

## Product and Application Guide



**General and Advanced Engineering Plastics**



QUADRANT

You inspire ... we materialize®

# You inspire ... we materialize



## Quadrant history:

The first engineering polymer shapes for machining.



## Quadrant today:

The broadest range of engineering polymer shapes allowing the most effective material choice.



## Quadrant tomorrow:

New products for new needs, developed by QEPP's global product and application development team.



For over 60 years, the companies that today form Quadrant have been developing new materials to meet changing demands of customers around the world. The innovative, collaborative spirit between our people and our customers has shaped our success and led to the industry's broadest range of engineering plastic shapes for machining. Our investment in innovation will only increase in the years ahead, to support your requirements for higher levels of performance, productivity and value.

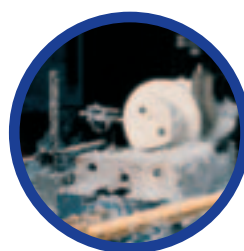


## Quadrant Engineering Plastics - Global Scope



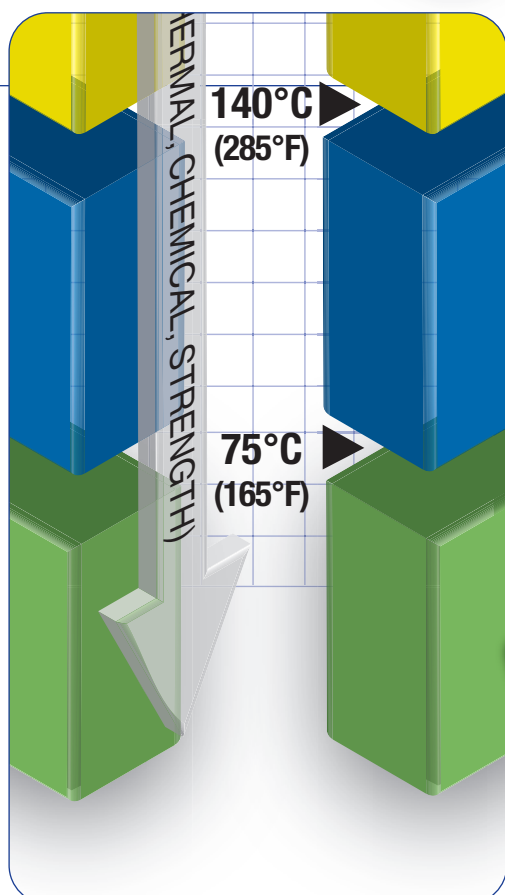
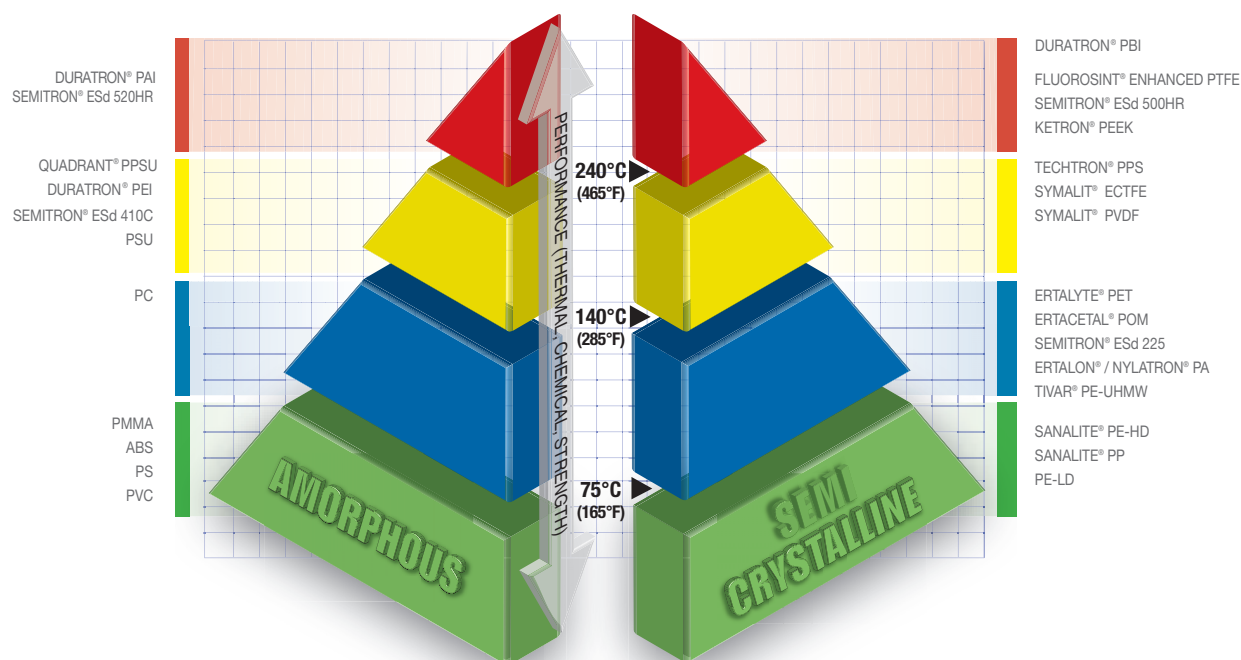
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# General Engineering Plastics

The materials performance pyramid ranks the most common thermoplastics according to their temperature performance. Amongst these materials, different “families” can be recognised, all exhibiting high value in use within numerous applications.



Semi-crystalline ERTALON® / NYLATRON® materials offer a high toughness, a low coefficient of friction and a good wear resistance. These properties make them ideal replacements for a wide variety of materials from metal to rubber.

ERTACETAL® provides high mechanical strength and stiffness coupled with enhanced dimensional stability. As a semi-crystalline material, ERTACETAL® is characterised by a low coefficient of friction and good wear properties.

Unreinforced, semi-crystalline ERTALYTE® offers a very good dimensional stability in combination with excellent wear resistance, a low coefficient of friction, high strength and resistance to moderate acidic solutions.

# ERTALON®/NYLATRON® POLYAMIDE (PA)

Within the polyamides, commonly referred to as “nylons”, we distinguish different types. The most important ones are: PA 6, PA 66, PA 11 and PA 12. The differences in physical properties which exist between these types are mainly determined by the composition and the structure of their molecular chains.

**Challenges:** Special wine-grape harvesting machines shake the grapes from the vines. The grapes fall down and are collected in baskets fixed to a rotating chain which transports them to a large container at the back of the machine.

**Solution:** Plastic shaking rods made from ERTALON 66 SA are used to remove the grapes from the vines.

**Benefits:** ERTALON 66 SA is kind towards the grapevines. It offers excellent fatigue resistance combined with high mechanical strength and excellent wear and abrasion resistance.

shaking rods



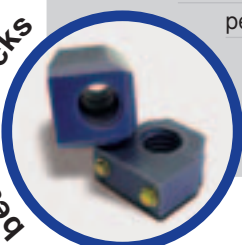
< wine-grape harvester

**Challenges:** Trailers that deliver new automobiles to dealerships carry significant loads. The drive mechanism that raises/lowers the expensive cargo needed costly and frequent lubrication and regular repair.

**Solution:** Easily machined parts made from the extreme wear resistant NYLATRON 703 XL.

**Benefits:** NYLATRON 703 XL excels in critical applications with the added benefit of “stick-slip” free performance, eliminating chatter and the subsequent loss of precise control.

bearing blocks



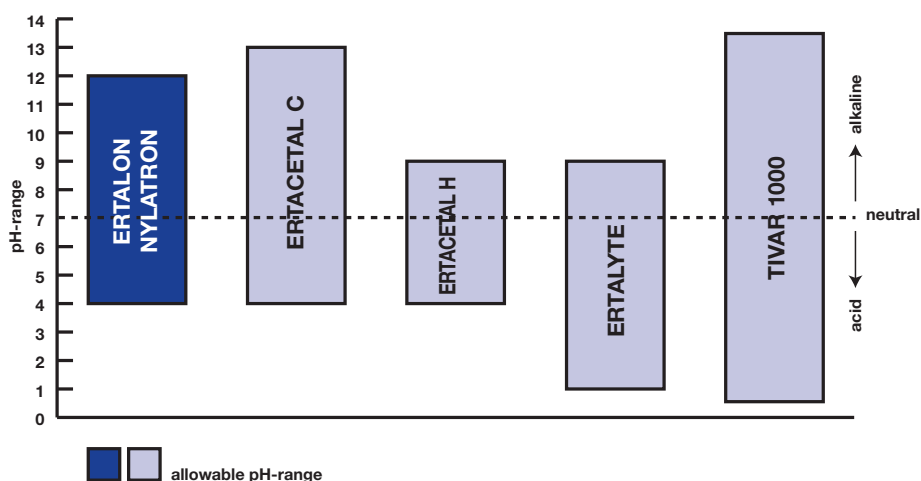
## MAIN CHARACTERISTICS

- High mechanical strength, stiffness, hardness and toughness
- Good fatigue resistance
- High mechanical damping ability
- Good sliding properties
- Excellent wear resistance
- Good electrical insulating properties
- Good resistance to high energy radiation (gamma- and X-rays)
- Good machinability

## APPLICATIONS

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, star wheels, cutting and chopping boards, insulators, ....

Fig. 1 CHEMICAL RESISTANCE AT 23°C



# Extruded grades

ERTALON® / NYLATRON®

\*natural (white)  
black  
\*blue

## ERTALON 6 SA

(PA 6)

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

\*natural (cream)  
black

## ERTALON 66 SA

(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 is reduced. Well suited for machining on automatic lathes.

