Engineering Plastic for Food Processing and Packaging Equipment

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Food Processing and Packaging Industry

IN THE FOOD PROCESSING AND PACKAGING INDUSTRY IT MEANS...

- Higher demands on the components in your equipment
- More frictional heat, more wear, more aggressive, hotter cleaning
- A whole new game in material selection

FASTER means hotter and some traditional materials can't take it. For example, higher temperatures mean more dimensional change in traditional parts, causing mating parts to buckle or gap and collect food. It can also mean poor fit and leakage.

MORE cut into downtime, and wear and lubrication become hot issues. That can mean more lubrication cost, and contamination. It can also mean unforeseen part failures from higher wear and from hotter, more aggressive cleaning to turn lines around faster.

NEW CHOICES FOR NEW CHALLENGES

Our proven and growing portfolio of engineering materials for components that handle these conditions includes materials that...

- Reduce weight and power requirements
- Survive a wide range of chemicals and temperatures
- Increase MTBR (Mean-Time-Between-Repair)
- Outwear standard materials by a factor of 10 or more – while reducing frictional drag
- Hold dimensions over wide temperature swings
- Eliminate costly lubrication

TO SIMPLIFY THINGS

A few key properties of engineering plastics – working in concert – have a major effect on equipment productivity. This guide helps the material selection challenge:

- It groups materials by their application area, chemical service and temperature capability
- Each group then compares materials on a few most important properties
- It also compares another key factor – relative cost

We back all of this up with technical support.

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APPLICATION AND PRODUCTION SUPPORT WHEN AND WHERE YOU NEED IT.

Our technical support team works with engineers and machinists from material selection through machining, for optimum performance, productivity and cost.

- Evaluation of performance needs and application environment
- Material selection – including selection software
- Material certifications
- Regulatory agency compliance
- Set-up and production recommendations from experienced machinists
- A wide range of material selection, design and fabrication guides and tools available

Quality Systems that ensure Consistency

FROM FULL LOT TRACEABILITY TO ISO CERTIFICATIONS, OUR PARTNERS, QUADRANT MEETS YOUR REQUIREMENTS FOR CONSISTENT QUALITY, PERFORMANCE AND MACHINABILITY.

As the first to line mark shapes materials, Quadrant sets the standard for traceability on our products right back to the resin lot and production shift.

They have also kept pace with industry standards and quality systems to comply with the needs of the industries that your company also serves. It is the inspiration behind our drive to provide the best levels of support for our materials in your applications.

Values based on 'Temperature of deflection under load' (ISO 75 / Method A: 1.8 Mpa)*

< 80°C	80 - 120°C	120 - 160°C	> 160°C
TIVAR® Oil Filled (PE-UHMW + oil)	ERTALON® 6 SA (PA 6)	TECHTRON® HPV PPS (PPS + solid lubricant)	PSU 1000 (PSU)
TIVAR® SurfaceProtect (PE-UHMW + other additives)	ERTALYTE® TX (PET + solid lubricant)	PC 1000 (PC)	DURATRON® U1000 PEI (PEI)
TIVAR® 1000 (PE-UHMW)	NYLATRON® LFG (PA 6 + oil)	KETRON® PEEK-TX (PEEK + solid lubricant)	QUADRANT PPSU (PPSU)
TIVAR® Ceram P (PE-UHMW + micro glass beads + additives)	ERTALON® 6 PLA (PA 6)	KETRON® PEEK 1000 (PEEK)	
TIVAR® CleanStat (PE-UHMW + specific additives)	ERTALYTE® (PET)		
TIVAR® H.O.T. (PE-UHMW + specific additives)	ERTALON® 66 SA (PA 66)		
	ERTACETAL® C (POM-C)		
	FLUOROSINT® 207 (PTFE + mica)		
	SYMALIT® PVDF 1000 (PVDF)		
	ERTACETAL® H (POM-H)		
SEE PAGES 7 - 8	SEE PAGES 9 - 12	SEE PAGES 13 - 14	SEE PAGE 15

Engineering Note:

A material's heat resistance is broadly characterised by both its temperature of deflection under load and its max continuously allowable service temperature. The property table on page 16-17 shows both. The temperature of deflection under load, formally called heat deflection temperature (HDT), is related to a certain level of stiffness at elevated temperature and is often considered as the max temperature limit for moderately to highly stressed, unconstrained components. The maximum continuous use temperature on the other hand is related to a certain level of permanent physical property degradation which occurs after long term exposure to elevated temperature (thermal-oxidative degradation).

TIVAR ULTRA-HIGH MOLECULAR WEIGHT POLYETHYLENE (PE-UHMW)

Food processing and packaging equipment designers have learnt that Tivar PE-UHMW materials can improve the efficiency and performance of handling systems. Tivar can help eliminate problems like noise, wear of mating parts and stretched chains that can cause costly downtime. With broad temperature performance, Tivar materials are ideal for freezing lines and operations that are intermittently exposed to temperatures up to 95°C.

TIVAR Oil Filled (PE-UHMW + oil)

An FDA compliant lubricant is added to the Tivar PE-UHMW to enhance its already good bearing performance.

