°C	-	m/(m.K)	50×10^{-6}	30×10^{-6}	30×10^{-6}	25×10^{-6}	50×10^{-6}	55×10^{-6}	45×10^{-6}	60×10^{-6}	130×10^{-6}
• average value between 23 and 150°C	-	m/(m.K)	50×10^{-6}	30×10^{-6}	30×10^{-6}	25×10^{-6}	60×10^{-6}	55×10^{-6}	45×10^{-6}	60×10^{-6}	145×10^{-6}
• average value above 150°C	-	m/(m.K)	110×10^{-6}	65×10^{-6}	65×10^{-6}	55×10^{-6}	80×10^{-6}	55×10^{-6}	45×10^{-6}	-	-
Temperature of deflection under load:											
• method A: 1.8 MPa	75	°C	160	195	230	230	115	200	190	170	105
Max. allowable service temperature in air:											
• for short periods (3)	-	°C	310	310	310	310	260	210	200	180	160
• continuously: for min. 20000 h (4)	-	°C	250	250	250	250	220	180	170	150	150
Flammability (5):											
• "Oxygen Index"	4589	%	35	43	40	40	47	44	47	30	44
• according to UL 94 (1.5 / 3 mm thickness)	-	-	V-0 / V-0	V-0 / V-0	V-0 / V-0	V-0 / V-0	V-0 / V-0	V-0 / V-0	V-0 / V-0	HB / HB	V-0 / V-0
MECHANICAL PROPERTIES at 23°C											
Tension test (6):											
• tensile stress at yield / tensile strength at break (7)	527	MPa	110 / -	- / 75	- / 90	- / 130	- / 75	76 / -	105 / -	80 / -	50 / -
• tensile strain at break (7)	527	%	20	5	5	5	5	30	10	10	> 20
• tensile modulus of elasticity (8)	527	MPa	4400	5900	6300	7700	3700	2500	3400	2700	2300
Compression test (9):											
• compressive stress at 1% strain (8)	604	MPa	29	34	41	49	28	18	25	20	17
• compressive stress at 2% strain (8	604	MPa	57	67	81	97	55	35	49	39	32
Charpy impact strength - Unnotched (10)	179/1eU	kJ/m²	no break	25	35	35	25	no break	no break	no break	no break
Charpy impact strength - Notched	179/1eA	kJ/m²	3.5	2.5	4	4	3.5	10	3.5	4	10
Ball indentation hardness (11)	2039-1	N/mm²	230	215	270	325	180	-	170	155	110
Rockwell hardness (11)	2039-2	-	M 105	M 85	M 99	M 102	M 84	M 80	M 114	M 91	M 75
ELECTRICAL PROPERTIES at 23°C											
Electric strength (12)	(243)	kV/mm	24	-	24	-	24	-	27	30	18
Volume resistivity	(93)	Ohm.cm	10^{16}	-	10^{15}	10^{5}	10^{15}	10^{15}	10^{18}	10^{17}	10^{15}
Surface resistivity	(93)	Ohm	10^{16}	-	10^{15}	-	10^{15}	10^{15}	10^{17}	10^{17}	10^{16}
Relativity permittivity: • at 100 Hz	(250)	-	3.2	-	3.2	-	3.3	3.4	3.0	3.0	7.4
• at 1 MHz	(250)	-	3.2	-	3.6	-	3.3	3.5	3.0	3.0	6.0
Dielectric dissipation factor tan δ: • at 100 Hz	(250)	-	0.001	-	0.001	-	0.003	0.001	0.002	0.001	0.025
• at 1 MHz	(250)	-	0.002	-	0.002	-	0.003	0.005	0.002	0.003	0.165
Comparative tracking index (CTI)	(112)	-	150	-	175	-	100	-	175	150	600

** : Machined tensile test specimens made per ASTM D 1708 and tested according to ASTM D 638.*

Legend:

(1) According to method 1 of ISO 62 and done on discs Ø 50 x 3mm.

(2) Values for this property are only given here for amorphous materials and not for semi-crystalline ones.

(3) Only for short time exposure (a few hours) in applications where no or only a very low load is applied to the material.

(4) Temperature resistance over a period of min. 20,000 hours. After this period of time, there is a decrease in tensile strength of about 50% as compared with the original value. The temperature values given here are thus based on the thermal-oxidative degradation which takes place and causes a reduction in properties.
Note, however, that the maximum allowable service temperature depends in many cases essentially on the duration and the magnitude of the mechanical stresses to which the material is subjected.