Please note that the ERTALON 66 SA natural rods over dia. 150 mm are made from a modified polyamide 66 resin (see the property values given on page 14 under ERTALON 66 SA-C).

reddish brown

## ERTALON 4.6

(PA 4.6)

Compared with conventional nylons, ERTALON 4.6 features a better retention of stiffness and creep resistance over a wide range of temperatures as well as 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 PET fall short.

grey-black

## ERTALON 66-GF30

(PA 66-GF30)

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

grey-black

## NYLATRON GS

(PA 66 + MoS<sub>2</sub>)

The addition of MoS<sub>2</sub> 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.



**TECH NOTES:** Nylons can absorb up to 9% by weight of water under high humidity or submerged in water. This results in dimensional changes and a corresponding reduction of physical properties. Proper design techniques can frequently compensate for this factor.

gears



**Challenges:** Metal gears create noise, wear mating parts and require lubrication.

**Solution:** Gears machined from ERTALON / NYLATRON nylons can solve these problems.

**Benefits:** ERTALON / NYLATRON gears can reduce noise, eliminate the need for lubrication and act as a sacrificial link in a system, thus saving destruction of other costly components.

insulating washers



**Challenges:** In electrical switch-cupboards the temperature can rise up to 100°C.

To protect the box against short-circuit, plastic washers are required. At higher temperatures, however, unreinforced plastics become more sensitive to creep.

**Solution:** In order to minimise creep, the insulating washers are made of ERTALON 66-GF30 which, due to its glass fibre reinforcement, loses less of its stiffness and creep resistance at elevated temperatures.

**Benefits:** Good retention of mechanical properties at elevated temperatures in combination with good electrical insulating properties.



# Cast grades

ERTALON® / NYLATRON®

**Challenges:** In this chicken processing line, the cutting tools move up and down driven by rollers moving in the slots of a cam drum. These tools are used for cutting the chicken into pieces.

**Solution:** ERTALON 6 PLA was selected, due to its excellent wear resistance and its food contact compliant composition. Cast PA 6 is the only material available in the sizes requested for the drums.

**Benefits:** Noise dampening, good impact resistance, availability of larger sizes – these are the key benefits of ERTALON 6 PLA in this application.

curve drum



**Challenges:** In aerial platforms, scissors are used as principle for lifting the platform, the end beams of the scissors must allow a safe and smooth movement in the guiding rail.

**Solution:** For the sliding blocks, strong and extreme wear resistant NYLATRON NSM has been chosen.

**Benefits:** The self-lubricating NYLATRON NSM provides higher wear resistance and lower friction. The internal lubricants help to prevent a jerky or intermittent motion known as stick-slip.

< aerial platforms

sliding blocks



## ERTALON 6 PLA

(PA 6)

Unmodified cast nylon 6 grade exhibiting characteristics which come very close to those of ERTALON 66 SA. It combines high strength, stiffness and hardness with good creep and wear resistance, heat ageing properties and machinability.

natural (ivory)\*  
black  
blue\*

## ERTALON 6 XAU+

(PA 6)

ERTALON 6 XAU+ is a heat stabilised cast nylon grade with a very dense and highly crystalline structure. Compared with conventional extruded or cast nylons, ERTALON 6 XAU+ offers superior heat ageing performance in air (much better resistance to thermal-oxidative degradation), allowing 15-30°C higher continuously allowable service temperatures. ERTALON 6 XAU+ is particularly recommended for bearings and other mechanical parts subject to wear which are operating in air for long periods of time at temperatures over 60°C.

black

## ERTALON LFX

(PA 6 + oil)

This internally lubricated cast nylon 6 is self-lubricating in the real meaning of the word. ERTALON LFX, especially developed for unlubricated, highly loaded and slow moving parts applications, yields a considerable enlargement of the application opportunities compared to standard cast nylons. It offers a reduced coefficient of friction (up to 50% lower), considerably increasing the pressure-velocity capabilities, and a vastly improved wear resistance (up to 10 times better).

green

## NYLATRON MC 901

(PA 6)

This modified cast nylon 6 grade with its distinctive blue colour exhibits higher toughness, flexibility and fatigue resistance than ERTALON 6 PLA. It has proved to be an excellent material for gear wheels, racks and pinions.

blue

## NYLATRON GSM

(PA 6 + MoS<sub>2</sub>)

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.

grey-black

## NYLATRON NSM

(PA 6 + solid lubricants)

NYLATRON NSM is a proprietary cast nylon 6 formulation containing solid lubricant additives which grant this material self-lubricity, excellent frictional behaviour, superior wear resistance and outstanding pressure-velocity capabilities (up to 5 times higher than conventional cast nylons). Being particularly suited for higher velocity, unlubricated moving parts applications, it is the perfect complement to the oil-filled grade ERTALON LFX.

grey

## NYLATRON LFG

(PA 6 + oil)

NYLATRON LFG (Lubricated Food Grade) is self-lubricating in the real meaning of the word, and has a FDA food contact compliant composition. The NYLATRON LFG has been specially developed for non-lubricated, highly loaded and slowly moving parts in food contact applications. Compared to standard cast nylons, it offers lower maintenance costs and longer service life.

natural (ivory)  
blue

## NYLATRON 703 XL

(PA 6 + internal lubricants)

This high performance cast nylon 6 bearing grade provides an even better wear resistance than NYLATRON NSM, combined with superior pressure-velocity capabilities and an industry first: a near zero level of "stick-slip". The elimination of stick-slip, mostly associated with chatter or squeaking, provides an extraordinary amount of motion control for high-precision applications.

purple

Quadrant Engineering Plastic Products offers both homopolymer and copolymer grades of ERTACETAL including an enhanced bearing grade material.

## MAIN CHARACTERISTICS

- High mechanical strength, stiffness and hardness
- Excellent resilience
- Good creep resistance
- High impact strength, even at low temperatures
- Very good dimensional stability (low water absorption)
- Good sliding properties and wear resistance
- Excellent machinability
- Good electrical insulating and dielectric properties
- Physiologically inert (most grades are suitable for food contact)
- Not self-extinguishing

## APPLICATIONS

Gear wheels with small modulus, cams, heavily loaded bearings and rollers, bearings and gears with small clearances, valve seats, snapfit assemblies, dimensionally stable precision parts, electrically insulating components.

rollers



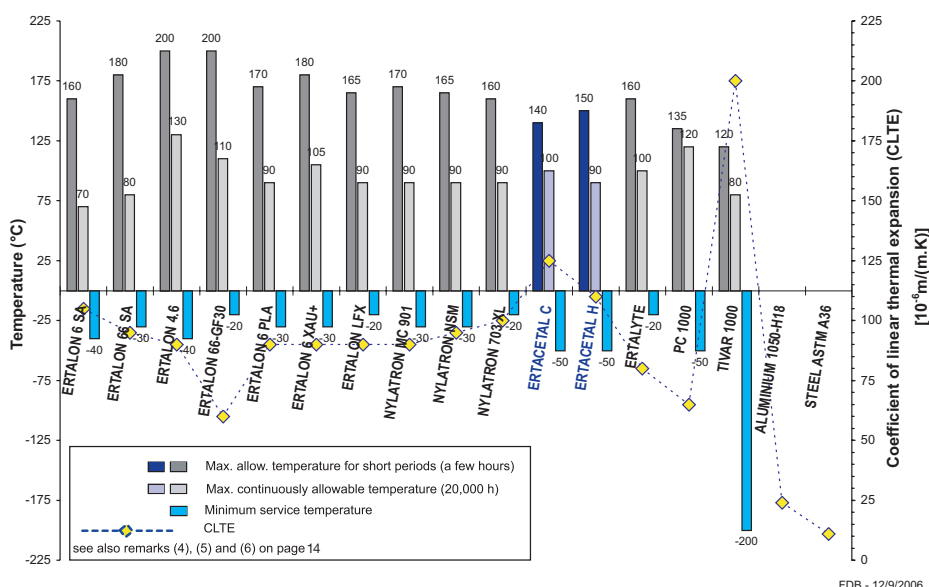
**Challenges:** Metal rollers in cargo truck lifts were being damaged in use.

**Solution:** Impact resistant ERTACETAL C rollers absorb collisions with loading docks without deforming and causing the system to fail.

**Benefits:** Reduced weight and an ability to bounce back made the dimensionally stable ERTACETAL C rollers a better choice than other materials.

**Fig. 2 MINIMUM AND MAXIMUM SERVICE TEMPERATURE IN AIR & COEFFICIENT OF LINEAR THERMAL EXPANSION**

(average value between 23°C and 100°C)



FDB - 12/9/2006

scraper blades



**Challenges:** Dairy nickel and stainless blades were costly and expensive to fabricate.

**Solution:** ERTACETAL C (porosity free POM-C) plate is machined into scraper blades used in commercial ice cream manufacturing equipment.

**Benefits:** The blades are easily cleaned and do not entrap dirt or bacteria. The low internal stress level of ERTACETAL C means parts that are machined flat, stay flat.



**TECH NOTES:** When it comes to outdoor applications, ERTACETAL is not recommended because of its poor UV-resistance.



# Grades

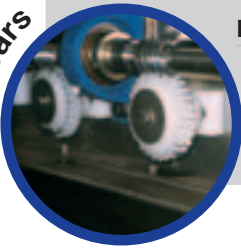
ERTACETAL®

**Challenges:** Vegetables are placed on a metal grid that advances through a freeze tunnel. This grid is supported and driven by stainless steel sprockets which are mounted on metal shafts. On one side of the tunnel, these shafts are driven by a worm - worm wheel combination.

**Solution:** The worm wheels are made of ERTACETAL C because of its high impact strength at -40°C and also its fatigue resistance.