Product Profile:

- Higher pressure-velocity capabilities (PV-limit)
- Food contact compliant composition (FDA *)

TIVAR Surface Protect (PE-UHMW + other additives)

Tivar Surface Protect is a modified PE-UHMW which enables more gentle treatment (less scratches and damage) of plastic containers during the filling, transportation, labelling and packaging process than Tivar 1000.

Product Profile:

- Improved sliding properties
- Food contact compliant composition (EU *)

TIVAR 1000 (PE-UHMW)

Tivar 1000 is a widely recognised engineering material with a remarkable combination of lubricity, chemical resistance and impact strength. It also has no moisture absorption and retains most of its key properties to -30°C. A broad range of shapes including plates, rods and profiles are possible.

Product Profile:

- Reduces noise and vibration
- Good wear resistance
- Very low moisture absorption
- Excellent chemical resistance
- Food contact compliant composition (EU & FDA *) and 3-A Dairy compliance

TIVAR Ceram P (PE-UHMW + micro glass beads + additives)

Product Profile:

- Improved wear resistance
- Food contact compliant composition (EU *)

<80°C Applications

TIVAR CleanStat (PE-UHMW + specific additives)

Tivar CleanStat provides PE-UHMW performance with the added benefit of static reduction. This helps to manage fines that are generated during manufacturing, processing and packaging operations. Used in drums, hoppers, chutes, buckets or any environment where particles are generated and can cause a loss of efficiency.

Product Profile:

- Long-wearing surface with a lower coefficient of friction than steel or aluminium
- Helps to reduce cleaning time
- Food contact compliant composition (EU & FDA *) and 3-A Dairy compliance

TIVAR H.O.T. (PE-UHMW + specific additives)

Newly developed Tivar H.O.T. pushes the performance envelope of PE-UHMW. With elevated temperature wear life up to 10 times longer when compared to standard PE-UHMW, Tivar H.O.T. is a new choice for wear strips, rollers and drag flights for the food processing and packaging industry.

Product Profile:

- Lasts up to 10x longer in elevated temperature environments
- Resists abrasion, corrosion, chemicals and moisture
- Excellent release characteristics
- Food contact compliant composition (EU & FDA *) and 3-A Dairy compliance
- Excels in a variety of industrial manufacturing environments where temperatures range up to 125°C

Challenges: Eliminate costly maintenance downtime caused by wear prone mixing paddles.

Solution: TIVAR H.O.T. eliminated the abrasion problem and easily withstands the harsh chemicals for cleaning.

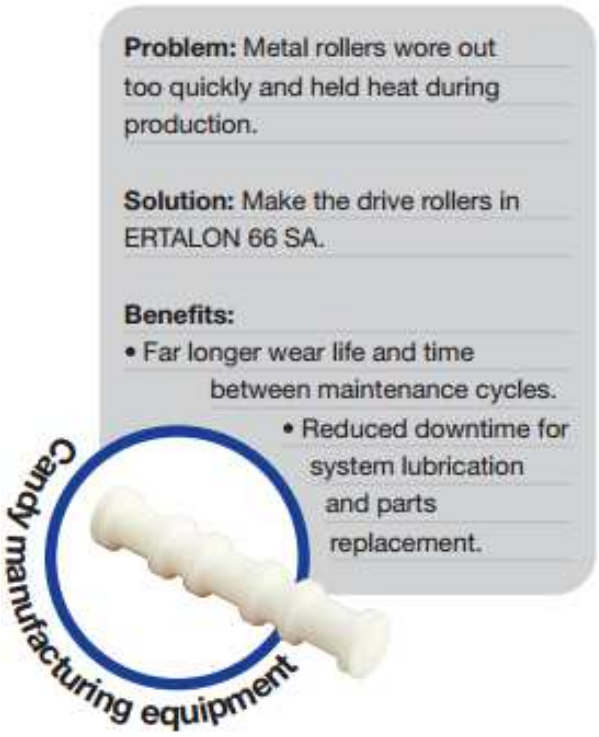
Benefits:

- Better even dispersion of sticky sugar slurry coated additives.
- Less downtime for cleanups.
- Resistant to harsh cleaning solutions.

Candy paddles

80 - 120°C Applications

Materials for this temperature range differ in bearing and wear, temperature and chemical resistance. All are more stable than PE-UHMW in temperature swings, to minimise dimensional change in mating parts. Compare them for the PE-UHMW best balance of cost and performance.



ERTALON 6 SA (PA 6)

Product Profile

- High strength and stiffness
- High impact strength
- Excellent wear resistance
- No corrosion
- Food contact compliant composition (EU & FDA *)

NYLATRON LFG (PA 6 cast nylon + oil)

Product Profile

- Lower coefficient of friction and higher PV-limits
- Improves bearing and wear performance over standard grades
- Uses: alternative to standard cast nylon where external lubrication is impractical
- Food contact compliant composition (EU & FDA *)

ERTALON 66 SA (PA 66)

Product Profile

- Higher strength and stiffness than Ertalon 6 SA
- Uses: screw-machined electrical insulators and food contact parts
- Food contact compliant composition (EU & FDA *)

Consider the versatility and cost saving potential of Nylatron Custom Castings:

The nylon casting process allows a range of formulations and sizes including large heavy walled tube, large diameter rod, thick plates and blocks. It also allows casting custom parts and near net shapes that can cut cost vs machining from a stock shape.