(5) These estimated ratings, derived from raw material supplier data, are not intended to reflect hazards presented by the materials under actual fire conditions. There are no UL-yellow cards available for these stock shapes.

(6) Test specimens : Type 1 B

(7) Test speed : 5mm / min.

(8) Test speed : 1 mm / min.

(9) Test specimens : cylinders (Ø 12 x 30 mm)

(10) Pendulum used : 4 J

(11) 10mm thick test specimens

(12) 1 mm thick test specimens. It is important to know that the dielectric strength of black KETRON PEEK-1000 can be as low as 50% of the value for natural material.

°: this table is a valuable help in the choice of material. The data listed here fall within the normal range of product properties of **dry** material, but **they should not be used to establish material specification limits** nor used alone as the basis of design.

It has to be noted that plenty of the products listed in this table are fibre reinforced and/or filled, and consequently they are anisotropic materials (properties differ when measured parallel and perpendicular to eg. the extrusion direction).

DURATRON® PAI

POLYAMIDE-IMIDE (PPS)

For high temperature applications, this advanced material offers an excellent combination of mechanical performance and dimensional stability.

DURATRON PAI is available in 5 different grades.

DURATRON T4203 PAI (yellow/ochre) PAI

DURATRON T4203 PAI offers the best toughness and impact strength of all DURATRON PAI grades. Because of its intrinsic high temperature resistance, high dimensional stability and good machinability, DURATRON T4203 PAI is very popular for precision parts in high tech equipment. In addition, its good electrical insulation and dielectric properties provide numerous possibilities in the field of electrical components.

DURATRON T4301 PAI (black) PAI

The addition of PTFE and graphite provides higher wear resistance and lower coefficient of friction compared to the unfilled grade. DURATRON T4301 PAI also offers excellent dimensional stability over a wide temperature range. This grade excels in severe wear applications such as non-lubricated bearings, seals, bearings cages and reciprocating compressor parts.

DURATRON T4501 PAI (black) PAI

This compression moulded material is similar in composition to DURATRON T4301 PAI, and is selected when larger shapes are required.

DURATRON T4503 PAI (yellow/ochre) PAI

This compression moulded material is similar in composition to DURATRON T4203 PAI, and is selected when larger shapes are required.

DURATRON T5530 PAI (black) PAI

This 30% glass fibre reinforced grade offers higher stiffness, strength and creep resistance than DURATRON T4203 PAI. It is well suited for structural applications supporting static loads for long periods of time at high temperatures. In addition, DURATRON T5530 PAI exhibits superb dimensional stability up to 260°C making it extremely popular for precision parts in eg. the electronics and semi-conductor industries. The use of DURATRON T5530 PAI is not recommended for sliding parts since the glass fibres tend to abrade the mating surface.

MAIN CHARACTERISTICS

- very high maximum allowable service temperature in air (250°C continuously)
- excellent retention of mechanical strength and stiffness over a wide temperature range
- superb dimensional stability up to 250°C
- excellent wear and frictional behaviour
- outstanding UV resistance
- exceptional resistance against high energy radiation (Gamma-rays and X-rays)
- inherent low flammability

APPLICATIONS

More efficient operation and more reliable long-term performance make DURATRON T4301 PAI the optimum material for sliding vanes in rotary compressors. The material's high stiffness an excellent dimensional stability even at elevated temperatures, enable the vanes to travel freely in and out of the slotted rotor without binding.

DURATRON® PI

POLYIMIDE (PI)

DURATRON PI parts offer a combination of properties that allows them to excel in applications requiring low wear and long life in severe environments.

APPLICATIONS

In hydraulic pressure relief valves on farm tractors, DURATRON PI seats provide a no-leak seal in 135°C hydraulic oil while resisting 26 MPa without creep. The DURATRON PI seats conform to the balls' shape and reseal even in the presence of particulate contaminants. The seals increase system reliability and reduce customer complaints.

MAIN CHARACTERISTICS

- extremely high maximum allowable service temperature in air (240°C continuously, with short term excursions up to 450°C)
- excellent retention of mechanical strength and stiffness over a wide range of temperatures
- good sliding properties and excellent wear resistance
- very low coefficient of linear thermal expansion
- excellent resistance to high energy radiation (Gamma-rays and X-rays)
- inherent low flammability
- low outgassing (except water)
- extremely high purity in terms of ionic contamination

DURATRON® PBI

POLYBENZIMIDAZOLE (PBI)

DURATRON PBI is the highest performance engineering thermoplastic available today. Thanks to its unique property profile, DURATRON PBI might bring the ultimate solution when no other plastics material can.