**Benefits:** Lower overall cost and increased productivity because of less downtime.

worm gears



## ERTACETAL C

(POM-C)

ERTACETAL C is Quadrant's copolymer acetal grade. Next to the standard natural grade, there is also a series of special colours available all showing an FDA food contact compliant composition.

The acetal copolymer is more resistant against hydrolysis, strong alkalis and thermal-oxidative degradation than the acetal homopolymer.

natural (white)\*  
black  
colours\*

## ERTACETAL H

(POM-H)

ERTACETAL H is Quadrant's homopolymer acetal grade. It offers a higher mechanical strength, stiffness, hardness and creep resistance as well as a lower thermal expansion rate and often also a better wear resistance than the acetal copolymer.

natural (white)\*  
black

## ERTACETAL H-TF

(POM-H + PTFE)

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 change 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.

deep brown

Within its portfolio of Life Science Grade Engineering Plastic Products – specifically developed for applications in the medical, pharmaceutical and biotechnology industries – Quadrant offers **ACETRON® LSG** biocompatible engineering plastic POM-C stock shapes for machining with certified ISO 10993 compliance (see also page 32).



### Food Compliant ERTACETAL C Colours

Yellow 10

Orange 20

Red 30

Blue 50

Green 60

Grey 70

Brown 80

Black 90

Table 1: FOOD CONTACT COMPLIANCE STATUS (1)

QUADRANT GEP STOCK SHAPES	BASE POLYMERS	EUROPEAN UNION Directive 2002/72/EC	GERMANY BfR	USA FDA Code of Federal Regulations (21 CFR)
ERTALON® 6 SA natural & blue	Polyamide 6	+	+	+
ERTALON® 66 SA natural	Polyamide 66	+	+	+
ERTALON® 6 SA & 66 SA black	Polyamide 6 & 66	-	-	-
ERTALON® 4.6	Polyamide 46	-	-	-
ERTALON® 66-GF30	Polyamide 66	-	-	-
NYLATRON® GS	Polyamide 66	+	+	-
ERTALON® 6 PLA natural & blue	Polyamide 6	+	+	+
NYLATRON® LFG natural & blue	Polyamide 6	-	+	+
other cast nylon grades	Polyamide 6	-	-	-
ERTACETAL® C natural (*)	Polyacetal Copolymer	+	+	+
ERTACETAL® C black	Polyacetal Copolymer	+/-	+/-	+/-
ERTACETAL® C Blue 50 & Black 90	Polyacetal Copolymer	+	+	+
ERTACETAL® C other colours	Polyacetal Copolymer	-	-	+
ERTACETAL® H natural	Polyacetal	+	+	+
ERTACETAL® H black & H-TF	Homopolymer	-	-	-
ERTALYTE® natural (*)	Polyethylene terephthalate	+	+	+
ERTALYTE® black	Polyethylene terephthalate	-	-	-
ERTALYTE® TX	Polyethylene terephthalate	+	+	+
PC 1000 natural	Polycarbonate	+	+	+

(1) This table gives the compliance of the raw materials used for the manufacture of the Quadrant EPP Stock Shapes with respect to their composition as set out in the regulations that apply in the Member States of the European Union (Directive 2002/72/EC, as amended), in Germany (BfR) and in the United States of America (FDA) for plastic materials and articles intended to come into contact with foodstuffs.

+: complies with the requirements of the regulations

-: does not comply with the requirements of the regulations

+/-: compliance depends on the shape (rod, plate or tube) and has to be examined on an individual basis

(\*) : 3-A Dairy compliant

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

# ERTALYTE® POLYETHYLENE TEREPHTHALATE (PET)

Quadrant Engineering Plastic Products' stock shapes made of crystalline thermoplastic polyester, are marketed under the trade names ERTALYTE (virgin grade) and ERTALYTE TX (bearing grade).

## MAIN CHARACTERISTICS

- High mechanical strength, stiffness and hardness
- Very good creep resistance
- Low and constant coefficient of friction
- Excellent wear resistance (comparable with or even better than nylon grades)
- Very good dimensional stability (better than polyacetal)
- Excellent stain resistance
- Better resistance to acids than nylon or polyacetal
- Good electrical insulating properties
- Physiologically inert (suitable for food contact)
- Good resistance to high energy radiation (gamma and X-rays)

## 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, ...

square piston



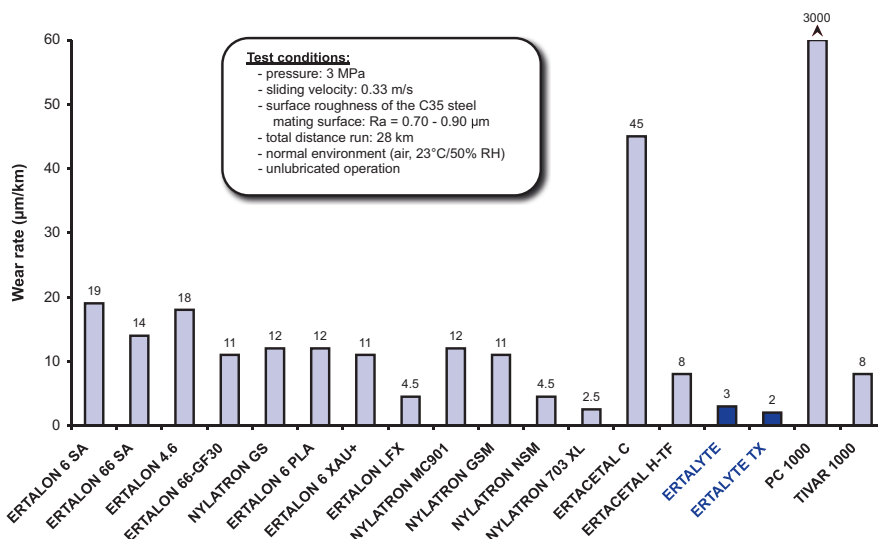
**Challenges:** The dough in a volumetric dosing machine is pressed into 6 small dosing chambers. In each chamber a plastics piston is moving back and forth, pushing out the right portion of dough.

**Solution:** ERTALYTE TX was selected because of its excellent wear resistance, sliding and release properties, dimensional stability (no jamming of the piston) and its food contact compliant composition.

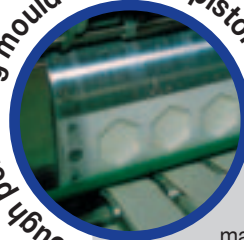
**Benefits:** Maintenance and design cost reductions, no corrosion problems like aluminium, food contact compliance, hygiene and safety performance along with considerable weight reduction.

**Fig. 3 WEAR RESISTANCE**

measured on a "plastics pin on rotating steel disk" - tribo system



dough portioning mould & ejector pistons



**Challenges:** In a bakery machine, the dough is pressed into a rotating shaping mould and the different shaped portions are then pushed out onto a conveyor belt by means of pistons.

**Solution:** ERTALYTE offering good machinability and a food contact compliant composition was selected for the manufacture of the portioning mould and the ejector pistons.

**Benefits:** Besides its excellent wear resistance assuring a constant weight of the dough portions, ERTALYTE shows good release properties, and high dimensional stability (hardly any moisture absorption).

# Grades

ERTALYTE®

**Challenges:** Guides to function as a type of cam producing a sinusoidal up and down movement of a punch at a speed of 2.7 m/s. The function occurs while the tablet pressing carousel is rotating, so complex machining was required to obtain the necessary geometry.

**Solution:** ERTALYTE TX for the parts that form the complete circle. The material has a low coefficient of friction, exceptional wear resistance and very good machinability.

**Benefits:** Low wear and lubrication free solution, ideal for a clean production environment.

punch guide



< rotary tablet press

## ERTALYTE

(PET)

natural (white)\*

black

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

## ERTALYTE TX

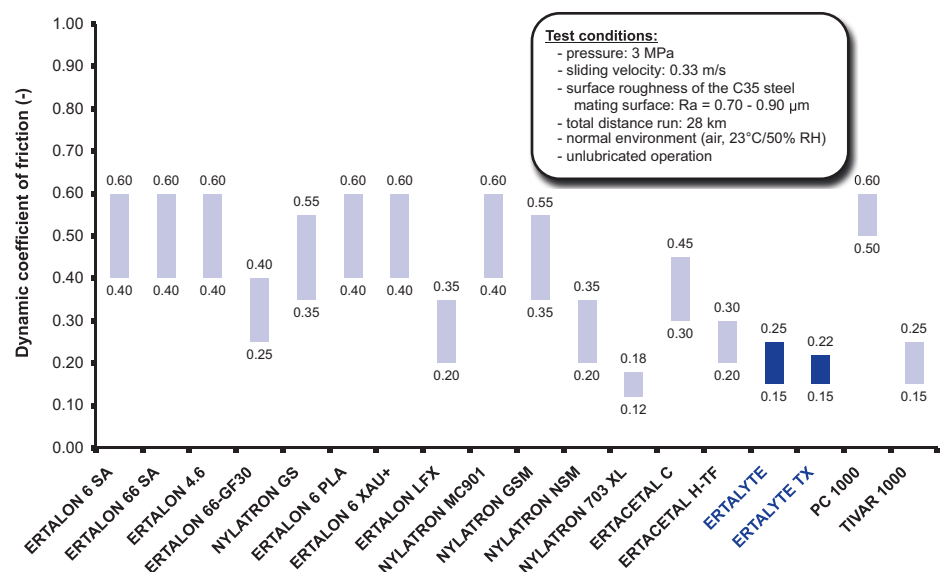
(PET + solid lubricant)

pale grey

ERTALYTE TX is a polyethylene terephthalate compound incorporating a uniformly dispersed solid lubricant. Its specific formulation makes it a premium internally lubricated bearing-grade. ERTALYTE TX not only has an outstanding wear resistance, but offers in comparison with ERTALYTE an even lower coefficient of friction as well as higher pressure-velocity capabilities.