ERTALYTE (PET)

Product Profile

- Combines acetal's dimensional stability, nylons strength – plus better wear resistance
- Resists staining, outperforms polyamide and acetal in acidic environments
- Excellent wear resistance
- Food contact compliant composition (EU & FDA *) and 3-A Dairy compliance
- Withstands "bleach solutions" unlike nylon and acetal

Problem: High cost, wear rate of stainless steel.

Solution: Pistons and valves machined from ERTALYTE rod.

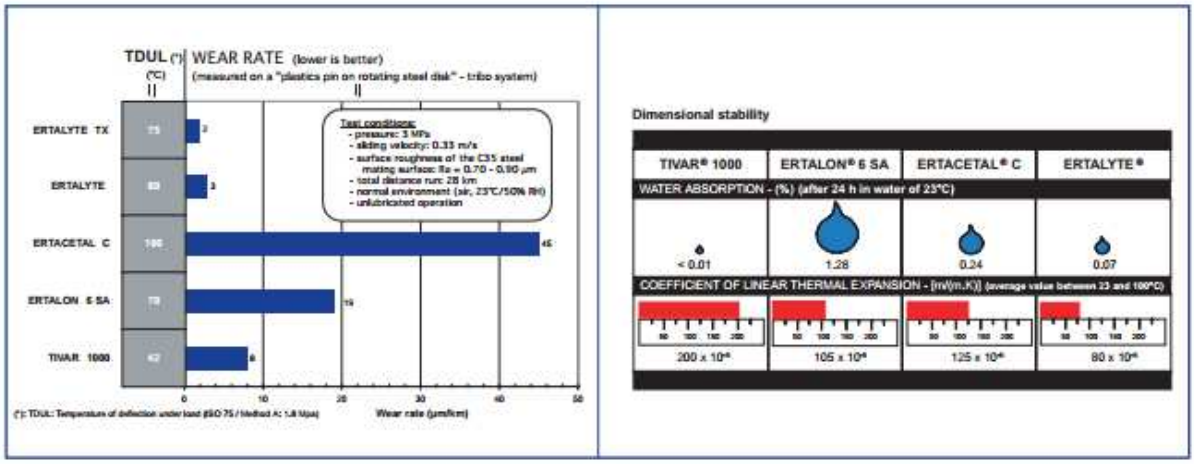
Benefits:
- Tight tolerances assure fill accuracy and efficiency - with a lower cost part.
- Lower weight allowed lighter duty, lower cost drives - which outlasted former units.
- Resistance to various liquids and chemicals afforded more production versatility.

ERTALYTE TX (PET + solid lubricant)

Product Profile

- Far less wear than standard PET, PBT and lubricated acetals – best in class
- Excels in high velocity load-bearing applications – wet or dry
- Minimises wear against soft metal and plastic mating parts
- Lower and more constant coefficient of friction than Ertalyte
- Food contact compliant composition (EU & FDA *)

*Detailed "food contact compliance statements" can be downloaded from our website.



Problem: Scraper blades in stainless steel were costly and wore mating parts quickly.

Solution: Replacement blades machined from ERTACETAL C plate.

Benefits:
- Lower part cost, minimal wear and repair cost on mating surfaces.
- Stiffness and low stress ensure flatness for mixing efficiency.
- Porosity-free quality minimises potential for trapped food and bacteria.

Food Contact Compliant (FDA) ERTACETAL C Colours

- Yellow 10
- Orange 20
- Red 30
- Blue 50
- Green 60
- Grey 70
- Brown 80
- Black 90

ERTACETAL C (POM-C)

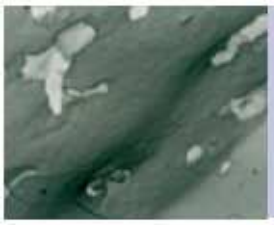
Product Profile

- Improved dimensional stability vs nylon – lower moisture absorption
- Free from centreline porosity
- Good chemical resistance in pH range of 4-13
- Hydrolysis resistance up to 85°C (much better than homopolymer acetal)
- Food contact compliant composition (EU & FDA *) and 3-A Dairy compliance (natural colour only)

ERTACETAL H (POM-H)

Product Profile

- Slightly higher mechanical strength and stiffness than copolymer acetal
- Better creep resistance than Ertacetal C
- Food contact compliant composition (EU & FDA *)



Some acetals - even copolymer or claimed porosity-free material - can contain tiny holes that trap dirt and bacteria. (photo-micrograph @ 500x)

Only Quadrant's **ERTACETAL C** combines porosity-free performance with the ease of machining that the industry's lowest stress levels provide.
(photo-micrograph @ 500x)

FLUOROSINT 207 (PTFE + mica)

Product Profile

- Unmatched dimensional stability among PTFE's (low CLTE); non-permeable in steam
- Excellent chemical and hydrolysis resistance
- Low deformation under load
- Excellent wear and frictional behaviour
- Food contact compliant composition (EU & FDA *)
- Ideal for seals and gaskets up to 260°C, where standard PTFE loses stability

Problem: Premature part wear at high temperature; contamination from lubrication of metal.