DURATRON PBI (black) PBI

DURATRON PBI offers the highest temperature resistance and best mechanical property retention of all unfilled thermoplastics. DURATRON PBI is very "clean" in terms of ionic impurity and does not outgas (except water). These characteristics make this material extremely attractive to high-tech industries eg. semiconductor and aerospace industries. Usually DURATRON PBI is used for critical components to decrease maintenance costs and to gain valuable production "uptime".

MAIN CHARACTERISTICS

- extremely high maximum allowable service temperature in air (310°C continuously, going up to 500°C for short periods of time)
- excellent retention of mechanical strength and stiffness over a wide temperature range
- excellent wear and frictional behaviour
- extremely low coefficient of linear thermal expansion
- excellent resistance against high energy radiation (Gamma-rays and X-rays)
- inherent low flammability
- high purity in terms of ionic contamination
- low outgassing (except water)

Light Bulb contact part

APPLICATIONS

Light bulb contact parts. Manufacturers of incandescent and fluorescent light bulbs use DURATRON PBI for high temperature contact parts like vacuum cups, fingers and holders. It offers a higher temperature resistance, improved wear performance and longer life than polyimides. DURATRON PBI also reduces the yield loss (broken bulbs) previously experienced with ceramics.

PHYSICAL PROPERTIES (Indicative values°)

PROPERTIES	Test methods ISO / (IEC)	Units	DURATRON PBI	DURATRON T4203 PAI	DURATRON T4301 PAI	DURATRON T5530 PAI
Colour	-	-	black	yellow	black	black
	-	-		ochre		
Density	1183	g/cm^3	1.30	1.41	1.45	1.61
Water absorption:						
• after 24/96 h immersion in water of 23°C (1)	62	mg	38 / 81	24 / -	18 / -	17 / -
	62	%	0.50/1.06	0.29/ -	0.21/ -	0.18/ -
• at saturation in air of 23°C / 50% RH	-	%	-	2.5	1.9	1.7
• at saturation in water of 23°C	-	%	14	4.5	3.5	3.0
THERMAL PROPERTIES						
Melting Point	-	°C	NA	NA	NA	NA
Glass transition temperature	-	°C	425	285	285	285
Thermal conductivity at 23°C	-	W/(K.m)	0.40	0.26	0.54	0.36
Coefficient of linear thermal expansion:						
• average value between 23 and 100°C	-	m/(m.K)	25 x 10^{-6}	30 x 10^{-6}	25 x 10^{-6}	25 x 10^{-6}
• average value between 23 and 150°C	-	m/(m.K)	25 x 10^{-6}	30 x 10^{-6}	25 x 10^{-6}	25 x 10^{-6}
• average value above 150°C	-	m/(m.K)	25 x 10^{-6}	30 x 10^{-6}	25 x 10^{-6}	25 x 10^{-6}
Temperature of deflection under load:						
• method A: 1.8 MPa	75	°C	425	280	280	280
Max. allowable service temperature in air:						
• for short periods (2)	-	°C	500	270	270	270
• continuously: for min. 20,000 h (3)	-	°C	310	250	250	250
Flammability (4):						
• "Oxygen Index"	4589	%	58	45	44	50
• according to UL 94 (1.5 / 3 mm thickness)	-	-	V-0 / V-0	V-0 / V-0	V-0 / V-0	V-0 / V-0
MECHANICAL PROPERTIES at 23°C						
Tension test (5):						
• tensile stress at yield / tensile strength at break (6)	527	MPa	- / 160	120 / -	- / 80	- / 95
• tensile strain at break (6)	527	%	3	10	5	3
• tensile modulus of elasticity (7)	527	MPa	5800	4500	5800	6000
Compression test (8):						
• compressive stress at 1% strain (7)	604	MPa	42	27	31	-
• compressive stress at 2% strain (7)	604	MPa	82	53	58	-
Charpy impact strength - Unnotched (9)	179/1eU	kJ/m^3	-	no break	-	-
Charpy impact strength - Notched	179/1eA	kJ/m^3	3.5	10	4	3.5
Ball indentation hardness (10)	2039-1	N/mm^2	375	200	200	-
Rockwell hardness (10)	2039-2	-	E 104	E 79	M 105	E 77
ELECTRICAL PROPERTIES at 23°C						
Electric strength (11)	(243)	kV/mm	22	24	-	28
Volume resistivity	(93)	Ohm.cm	10^{14}	10^{17}	10^{15}	10^{17}
Surface resistivity	(93)	Ohm	> 10^{12}	10^{18}	10^{17}	10^{18}
Relativity permittivity: • at 100 Hz	(250)	-	3.3	4.2	6.0	4.4
• at 1 MHz	(250)	-	3.3	3.9	5.4	6.5
Dielectric dissipation factor tan δ: • at 100 Hz	(250)	-	0.001	0.026	0.037	0.022
• at 1 MHz	(250)	-	-	0.031	0.042	0.050
Comparative tracking index (CTI)	(112)	-	-	-	-	-