## Fig. 4 DYNAMIC COEFFICIENT OF FRICTION

measured on a "plastics pin on rotating steel disk" - tribo system

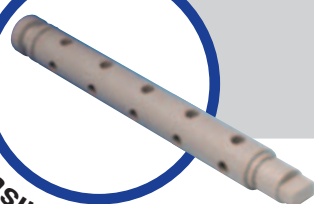


**Challenges:** High process unit temperatures warped portioning unit components. Additional cooling equipment was required to package hot products.

**Solution:** Quadrant EPP offered ERTALYTE TX for moderate temperature packaging.

**Benefits:** ERTALYTE TX's dimensional stability and wear resistance drastically improved part life.

distribution valves



**TECH NOTES:** Since ERTALYTE tends to be rather notch and impact sensitive, all "internal" corners should be radiused ( $R > 1$  mm) and to avoid chipping the edges during turning, boring or milling, chamfered edges are advantageous, providing a smoother transition between the cutting tool and the plastics work.

# PC 1000 POLYCARBONATE (PC)



Quadrant Engineering Plastic Products is marketing non-UV-stabilised polycarbonate stock shapes under the trade name PC 1000. It is a natural, “non-optical” industrial quality (clear, translucent).

## 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 (very low water absorption and low CLTE)
- Natural colour (clear, translucent)
- Good electrical insulating and dielectric properties
- Physiologically inert (suitable for food contact)

## APPLICATIONS

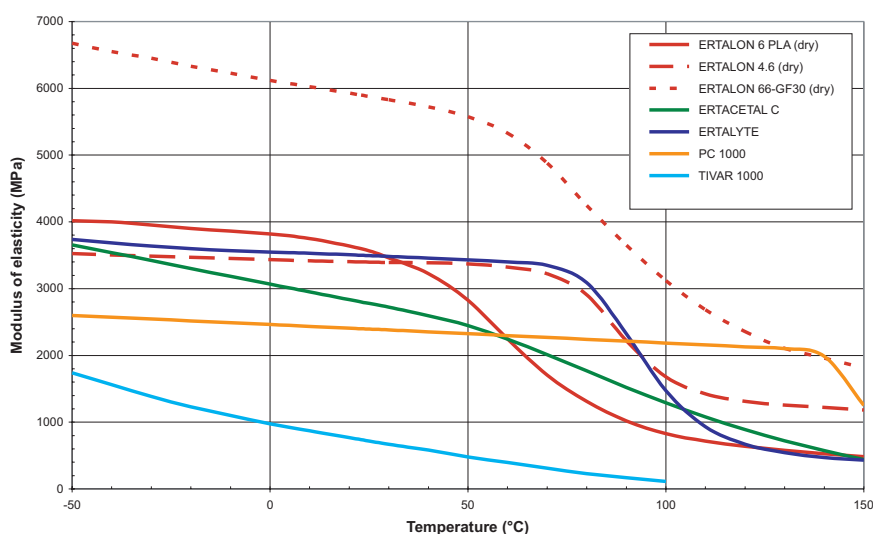
Components for precision engineering, safety glazing, insulating parts for electrical engineering, parts in contact with foodstuffs, components for medical and pharmaceutical devices, ....

Within its portfolio of Life Science Grade Engineering Plastic Products – specifically developed for applications in the medical, pharmaceutical and biotechnology industries – Quadrant offers **PC LSG natural** biocompatible engineering plastic stock shapes for machining with certified USP Class VI and ISO 10993 compliance (see also page 32).



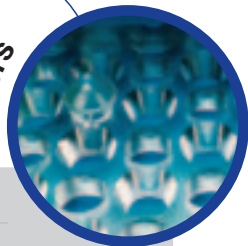
**Fig. 5 STIFFNESS VERSUS TEMPERATURE**

derived from DMA-curves



**TECH NOTES:** PC 1000 stock shapes show an “as extruded” surface which is not optically clear. Finished parts can be both mechanically and vapour polished to improve optical clarity. Caution: during machining, do not use water-soluble coolants but preferably pure water or compressed air.

holders

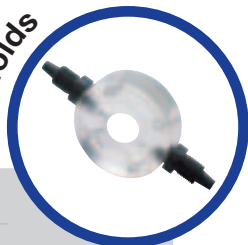


**Challenges:** During the light bulb etching process with hydrofluoric acid (to produce white bulbs), the bulbs are placed in holders.

**Solution:** Due to its good resistance to hydrofluoric acid, PC 1000 has been chosen for this application.

**Benefits:** PC 1000 combines high dimensional stability and low level of internal stress with a high temperature resistance.

manifolds



**Challenges:** Many industries using acrylic parts need transparent manifolds and sight glasses that can withstand higher temperatures and impact.

**Solution:** PC 1000 is easily machined into these parts and meets the higher performance needs.

**Benefits:** PC 1000 has far higher temperature resistance than acrylic and offers greater impact resistance.

# Production Capabilities / Custom Casting

Quadrant EPP's wide range of manufacturing technologies enables it to produce cost-effective parts and components large and small. All are available with complete batch traceability and documentation in line with relevant ISO standards.

## Custom Casting

Custom casting is often more economical than machining or injection moulding, particularly for small or medium quantity production runs of parts that are too large or too costly to injection mould. It can eliminate or reduce certain machining operations, reduce scrap and cycle times, and it can also produce parts of virtually unlimited size and thickness. Our mission is to provide the highest quality, economical products - from a single prototype to thousands of production pieces.

## Atmospheric Pressure Casting (APC)

APC can manufacture plastic parts without externally applied pressure and is useful for low-to-medium volume runs or for parts that have intricate design details. Tooling cost is significantly lower than injection moulding tools. Economical production runs can be as small as 1 (ONE!) piece only. Cast weight up to 800 kg is possible.

## Low Pressure Casting (LPC)

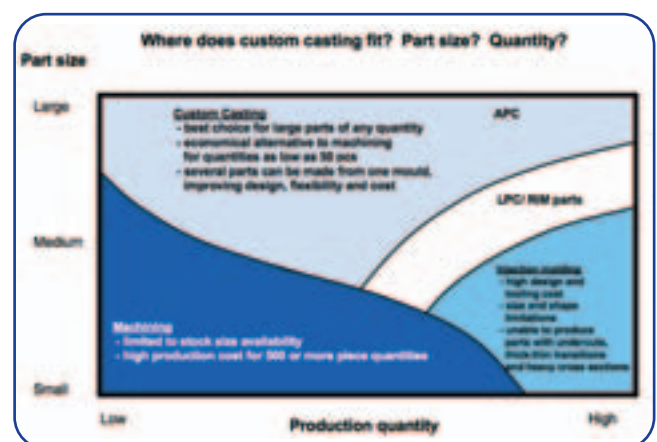
LPC technology bridges the gap between machining and injection moulding for medium to high series eliminating wall thickness limitations and enabling production series of a few hundred to several thousands parts per year. LPC's lower processing and injection pressures also enable the use of aluminium tools rather than hardened steel. Generally, tool cost can be significantly lower than for injection-moulding tools.

## Reaction Injection Moulding (RIM)

RIM is a casting technology that applies low pressure to mix specific additives with the base material. It shows very specific properties after "injection" in the mould and the polymerisation of the material. Metal inserts can be integrated into the moulding component in one operation.

## Benefits of Quadrant's unique production capabilities:

- eliminates / minimises machining
- reduces scrap and cycle time
- custom shaped, blanks near-net and cast-to-size parts
- minimises flow-induced stress
- permits larger cross-sections than alternative means
- offers very high dimensional stability over time
- economical, even with single-piece production
- part weight to 800 kg feasible
- removes wall thickness limitations
- suitable for runs from a few hundred to several thousands
- process parameters allow aluminium tooling
- ideal for pilot and evaluation runs
- well suited for highly-advanced materials and applications
- specially capable of incorporating inserts, multi-material designs
- full range of material options based on cast PA 6
- flexible options for dimensions and finishes