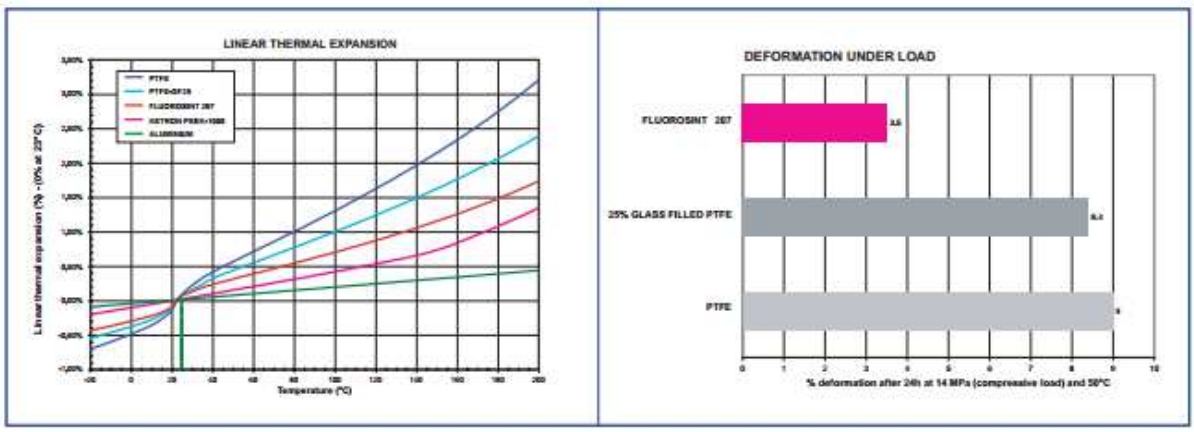
Solution: Composite design - bearing surfaces made from FLUOROSINT 207 supported by metal.

Benefits:
- FLUOROSINT 207 eliminates high wear from dynamic load.
- Metal adds structural strength and avoids wear exposure.
- Avoids deformation and degradation from exposure to hot cooking oils.

SYMALIT PVDF 1000 (PVDF)

Product Profile

- High maximum allowable service temperature in air (continuously 150°C)
- Excellent chemical and hydrolysis resistance
- Good mechanical strength, stiffness and creep resistance (better than other plain fluoropolymers)
- High dimensional stability (hardly any water absorption)
- Good sliding properties and wear resistance
- Outstanding UV resistance
- Food contact compliant composition (EU & FDA *) and 3-A Dairy compliance



We have an ongoing development effort in materials for this application range as cleaning methods get hotter and more aggressive. These advanced materials deliver unique levels of wear and chemical resistance, dimensional stability and strength retention. Their diversity provides options for the best balance of cost and performance, without expensive over-engineering.

Challenges: A manufacturer of food processing equipment needed a material that could withstand aggressive wash down cycles and perform without lubrication.

Solution: TECHTRON HPV PPS was used as a bearing in this new unit that offered a more compact, less complicated design that was capable of higher speed and greater output.

Benefits:

- TECHTRON HPV PPS combines the excellent chemical resistance of PPS with the wear resistance and performance of premium bearing materials.

TECHTRON HPV PPS (PPS)

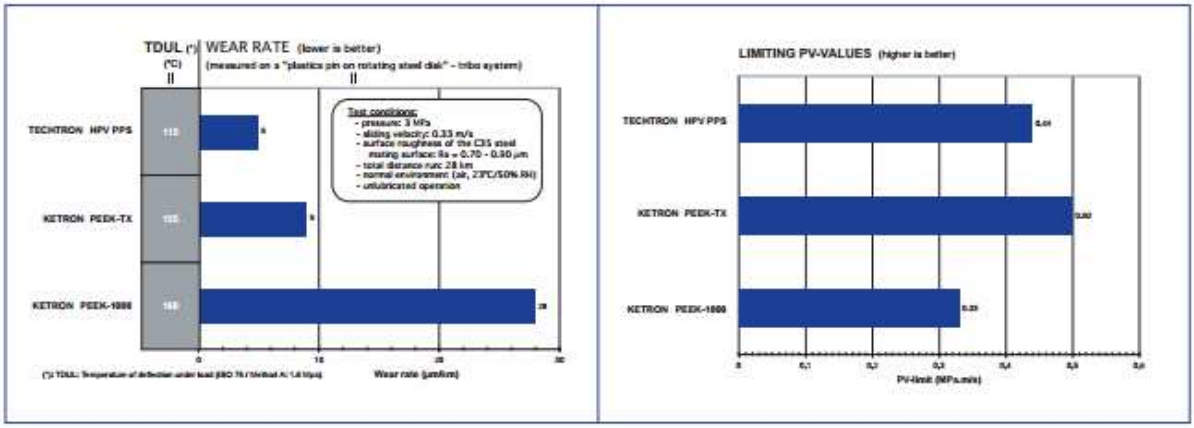
Product Profile

- Unique combination of excellent wear and chemical resistance in the 90° - 115°C temperature range
- No abrasive glass fibres common to filled PPS – minimises counter-face wear
- High load capacity over a wide temperature range
- Very good dimensional stability
- Food contact compliant composition (EU & FDA *)
- Uses: cost-effective high performance alternative to PEEK below 120°C

PC 1000 (PC)