** : Machined tensile test specimens made per ASTM D 1708 and tested according to ASTM D 638*

Legend:A

(1) According to method 1 of ISO 62 and done on discs Ø 50 x 3mm.

(2) Values for this property are only given here for amorphous materials and not for semi-crystalline ones.

(3) Only for short time exposure (a few hours) in applications where no or only a very low load is applied to the material.

(4) Temperature resistance over a period of min. 20,000 hours. After this period of time, there is a decrease in tensile strength of about 50% as compared with the original value. The temperature values given here are thus based on the thermal-oxidative degradation which takes place and causes a reduction in properties.
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(5) These estimated ratings, derived from raw material supplier data, are not intended to reflect hazards presented by the materials under actual fire conditions. There are no UL-yellow cards available for these stock shapes.

(6) Test specimens : Type 1 B

(7) Test speed : 5mm / min

(8) Test speed : 1 mm / min.

(9) Test specimens : cylinders (Ø 12 x 30 mm)

(10) Pendulum used : 4 J

(11) 10mm thick test specimens

(12) 1 mm thick test specimens. It is important to know that the dielectric strength of black KETRON PEEK-1000 can be as low as 50% of the value for natural material.

°: this table is a valuable help in the choice of material. The data listed here fall within the normal range of product properties of **dry** material, but **they should not be used to establish material specification limits** nor used alone as the basis of design.

It has to be noted that plenty of the products listed in this table are fibre reinforced and/or filled, and consequently they are anisotropic materials (properties differ when measured parallel and perpendicular to eg. the extrusion direction).

Dotmar have technical people available to assist you in the early brain-storming stages of your design. Additionally, the focus and knowledge of Dotmar will help you use the best engineering thermoplastic for your applications.

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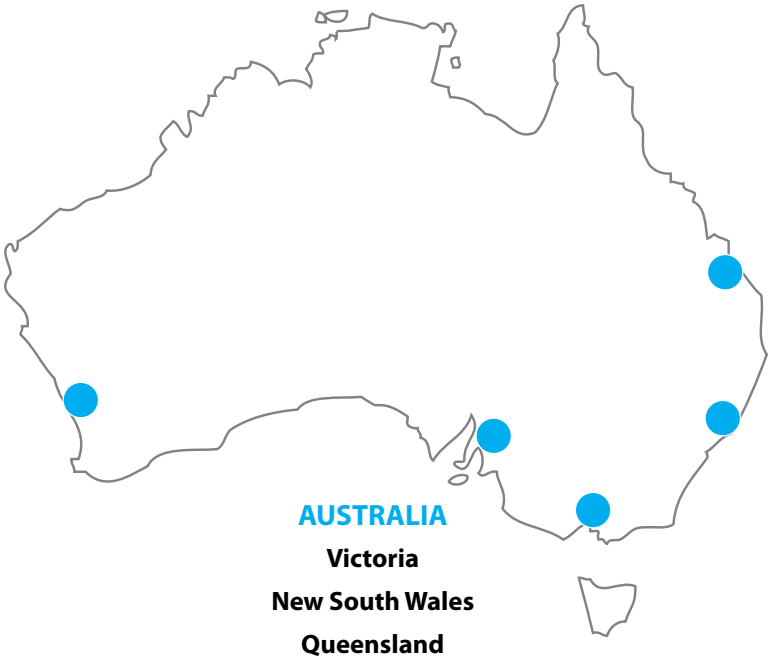

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