# General Engineering Plastic Stock Shapes

PROPERTIES	Test methods	Units	ERTALON 6 SA	ERTALON 66 SA	ERTALON 66 SA-C	ERTALON 4.6	ERTALON 66-GF30	NYLATRON GS
Colour	-	-	natural (white)/ black	natural (cream)/ black	natural (white)	reddish brown	black	grey-black
Density	ISO 1183-1	g/cm <sup>3</sup>	1.14	1.14	1.14	1.18	1.29	1.15
Water absorption:								
- after 24/96 h immersion in water of 23°C (1)	ISO 62	mg	86/168	40/76	65/120	90/180	30/56	46/85
	ISO 62	%	1.28/2.50	0.60/1.13	0.97/1.79	1.30/2.60	0.39/0.74	0.68/1.25
- at saturation in air of 23°C / 50% RH	-	%	2.6	2.4	2.5	2.8	1.7	2.3
- at saturation in water of 23°C	-	%	9	8	8.5	9.5	5.5	7.8
<b>Thermal Properties (2)</b>								
Melting temperature (DSC, 10°C/min)	ISO 11357-1/-3	°C	220	260	240	290	260	260
Glass transition temperature (DSC, 20°C/min) - (3)	ISO 11357-1/-2	°C	-	-	-	-	-	-
Thermal conductivity at 23°C	-	W/(K.m)	0.28	0.28	0.28	0.30	0.30	0.29
Coefficient of linear thermal expansion:								
- average value between 23 and 60°C	-	m/(m.K)	90 x 10 <sup>-6</sup>	80 x 10 <sup>-6</sup>	85 x 10 <sup>-6</sup>	80 x 10 <sup>-6</sup>	50 x 10 <sup>-6</sup>	80 x 10 <sup>-6</sup>
- average value between 23 and 100°C	-	m/(m.K)	105 x 10 <sup>-6</sup>	95 x 10 <sup>-6</sup>	100 x 10 <sup>-6</sup>	90 x 10 <sup>-6</sup>	60 x 10 <sup>-6</sup>	90 x 10 <sup>-6</sup>
Temperature of deflection under load:								
- method A: 1.8 MPa	ISO 75-1/-2	°C	70	85	75	160	150	85
Max. allowable service temperature in air :								
- for short periods (4)	-	°C	160	180	170	200	200	180
- continuously : for 5,000 / 20,000 h (5)	-	°C	85/70	95/80	90/75	155/135	120/110	95/80
Min. service temperature (6)	-	°C	-40	-30	-30	-40	-20	-20
Flammability (7):								
- "Oxygen Index"	ISO 4589-1/-2	%	25	26	24	24	-	26
- according to UL 94 (3 / 6 mm thickness)	-	-	HB / HB	HB / V-2	HB / HB	HB / HB	HB / HB	HB / HB
<b>Mechanical Properties at 23°C (8)</b>								
Tension test (9):								
- tensile stress at yield / tensile stress at break (10)	ISO 527-1/-2	MPa	80 / -	90 / -	86 / -	105 / -	NA / 100	93 / -
	ISO 527-1/-2	MPa	45 / -	55 / -	50 / -	55 / -	NA / 75	55 / -
- tensile strength (10)	ISO 527-1/-2	MPa	80	93	86	105	100	95
- tensile strain at yield (10)	ISO 527-1/-2	%	4	5	5	18	NA	5
- tensile strain at break (10)	ISO 527-1/-2	%	> 50	50	> 50	25	5	20
	ISO 527-1/-2	%	> 100	> 100	> 100	> 100	12	> 50
- tensile modulus of elasticity (11)	ISO 527-1/-2	MPa	3300	3550	3350	3400	5900	3600
	ISO 527-1/-2	MPa	1425	1700	1475	1350	3200	1725
Compression test (12):								
- compressive stress at 1 / 2 / 5 % nominal strain (11)	ISO 604	MPa	24 / 46 / 80	25 / 49 / 92	24 / 47 / 88	23 / 45 / 94	28 / 55 / 90	25 / 49 / 92
Creep test in tension (9):								
- stress to produce 1% strain in 1000 h ( $\sigma_{1/1000}$ )	ISO 899-1	MPa	18	20	19	22	26	21
	ISO 899-1	MPa	7	8	7.5	7.5	18	9
Charpy impact strength - unnotched (13)	ISO 179-1/1eU	kJ/m <sup>2</sup>	no break	no break	no break	no break	50	no break
Charpy impact strength - notched	ISO 179-1/1eA	kJ/m <sup>2</sup>	5.5	4.5	5	8	6	4
Izod impact strength - notched	ISO 180/A	kJ/m <sup>2</sup>	5.5	4.5	5	8	6	4
	ISO 180/A	kJ/m <sup>2</sup>	15	11	13	25	11	9
Ball indentation hardness (14)	ISO 2039-1	N/mm <sup>2</sup>	150	160	155	165	165	165
Rockwell hardness (14)	ISO 2039-2	-	M 85	M 88	M 87	M 92	M 76	M 88
<b>Electrical Properties at 23 °C</b>								
Electric strength (15)	IEC 60243-1	kV/mm	25	27	26	25	30	26
	IEC 60243-1	kV/mm	16	18	17	15	20	17
Volume resistivity	IEC 60093	Ohm.cm	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>
	IEC 60093	Ohm.cm	> 10 <sup>12</sup>	> 10 <sup>12</sup>	> 10 <sup>12</sup>	> 10 <sup>12</sup>	> 10 <sup>12</sup>	> 10 <sup>12</sup>
Surface resistivity	IEC 60093	Ohm	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>
	IEC 60093	Ohm	> 10 <sup>12</sup>	> 10 <sup>12</sup>	> 10 <sup>12</sup>	> 10 <sup>12</sup>	> 10 <sup>12</sup>	> 10 <sup>12</sup>
Relative permittivity $\epsilon_r$ : - at 100 Hz	IEC 60250	-	3.9	3.8	3.8	3.8	3.9	3.8
	IEC 60250	-	7.4	7.4	7.4	7.4	6.9	7.4
- at 1 MHz	IEC 60250	-	3.3	3.3	3.3	3.4	3.6	3.3
	IEC 60250	-	3.8	3.8	3.8	3.8	3.9	3.8
Dielectric dissipation factor tan $\delta$ : - at 100 Hz	IEC 60250	-	0.019	0.013	0.013	0.009	0.012	0.013
	IEC 60250	-	0.13	0.13	0.13	0.13	0.19	0.13
- at 1 MHz	IEC 60250	-	0.021	0.020	0.020	0.019	0.014	0.020
	IEC 60250	-	0.06	0.06	0.06	0.06	0.04	0.06
Comparative tracking index (CTI)	IEC 60112	-	600	600	600	400	475	600
	IEC 60112	-	600	600	600	400	475	600

Note: 1 g/cm<sup>3</sup> = 1,000 kg/m<sup>3</sup> ; 1 MPa = 1 N/mm<sup>2</sup> ; 1 kV/mm = 1 MV/m.

NA : Not applicable (there is no yield point)

## Legend:

+ : values referring to dry material

++ : values referring to material 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 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 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, based on 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-yellow cards available for these stock shapes.



## PHYSICAL PROPERTIES (INDICATIVE VALUES\*)

ERTALON 6 PLA	ERTALON 6 XAU+	ERTALON LFX	NYLATRON MC 901	NYLATRON GSM	NYLATRON NSM	NYLATRON LFG	NYLATRON 703 XL	ERTACETAL C	ERTACETAL H	ERTACETAL H-TF	ERTALYTE (16)	ERTALYTE TX	PC 1000
<i>natural (ivory)/black</i>	<i>black</i>	<i>green</i>	<i>blue</i>	<i>grey-black</i>	<i>grey</i>	<i>natural (ivory)/blue</i>	<i>purple</i>	<i>natural (white)/black</i>	<i>natural (white)/black</i>	<i>deep brown</i>	<i>natural (white)/black</i>	<i>pale grey</i>	<i>natural (clear, translucent)</i>
1.15	1.15	1.135	1.15	1.16	1.14	1.135	1.11	1.41	1.43	1.50	1.39	1.44	1.20
44/83	47/89	44/83	49/93	52/98	40/76	44/83	40/76	20/37	18/36	16/32	6/13	5/11	13/23
0.65/1.22	0.69/1.31	0.66/1.24	0.72/1.37	0.76/1.43	0.59/1.12	0.66/1.24	0.61/1.16	0.24/0.45	0.21/0.43	0.18/0.36	0.07/0.16	0.06/0.13	0.18/0.33
2.2	2.2	2	2.3	2.4	2	2	2	0.20	0.20	0.17	0.25	0.23	0.15
6.5	6.5	6.3	6.6	6.7	6.3	6.3	6.3	0.80	0.80	0.72	0.50	0.47	0.40
215	215	215	215	215	215	215	215	165	180	180	245	245	-
-	-	-	-	-	-	-	-	-	-	-	-	-	150
0.29	0.29	0.28	0.29	0.30	0.29	0.28	0.30	0.31	0.31	0.31	0.29	0.29	0.21
80 x 10 <sup>-6</sup>	80 x 10 <sup>-6</sup>	80 x 10 <sup>-6</sup>	80 x 10 <sup>-6</sup>	80 x 10 <sup>-6</sup>	80 x 10 <sup>-6</sup>	80 x 10 <sup>-6</sup>	85 x 10 <sup>-6</sup>	110 x 10 <sup>-6</sup>	95 x 10 <sup>-6</sup>	105 x 10 <sup>-6</sup>	60 x 10 <sup>-6</sup>	65 x 10 <sup>-6</sup>	65 x 10 <sup>-6</sup>
90 x 10 <sup>-6</sup>	90 x 10 <sup>-6</sup>	90 x 10 <sup>-6</sup>	90 x 10 <sup>-6</sup>	90 x 10 <sup>-6</sup>	95 x 10 <sup>-6</sup>	95 x 10 <sup>-6</sup>	100 x 10 <sup>-6</sup>	125 x 10 <sup>-6</sup>	110 x 10 <sup>-6</sup>	120 x 10 <sup>-6</sup>	80 x 10 <sup>-6</sup>	85 x 10 <sup>-6</sup>	65 x 10 <sup>-6</sup>
80	80	75	80	80	75	75	70	100	110	100	80	75	130
170	180	165	170	170	165	165	160	140	150	150	160	160	135
105/90	120/105	105/90	105/90	105/90	105/90	105/90	105/90	115/100	105/90	105/90	115/100	115/100	130/120
-30	-30	-20	-30	-30	-30	-20	-20	-50	-50	-20	-20	-20	-50
25	25	-	25	25	-	-	< 20	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	HB / HB
86 / -	84 / -	72 / -	82 / -	80 / -	78 / -	72 / -	60 / -	66 / -	78 / -	NA / 55	90 / -	76	74 / -
55 / -	55 / -	45 / -	50 / -	50 / -	50 / -	45 / -	40 / -	68 / -	78 / -	NA / 55	90 / -	76	74 / -
88	86	73	84	82	80	73	60	66	78	55	90	76	74
5	5	5	5	5	5	5	6	20	40	NA	4	4	6
25	25	25	35	25	25	25	15	50	50	10	15	5	> 50
> 50	> 50	> 50	> 50	> 50	> 50	> 50	> 25	35	35	10	15	7	> 50
3600	3500	3000	3300	3400	3150	3000	2750	2800	3300	3100	3500	3300	2400
1750	1700	1450	1600	1650	1525	1450	1350	2800	3300	3100	3500	3300	2400
26 / 51 / 92	26 / 51 / 92	22 / 43 / 79	24 / 47 / 86	25 / 49 / 88	23 / 44 / 81	22 / 43 / 79	20.5 / 40 / 67	19 / 35 / 67	22 / 40 / 75	20 / 37 / 69	26 / 51 / 103	24 / 47 / 95	18 / 35 / 72
22	22	18	21	21	18	18	16	13	15	13	26	23	17
10	10	8	9	9	8	8	7	13	15	13	26	23	17
no break	no break	50	no break	no break	100	50	25	150	200	30	50	30	no break
3.5	3.5	4	3.5	3.5	4	4	3	7	10	3	2	2.5	9
3.5	3.5	4	3.5	3.5	4	4	3	7	10	3	2	2.5	9
7	7	7	7	7	7	7	6	7	10	3	2	2.5	9
165	165	145	160	160	150	145	120	140	160	140	170	160	120
M 88	M 87	M 82	M 85	M 84	M 81	M 82	R 109 (M 59)	M 84	M 88	M 84	M 96	M 94	M 75
25	29	22	25	24	25	22	-	20	20	20	22	21	28
17	19	14	17	16	17	14	-	20	20	20	22	21	28
> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>
> 10 <sup>12</sup>	> 10 <sup>12</sup>	> 10 <sup>12</sup>	> 10 <sup>12</sup>	> 10 <sup>12</sup>	> 10 <sup>12</sup>	> 10 <sup>12</sup>	> 10 <sup>12</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>
> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>
> 10 <sup>12</sup>	> 10 <sup>12</sup>	> 10 <sup>12</sup>	> 10 <sup>12</sup>	> 10 <sup>12</sup>	> 10 <sup>12</sup>	> 10 <sup>12</sup>	> 10 <sup>12</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>
3.6	3.6	3.5	3.6	3.6	3.6	3.5	-	3.8	3.8	3.6	3.4	3.4	3
6.6	6.6	6.5	6.6	6.6	6.6	6.5	-	3.8	3.8	3.6	3.4	3.4	3
3.2	3.2	3.1	3.2	3.2	3.2	3.1	-	3.8	3.8	3.6	3.2	3.2	3
3.7	3.7	3.6	3.7	3.7	3.7	3.6	-	3.8	3.8	3.6	3.2	3.2	3
0.012	0.015	0.015	0.012	0.012	0.012	0.015	-	0.003	0.003	0.003	0.001	0.001	0.001
0.14	0.15	0.15	0.14	0.14	0.14	0.15	-	0.003	0.003	0.003	0.001	0.001	0.001
0.016	0.017	0.016	0.016	0.016	0.016	0.016	-	0.008	0.008	0.008	0.014	0.014	0.008
0.05	0.05	0.05	0.05	0.05	0.05	0.05	-	0.008	0.008	0.008	0.014	0.014	0.008
600	600	600	600	600	600	600	-	600	600	600	600	600	350 (225)
600	600	600	600	600	600	600	-	600	600	600	600	600	350 (225)