Product Profile

- High mechanical strength
- Good creep resistance
- Very high impact strength, even at low temperatures
- Very good dimensional stability (very low water absorption and low coefficient of linear thermal expansion)
- Food contact compliant composition (EU & FDA *)



KETRON PEEK-1000 (PEEK)

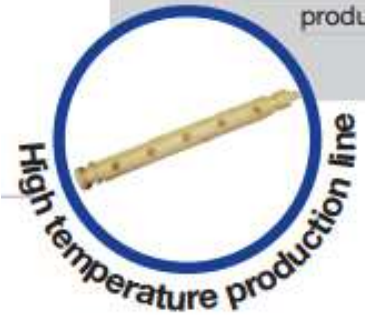
Product Profile

- Ideal for food contact bearing and wear applications from 115° - 160°C
- Resists wide range of aggressive, hot chemicals and cleaning solutions
- High mechanical strength, stiffness and creep resistance, over a wide temperature range
- Food contact compliant composition (EU & FDA *) and 3-A Dairy compliance (natural colour only)
- Uses: oven and hot process parts, exposure to steam, chemicals under pressure
- Very good dimensional stability

Challenges: High process unit temperatures warped portioning unit components. A cooling unit was required that reduced production efficiency.

Solution: Machined components from high temperature resistant KETRON PEEK 1000.

Benefits:
- Eliminated distortion from high temperatures; improved production life of parts.



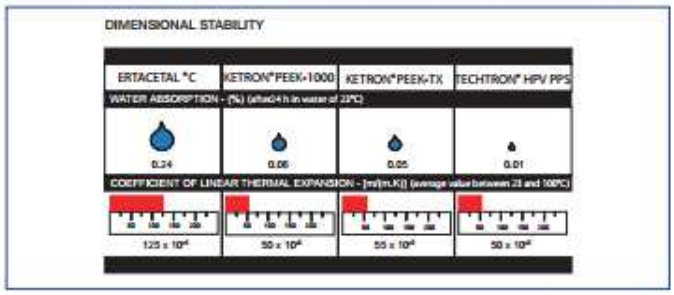
KETRON PEEK-TX (PEEK + solid lubricant)

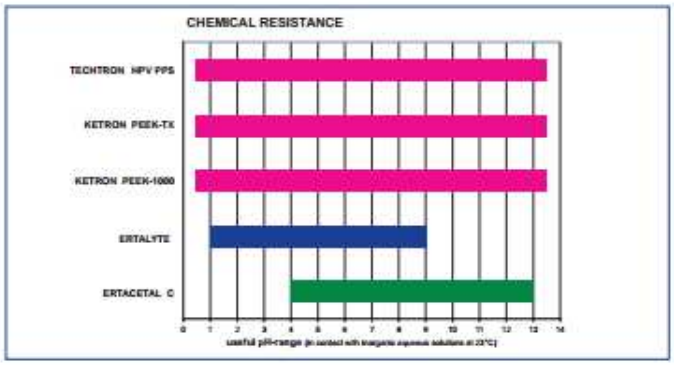
Product Profile

- Self-lubricating grade
- Superior wear and frictional performance over Ketron PEEK 1000
- Food contact compliant composition (EU & FDA *)

KETRON PEEK offers an excellent combination of physical properties:

Properties	KETRON PEEK-1000	KETRON PEEK-TX	TECHTRON HPV PPS
Overall chemical resistance	excellent	excellent	excellent
Dimensional stability	very good	very good	very good
Steam resistance (autoclavability)	excellent	excellent	very good
Wear resistance (unlubricated on steel)	good	very good	excellent
Continuous use temperature in air	250°C	250°C	220°C
Temperature of deflection under load	160°C	155°C	115°C
Relative stiffness (*) at different temperatures:			
• 23°C	100%	100%	100%
• 100°C	92%	89%	81%
• 150°C	78%	73%	23%
• 200°C	17%	17%	15%





The materials in the 160°C + class open the weight saving and design versatility benefits of engineering plastics to applications once restricted to speciality metals and glass. Their lighter weight can mean lower-cost drive systems – and they can reduce part cost depending on the type of metal or glass replaced.

Problem: Costly metal part required disassembly to clean. Temperatures eliminated many plastics.

Solution: One-piece spools machined from DURATRON PEI

Benefits:

- Durable, long lasting parts withstand high temperatures near baking environment.
- One piece machined part reduced cost and cleaning time vs. metal assembly.

Challenges: Glass breakage concerns; temperature failure in other transparent plastics.

Solution: Transparent PSU 1000 sight glass units.

Benefits:

- Durable - no breakage.
- Cost effective vs. glass.
- Resists hot cleaning agents and acidic cleansers.

PSU 1000 (PSU)

Product Profile

- Structural strength to 170°C
- Withstands hot water and steam – tough, durable
- Food contact compliant composition (EU & FDA *) and 3-A Dairy compliance
- Uses: sight glasses, material conveying bins

ULTEM PEI 1000 (PEI)

Product Profile

- Higher structural strength than polysulphone to 200°C
- Very good hydrolysis resistance
- Very high resistance to high energy radiation (gamma rays)
- Food contact compliant composition (EU & FDA *)
- Uses: similar to polysulphone, with a higher temperature limit under load

RADEL PPSU 1000 (PPSU)

- Best resistance to multiple sterilisation cycles and chemicals in this range of amorphous materials.
- Good retention of strength and stiffness up to 200°C
- Much higher impact strength than polysulphone and polyetherimide
- Food contact compliant composition (EU & FDA *)
- Uses: similar to PSU 1000 and Duratron U1000 PEI, with greater chemical and impact resistance

PROPERTIES	Test methods	Units	TIVAR® 1000	ERTALON® 6 SA	ERTALON® 66 SA	ERTALON® 6 PLA	NYLATRON® LFG
Clour			natural (white)	natural (white) / blue	natural (cream)	natural (ivory) / blue	natural (ivory) / blue
Density	ISO 1183-1	g/cm³	0.93	1.14	1.14	1.15	1.135
Water absorption:							
- after 24/96 h immersion in water of 23°C (1)	ISO 62	mg	≈0	86 /168	40 / 76	44 / 83	44 / 83
	ISO 62	%	≈0	1.28 / 2.50	0.60 / 1.13	0.65 / 1.22	0.66 / 1.24
- at saturation in air of 23°C / 50% RH	-	%	≈0	2.6	2.4	2.2	2
- at saturation in water of 23°C	-	%	0.01	9	8	6.5	6.3
Thermal Properties (2)							
Melting temperature (DSC, 10°C/min)	ISO 11357-1/-3	°C	135	220	260	215	215
Glass transition temperature (DSC, 20°C/min) - (3)	ISO 11357-1/-2	°C	-	-	-	-	-
Thermal conductivity at 23°C	-	W/(K.m)	0.40	0.28	0.28	0.29	0.28
Coefficient of linear thermal expansion:							
- average value between 23 and 100°C	-	m/(m.K)	200 x 10⁻⁶	105 x 10⁻⁶	95 x 10⁻⁶	90 x 10⁻⁶	90 x 10⁻⁶
- average value between 23 and 150°C	-	m/(m.K)	-	-	-	-	-
- average value above 150°C		m/(m.K)	-	-	-	-	-
Temperature of deflection under load:							
- method A: 1.8 MPa	ISO 75-1/-2	°C	42	70	85	80	75
Max. allowable service temperature in air :							
- for short periods (4)	-	°C	120	160	180	170	165
- continuously : for 20,000 h (5)	-	°C	80	70	80	90	90
Min. service temperature (6)	-	°C	-200	-40	-30	-30	-20
Flammability (7):							
- "Oxygen Index"	ISO 4589-1/-2	%	< 20	25	26	25	-
- according to UL 94 (3 mm thickness) -	-	-	HB	HB	HB	HB	HB
Mechanical Properties at 23°C (8)							
Tension test (9):							
- tensile stress at yield / tensile stress at break (10)	ISO 527-1/-2	MPa	19 / -	80 / -	90 / -	86 / -	72 / -
- tensile strength (10)	ISO 527-1/-2	MPa	> 30	80	93	88	73
- tensile strain at yield (10)	ISO 527-1/-2	%	15	4	5	5	5
- tensile strain at break (10)	ISO 527-1/-2	%	> 50	> 50	50	25	25
- tensile modulus of elasticity (11)	ISO 527-1/-2	MPa	750	3300	3550	3600	3000
Charpy impact strength - unnotched (12)	ISO 179-1/1eU	kJ/m²	no break	no break	no break	no break	50
Charpy impact strength - notched	ISO 179-1/1eA	kJ/m²	110 P	5.5	4.5	3.5	4
Izod impact strength - notched	ISO 180/A	kJ/m²	75 P	5.5	4.5	3.5	4
Ball indentation hardness (13)	ISO 2039-1	N/mm²	33	150	160	165	145
Rockwell hardness (13)	ISO 2039-2	-	-	M 85	M 88	M 88	M 82
Electrical Properties at 23 °C							
Electric strength (14)	IEC 60243-1	kV/mm	45	25	27	25	22
Volume resistivity	IEC 60093	Ohm.cm.	> 10^{14}	> 10^{14}	> 10^{14}	> 10^{14}	> 10^{14}
Surface resistivity	ANSI/ESD STM 11.11	Ohm/sq.	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}
Relative permittivity ε_r: - at 100 Hz	IEC 60250	-	2.1	3.9	3.8	3.6	3.5
- at 1 MHz	IEC 60250	-	3	3.3	3.3	3.2	3.1
Dielectric dissipation factor tan δ: - at 100 Hz	IEC 60250	-	0.0004	0.019	0.013	0.012	0.015
- at 1 MHz	IEC 60250	-	0.0010	0.021	0.020	0.016	0.016
Comparative tracking index (CTI)	IEC 60112	-	600	600	600	600	600

Note: 1 g/cm³ = 1,000 kg/m³ ; 1 MPa = 1 N/mm² ; 1 kV/mm = 1 MV/m. NA: not applicable NYP: there is no yield point

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

(2) The figures given for these properties are for the most part derived from raw material supplier data and other publications.

(3) Values for this property are only given here 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 20,000 hours. After this period of time, there is a decrease in tensile strength - measured at 23°C - 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.