(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 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 ; only ERTALON 66-GF30, NYLATRON 703 XL, ERTACETAL H-TF and ERTALYTE TX had to be tested at 5 mm/min).

(11) Test speed: 1 mm/min.

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

(13) Pendulum used: 15 J.

(14) 10 mm thick test specimens

(15) Electrode configuration: Ø 25 / Ø 75 mm coaxial cylinders ; in transformer oil according to IEC 60296 ; 1 mm thick natural coloured test specimens. Please note that the electric strength of black extruded material (ERTALON 6 SA, ERTALON 66 SA, ERTACETAL and ERTALYTE) can be considerably lower than that of natural material. Possible microporosity in the centre of polyacetal stock shapes also significantly reduces the electric strength.

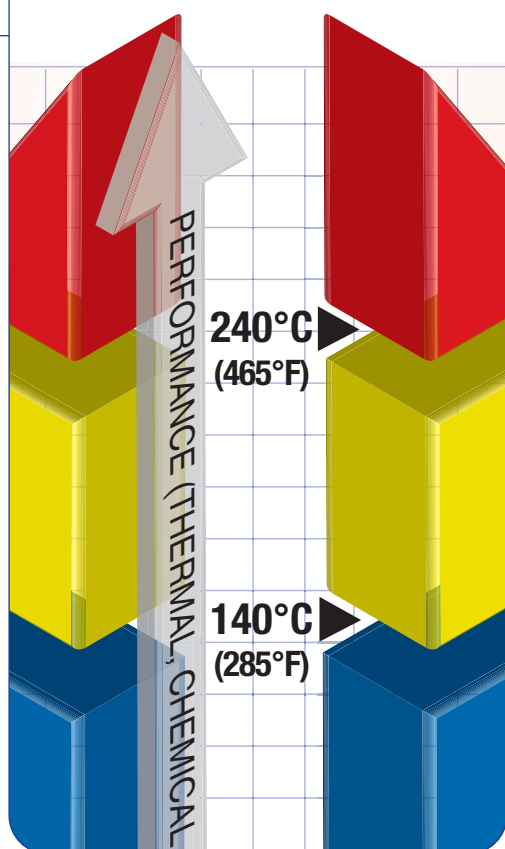
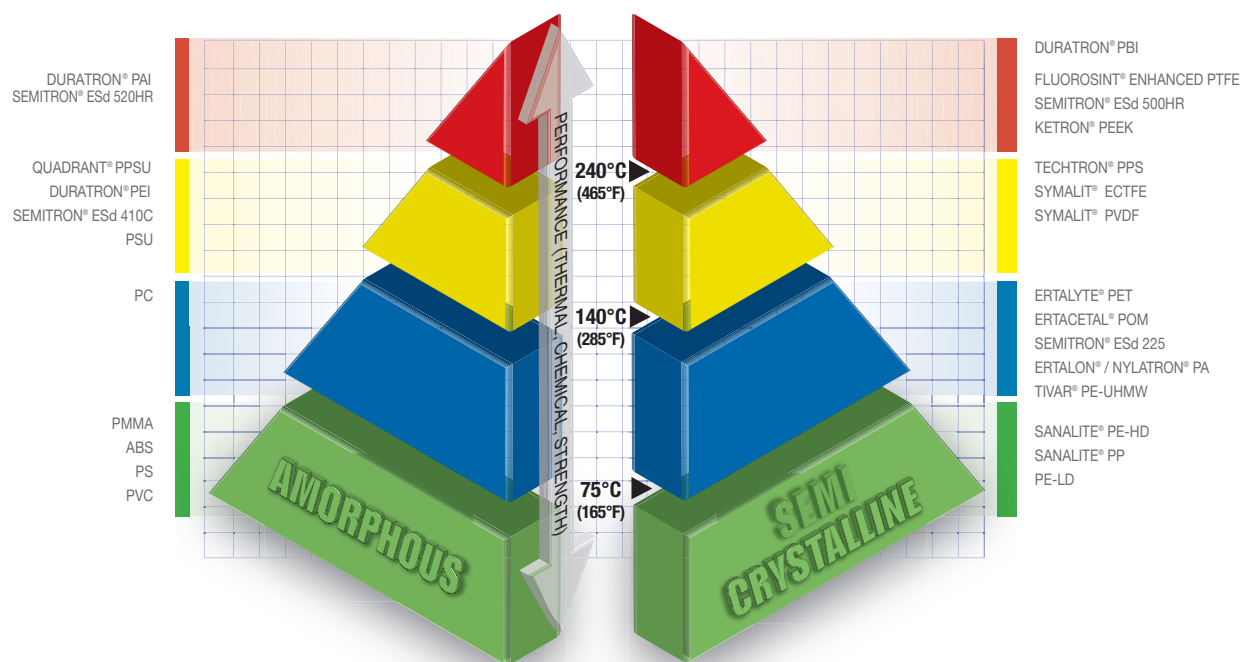
(16) The property-values given below do not apply to the 2 – 6 mm thick ERTALYTE sheets.

• This table is a valuable help in the choice of a material. The data listed here fall within the normal range of product properties. **However, they are not guaranteed and 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 an anisotropic material (properties differ when measured parallel and perpendicular to the extrusion direction).

# Advanced Engineering Plastics

The materials performance pyramid ranks the most common thermoplastics according to their temperature performance. Amongst these materials, different “families” can be recognised, all exhibiting high value in use within numerous applications.



DURATRON® PBI and DURATRON® PAI for top performance!

Characterised by an extreme temperature resistance (up to 310°C continuously for DURATRON® PBI), these materials perform where others would fail. DURATRON® PBI and DURATRON® PAI are suitable for both structural and friction & wear applications. SEMITRON® ESd 520HR is a static dissipative polyamideimide grade

Semi-crystalline AEP like KETRON® PEEK, TECHTRON® HPV PPS, FLUOROSINT® and SYMALIT® PVDF typically offer a combination of excellent chemical and mechanical properties, also at elevated temperatures. These materials can be used for both structural and friction & wear applications. SEMITRON® ESd 225 is a static dissipative acetal grade, SEMITRON® ESd 500HR is a static dissipative reinforced PTFE grade.