(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 and other publications, are not intended to reflect hazards presented by the materials under actual fire conditions. There are no 'UL File Numbers' available for the Quadrant EPP stock shapes.

(8) Most of the figures given for the mechanical properties are average values of tests run on dry test specimens machined out of rods Ø 40 - 60 mm. Except for the hardness tests, the test specimens were then taken from an area mid between centre and outside diameter, with their length in longitudinal direction of the rod.

(9) Test specimens: Type 1 B

(10) Test speed: 5 or 50 mm/min [chosen acc. to ISO 10350-1 as a function of the ductile behaviour of the material (tough or brittle) ; only ERTALYTE TX, KETRON PEEK-TX and TECHTRON HPV PPS were tested at 5 mm/min].

ERTACETAL® C	ERTACETAL® H	ERTALYTE® (15)	ERTALYTE® TX	PC 1000	KETRON® PEEK-1000	KETRON® PEEK-TX	TECHTRON® HPV PPS	QUADRANT PPSU	PSU 1000	DURATRON® U1000 PEI	SYMALIT® PVDF 1000	FLUOROSINT® 207
natural (white) / colours	natural (white)	natural (white)	pale grey	natural (clear, translucent)	natural (brownish grey) / black	blue	deep blue	black	natural (yellow, translucent)	natural (amber, translucent)	natural (white)	white
1.41	1.43	1.39	1.44	1.20	1.31	1.39	1.42	1.29	1.24	1.27	1.78	2.30
20 / 37	18 / 36	6 / 13	5 / 11	13 / 23	5 / 10	4 / 9	1 / 2	25 / 54	19 / 38	16 / 34	1 / 3	4 / -
0.24 / 0.45	0.21 / 0.43	0.07 / 0.16	0.06 / 0.13	0.18 / 0.33	0.06 / 0.12	0.05 / 0.10	0.01 / 0.02	0.30 / 0.65	0.24 / 0.48	0.19 / 0.40	0.01 / 0.03	0.03 / -
0.20	0.20	0.25	0.23	0.15	0.20	0.18	0.05	0.50	0.30	0.70	0.05	-
0.80	0.80	0.50	0.47	0.40	0.45	0.40	1.10	1.10	0.80	1.30	0.05	2.0
165	180	245	245	NA	340	340	280	NA	NA	NA	175	327
-	-	-	-	150	-	-	-	225	190	220	-	-
0.31	0.31	0.29	0.29	0.21	0.25	0.25	0.30	0.30	0.26	0.24	0.19	-
125 x 10^{-4}	110 x 10^{-4}	80 x 10^{-4}	85 x 10^{-4}	65 x 10^{-4}	50 x 10^{-4}	55 x 10^{-4}	50 x 10^{-4}	55 x 10^{-4}	60 x 10^{-4}	45 x 10^{-4}	130 x 10^{-4}	85 x 10^{-4}
-	-	-	-	-	55 x 10^{-4}	60 x 10^{-4}	60 x 10^{-4}	55 x 10^{-4}	60 x 10^{-4}	45 x 10^{-4}	145 x 10^{-4}	90 x 10^{-4}
-	-	-	-	-	130 x 10^{-4}	140 x 10^{-4}	100 x 10^{-4}	55 x 10^{-4}	-	45 x 10^{-4}	-	155 x 10^{-4}
100	110	80	75	130	160	155	115	205	170	195	105	100
140	150	160	160	135	310	310	260	210	180	200	160	280
100	90	100	100	120	250	250	220	180	150	170	150	260
-50	-50	-20	-20	-50	-50	-20	-20	-50	-50	-50	-50	-50
15	15	25	25	25	35	40	44	38	30	47	44	≥ 95
HB	HB	HB	HB	HB	V-0	V-0	V-0	V-0	HB	V-0	V-0	V-0
66 / -	78 / -	90 / -	76 / -	74 / -	115 / -	90 / -	NYP / 78	83 / -	88 / -	129 / -	60 / -	10 / -
66	78	90	76	74	115	90	78	83	88	129	60	10
20	40	4	4	6	5	6	NYP	8	5	7	9	4
50	50	15	5	> 50	17	8	3.5	> 50	10	13	30	50
2800	3300	3500	3300	2400	4300	3750	4000	2450	2850	3500	2200	1800
150	200	50	30	no break	no break	30	25	no break	180	105	150	50
7	10	2	2.5	9	3.5	3.5	4	12	3.5	3.5	10	8
7	10	2	2.5	9	4	3.5	4	12.5	4	4.5	9	7
140	160	170	160	120	190	165	160	95	115	165	110	45
M 84	M 88	M 96	M 94	M 75	M 105	M 93	M 82	M 90	M 89	M 115	M 78	R 50
20	20	22	21	28	24	22	24	26	30	27	18	8
> 10^{14}	< 10^{15}	> 10^{14}	> 10^{14}	> 10^{14}	> 10^{14}	> 10^{14}	> 10^{14}	> 10^{14}	> 10^{14}	> 10^{15}	> 10^{14}	> 10^{13}
> 10^{13}	< 10^{15}	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}
3.8	3.8	3.4	3.4	3	3.2	3.2	3.3	3.4	3.0	3.0	7.4	-
3.8	3.8	3.2	3.2	3	3.2	3.2	3.3	3.5	3.0	3.0	6.0	2.65
0.003	0.003	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.001	0.002	0.025	-
0.008	0.008	0.014	0.014	0.008	0.002	0.002	0.003	0.005	0.003	0.002	0.165	0.008
600	600	600	600	350 (225)	150	150	100	-	150	175	600	-

(11) Test speed: 1 mm/min

(12) Pendulum used: 15 J

(13) Measured on 10 mm thick test specimens (discs), mid between centre and outside diameter.