Amorphous AEP like QUADRANT® PPSU, DURATRON® PEI and PSU exhibit an outstanding retention of their mechanical properties up to the glass transition temperature and excellent electrical properties. Additionally, their food contact compliant composition and resistance to hot water or steam offer great possibilities for structural parts in medical, pharmaceutical and dairy industries. SEMITRON® ESd 410C is a static dissipative polyetherimide grade.

# DURATRON® PBI

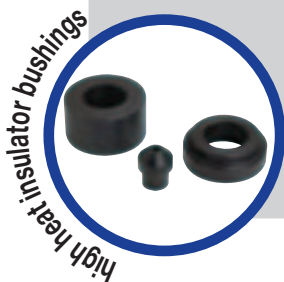
POLYBENZIMIDAZOLE (PBI)

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

**Challenges:** Hot runner systems needed a material that could endure the high temperatures but did not “stick” to the finished moulded parts.

**Solution:** DURATRON PBI machined bushings outperformed all other materials tested in the application.

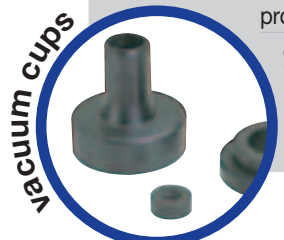
**Benefits:** DURATRON PBI is unique in its ease of clean up in hot runner systems. Moulded parts do not stick to DURATRON PBI during their “freeze” cycle in the mould.



**Challenges:** Engineers were looking for a more cost-effective solution for an extremely high temperature glass handling application.

**Solution:** DURATRON PBI outperformed prior materials and reduced the component cost.

**Benefits:** DURATRON PBI proved more wear resistant than polyimides. The DURATRON PBI cups reduced product breakage compared to the ceramics tested. It also proved more cost-effective than pressed carbon or polyimide materials



## 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, stiffness and creep resistance over a wide temperature range
- Excellent wear & frictional behaviour
- Extremely low coefficient of linear thermal expansion
- Excellent resistance against high energy radiation (gamma- and X-rays)
- Inherent low flammability
- High purity in terms of ionic contamination
- Good electrical insulating and dielectric properties

### DURATRON CU60 PBI

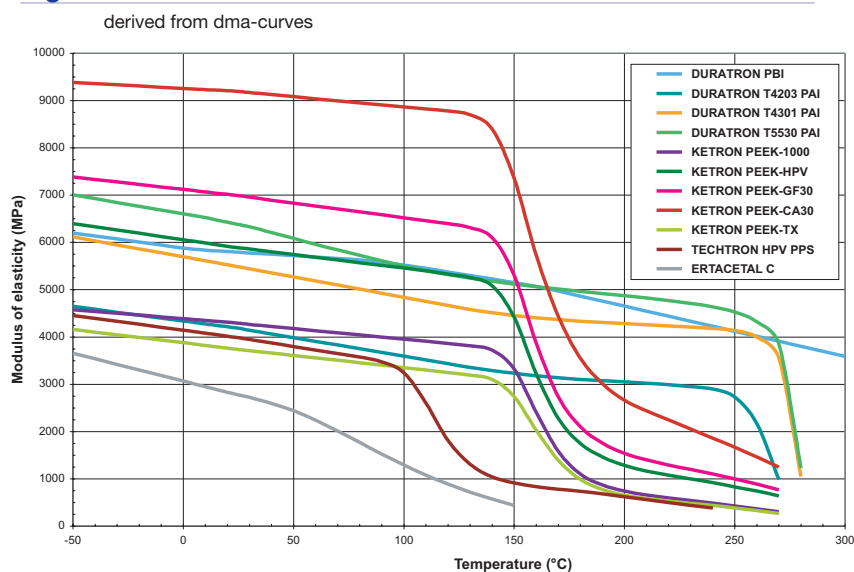
(PBI)

black

DURATRON PBI offers the highest temperature resistance and best mechanical property retention over 200°C 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 such as semiconductor and aerospace industries.

Usually DURATRON PBI is used in critical components to decrease maintenance costs and to gain valuable production “uptime”. It is used to replace metals and ceramics in pump components, valve seats (high tech valves), bearings, rollers, high temperature insulators.

**Fig. 6 STIFFNESS VERSUS TEMPERATURE**



**TECH NOTES:** 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 200°C should be “dried” prior to use or kept dry to avoid deformation from thermal shock.

# DURATRON® PAI POLYAMIDE-IMIDE (PAI)

With its versatile performance capabilities and proven use in a broad range of applications, DURATRON polyamide-imide (PAI) shapes are offered in extruded and compression moulded grades. For high temperature applications, this advanced material offers an excellent combination of mechanical performance and dimensional stability.

## MAIN CHARACTERISTICS

- Very high maximum allowable service temperature in air (250°C continuously)
- Excellent retention of mechanical strength, stiffness and creep resistance over a wide temperature range
- Superb dimensional stability up to 250°C
- Excellent wear & frictional behaviour (particularly DURATRON T4301 & T4501 PAI)
- Very good UV-resistance
- Exceptional resistance against high energy radiation (gamma- and X-rays)
- Inherent low flammability



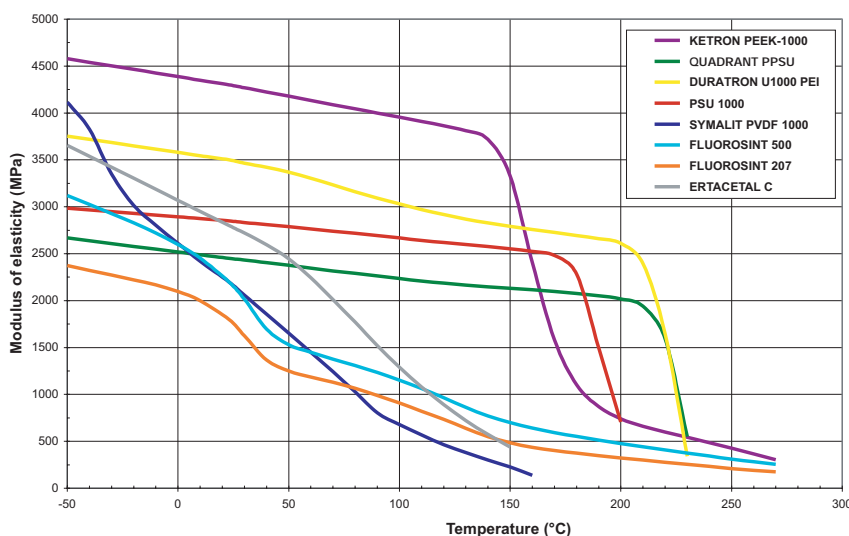
**Challenges:** Rotary compressors needed a vane material that could survive with limited lubrication and maintain close tolerances at high speeds and loads.

**Solution:** DURATRON T4301 PAI was the ideal replacement for the composite material that was previously used.

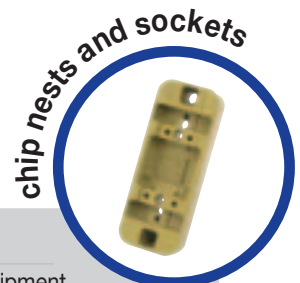
**Benefits:** DURATRON PAI's very low coefficient of thermal expansion, excellent wear resistance and high load capabilities made economic sense for the manufacturer who was able to tout their unit's reliable long-term performance.

**Fig. 7 STIFFNESS VERSUS TEMPERATURE**

derived from dma-curves



**TECH NOTES:** As DURATRON PAI shows a relatively high moisture absorption, parts used in high temperature service or made to tight tolerances should be kept dry prior to installation. Thermal shock resulting in deformation can occur if moisture laden parts are rapidly exposed to temperatures above 200°C.



**Challenges:** Manufacturers of equipment that test completed IC's had problems with dimensional changes of the test sockets they used.

**Solution:** DURATRON T4203 PAI and DURATRON T5530 PAI sockets and nests replaced expensive VESPEL® PI parts and handle the broad temperature range present during testing.

**Benefits:** The better dimensional stability at higher temperature helped to increase the reliability of the testing equipment and extend part life.

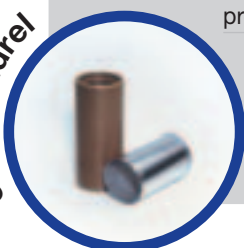
**Challenges:** Packaging equipment designers needed a material that had extreme strength and could deal with the impact occurring in real-world production. Can mandrels are used to form aluminium blanks into beverage and food containers.

**Solution:**

Replacement of nylon, PE-UHMW and coated steel mandrels with DURATRON T4203 PAI offered improved performance and less downtime replacing damaged production parts.

**Benefits:** Stiff, strong DURATRON T4203 PAI permitted higher production rates because of its ability to operate at higher temperatures.

can mandrel



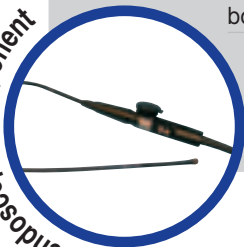
**Challenges:** The piezo elements on this endoscope need to be fixed on a very rigid frame in order to make sharp pictures of the patient's heart.

**Solution:** DURATRON T4203 PAI offers exceptional mechanical properties, excellent dimensional stability and can be machined to extremely tight tolerances.

**Benefits:** A very precise piece of equipment allowing for better patient diagnosis. As the part does not come in direct contact with the human body, no biocompatibility classification (ISO 10993, USP) is required.



Microscopic component



## DURATRON T4203 PAI (extruded)

(PAI)

yellow-ochre

**DURATRON T4503 PAI (compression moulded)**

(PAI)

yellow-ochre

DURATRON T4203 PAI offers the best toughness and impact strength of all DURATRON PAI grades. This extruded DURATRON PAI 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 moulded DURATRON T4503 PAI is similar in composition to DURATRON T4203 PAI, and is selected when larger shapes are required.