(14) Electrode configuration: Ø 25 / Ø 75 mm coaxial cylinders ; in transformer oil according to IEC 60296 ; 1 mm thick test specimens. Please note that the electric strength of black material (ERTACETAL C, KETRON PEEK-1000 and QUADRANT PPSU) can be considerably lower than the figure listed in the table which refers to natural material. Possible microporosity in the centre of polyacetal stock shapes also significantly reduces the electric strength.

(15) The property-values given below do not apply to the 2 - 6 mm thick ERTALYTE sheets.

Our product that can withstand different cleaning and sanitising procedures such as CIP (Clean-In-Place), COP (Clean-Out-of-Place), and SIP (Sterilisation-in-Place). The choice of the most suitable plastics material depends on available chemical resistance data and practical experience, but often preliminary testing of the finished plastics part under actual service conditions (right chemical, concentration, temperature and contact time, as well as loading conditions) is required to assess its final suitability for the given application.

CHEMICAL RESISTANCE CARD

CHEMICALS	Concentration (%)	Temperature (°C)	QUADRANT EPP MATERIALS												
			ERTALON® / NYLATRON® (PA)	ERTACETAL® C (POM-C)	ERTACETAL® H (POM-H)	ERTALYTE® (PET)	PC 1000	TIVAR® 1000 (PE-UHMW)	KETRON® PEEK	TECHTRON® HPV PPS	QUADRANT PPSU	DURATRON® U1000 PEI	PSU 1000	SYMALIT® PVDF (**)	FLUOROSINT® (PTFE)
Hydrogen peroxide	1	RT	C	A	A	A	A	A	A	A	A	A	A	A	A
Nitric acid	1	RT	B	C	C	A	A	A	A	A	A	A	A	A	A
Nitric acid	5	80	C	C	C	C	C	B	B	B	A	B	A	A	A
Phosphoric acid	1	RT	B	B	B	A	A	A	A	A	A	A	A	A	A
Phosphoric acid	5	80	C	C	C	B	C	B	A	A	A	A	A	A	A
Sodium hydroxide	1	RT	A	A	B	A	B	A	A	A	A	A	A	A	A
Sodium hydroxide	5	80	C	A	C	C	C	B	A	A	A	B	A	C	A
Sodium hypochlorite (300 ppm active chlorine)		20	B	B	B	A	A	A	A	A	A	A	A	A	A
Steam sterilisation (single autoclaving)	UD	134	A	A	A	A	A(*)	NA	A	A	A	A	A	A	A
Steam sterilisation (repeated autoclaving) (***)	UD	134	C	C	C	C	C	NA	A	A	A	A	A	A	A
Sulphuric acid	1	RT	B	A	C	A	A	A	A	A	A	A	A	A	A
Sulphuric acid	3	60	C	C	C	A	A	A	B	A	A	A	A	A	A
Water	UD	60	A	A	A	A	A	A	A	A	A	A	A	A	A
Water	UD	80	B	A	B	B	B	B	A	A	A	A	A	AA	A
Water	UD	95	C	B	C	C	C	C	A	B	A	A	A	A	A

QUADRANT

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Legend to the table

(*) : for this material, the max. sterilisation temperature is limited to 121°C.

(**) : it has to be pointed out that stress cracking can occur on SYMALIT PVDF 1000 parts when simultaneously exposed to mechanical stress and to an environment with pH ≥12, or when operating in a medium which is likely to generate atomic chlorine.

(***) : considering the different inherent properties of these plastics, the influence of design of the plastic parts, cycle times and chemical environment (boiler feed water additives, etc.), the allowable number of sterilisation cycles is to be determined by the user under practical operating conditions.

Resistance ratings:

A : Resistant. Little or no change in weight. Small effect on mechanical properties. In general acceptable service life.

B : Partially resistant. In course of time, there is a distinct deterioration in mechanical properties and a change in weight. In many cases a short term exposure or limited number of cleaning cycles may be considered allowable (to be evaluated by practical testing).

C : Non-resistant. After a short time, the material is seriously affected (considerable reduction of the mechanical strength and changes in weight). Using the material under these conditions is not recommended.

NA : Not applicable for this material.

Concentration (%):

A number, e.g. 5, indicates "5 g of solute per 100 g of aqueous solution" (5 % by weight).

UD : Undiluted (technically pure chemical)

Temperature (°C):

RT : Room temperature (15 – 25°C)

Note: The ratings given in the table above - derived from raw material supplier data, literature related to the chemical resistance of plastics, and own experience - are intended as a guide only and refer to unstressed parts. It has to be pointed out that particularly the amorphous thermoplastics (PC, PSU, PEI and PPSU) are sensitive to "stress cracking", meaning that environments which are completely harmless to unstressed parts, may cause stress cracking when in contact with stressed parts.