**DURATRON T4301 PAI (extruded)**

(PAI + graphite + PTFE)

black

**DURATRON T4501 PAI (compression moulded)**

(PAI + graphite + PTFE)

black

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

Compression moulded DURATRON T4501 PAI is similar in composition to DURATRON T4301 PAI, and is selected when larger shapes are required.

**DURATRON T5530 PAI (compression moulded)**

(PAI-GF30)


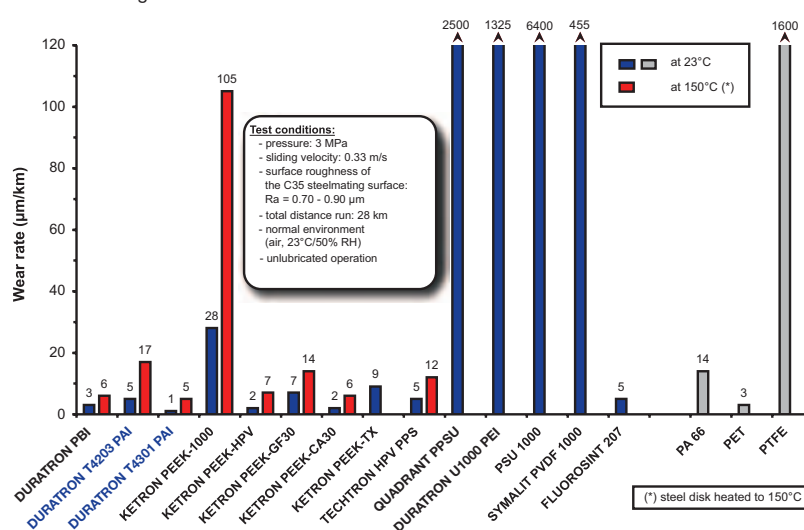
black

This 30% glass fibre reinforced grade offers higher stiffness, strength and creep resistance than the DURATRON PAI grades mentioned above. 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 250°C making it extremely popular for precision parts in e.g. the electronical and semiconductor industries.

The suitability of DURATRON T5530 PAI for sliding parts, however, is to be carefully examined since the glass fibres tend to abrade the mating surface.

### Fig. 8 WEAR RESISTANCE

average values between 23°C and 150°C



**TECH NOTES:** DURATRON PAI suffers from severe attack by a wide variety of chemicals. Also steam causes rapid degradation of this material. Whenever an outstanding chemical and hydrolysis resistance at high temperatures is required, KETRON® PEEK may be the preferred material.



# KETRON® PEEK POLYETHERETHERKETONE (PEEK)

The KETRON PEEK family of materials is based on polyetheretherketone resin. This semi-crystalline advanced material exhibits a unique combination of high mechanical properties, temperature resistance and excellent chemical resistance making it the most popular advanced plastics material.

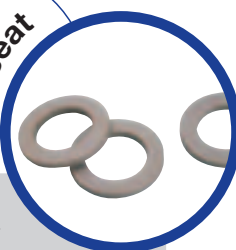
## MAIN CHARACTERISTICS

- Very high maximum allowable service temperature in air (250°C continuously, up to 310°C for short periods of time)
- High mechanical strength, stiffness and creep resistance, also at elevated temperatures
- Excellent chemical and hydrolysis resistance
- Excellent wear & frictional behaviour
- Very good dimensional stability
- Excellent resistance to high energy radiation (gamma- and X-rays)
- Inherent low flammability and very low levels of smoke evolution during combustion

## APPLICATIONS

KETRON PEEK is often used to replace PTFE when higher mechanical load bearing capacity, or when superior wear resistance is needed. KETRON PEEK is widely selected as a replacement for metal components. Examples of components made from PEEK grades: pump components, valve seats, bearings, rollers, gears, high temperature insulators, components exposed to boiling water or steam.

valve seat



**Challenges:** Premature replacement of a glass-filled PTFE seat caused excessive warranty expense for a manufacturer of industrial cleaning equipment.

**Solution:** KETRON PEEK-1000 replaced the poppet seat and allowed increased reliability of the mixing unit in the cleaning equipment.

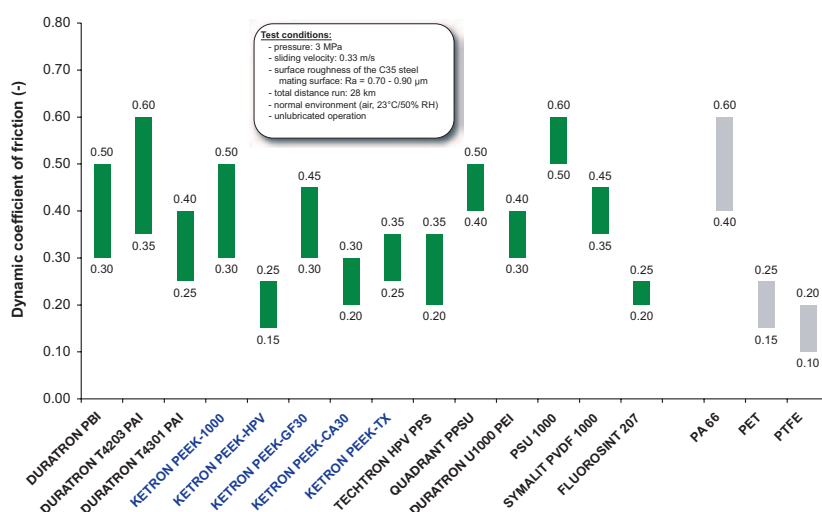
**Benefits:** Hydrolysis resistant and far more stable than PTFE, KETRON PEEK-1000 retains its properties after thousands of hours of operation.

medical instrument grips



**Fig. 9 DYNAMIC COEFFICIENT OF FRICTION AT 23°C**

measured on a "plastics pin on rotating steel disk" - tribo system



**TECH NOTES:** From 150°C onwards (above the glass transition temperature), the mechanical properties of all KETRON PEEK grades drop off significantly and the coefficient of linear thermal expansion increases considerably. Consequently, a material like DURATRAN® PAI could be better suited for close tolerance parts operating under high loads at temperatures over 150°C.

**Challenges:** A medical instruments manufacturer was looking for a material that could withstand multiple sterilisation cycles. The material needed to conform to ISO and USP biocompatibility standards.

**Solution:** KETRON PEEK-GF30 LSG blue easily withstands the sterilisation cycles, is easy to machine and has excellent mechanical properties. It also comes with all the required certificates.

**Benefits:** KETRON PEEK-GF30 LSG blue improves lifetime thanks to its resistance against multi-sterilisation cycles in autoclaves and hot air at 180°C.



# Grades

KETRON® PEEK

**All our KETRON PEEK grades are based on VICTREX® PEEK polymers.**

**Challenges:** During the filling operation, viscous liquids are pressed through these valves and dosed directly into the single portion packages. Designers were looking for a material that offered chemical resistance and dimensional stability. Food contact compliance was also needed.

**Solution:** KETRON PEEK-1000 offers the requested chemical resistance against foodstuffs and cleaning agents, as well as excellent wear resistance and dimensional stability. KETRON PEEK-1000 offers a

food contact compliant composition in line with the EU & US regulatory requirements.

**Benefits:** The part lifetime is increased and maintenance significantly reduced. Furthermore, KETRON PEEK-1000 is easily machined.

bearing valves

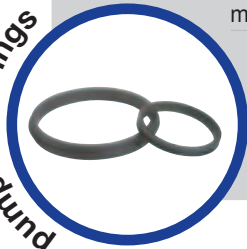


**Challenges:** Centrifugal pump wear parts were failing due to corrosion and galling.

**Solution:** The bronze parts shipped with the original units were replaced with KETRON PEEK-CA30 parts. The PEEK rings eliminated the problem and increased the efficiency of the units.

**Benefits:** The chemical resistance, temperature resistance and good stability of the carbon fibre filled PEEK-CA30 form the ideal material for high temperature, close tolerance applications where chemicals are present.

pump wear rings



## KETRON PEEK-1000



(PEEK)

KETRON PEEK-1000 stock shapes are produced from virgin polyetheretherketone resin and offer the highest toughness and impact strength of all KETRON PEEK grades. Both KETRON PEEK-1000 natural & 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 manufacture of KETRON PEEK-1000 stock shapes complies with the regulations of the European Union (Directive 2002/72/EC, as amended) and the United States of America (FDA) for plastic materials and articles intended to come into contact with foodstuffs.

natural  
(brownish grey)  
black

## KETRON PEEK-GF30

(PEEK-GF30)

This 30% glass fibre reinforced grade offers a higher stiffness and creep resistance than KETRON PEEK-1000 and has a much better dimensional stability. This grade is very appropriate for structural applications carrying high static loads for long periods of time at elevated temperatures. The suitability of KETRON PEEK-GF30 for sliding parts, however, is to be carefully examined since the glass fibres tend to abrade the mating surface.

brownish grey

## KETRON PEEK-HPV

(PEEK + CF + PTFE + graphite)

The addition of carbon fibres, PTFE and graphite to virgin PEEK results in a KETRON PEEK "bearing grade". Its excellent tribological properties (low friction, long wear and high pressure-velocity capabilities) make this grade especially suited for wear and friction applications.

black

## KETRON PEEK-CA30

(PEEK-CF30)

This 30% carbon fibre reinforced grade combines even higher stiffness, mechanical strength and creep resistance than KETRON PEEK-GF30 with an optimum wear resistance. Moreover, compared with unreinforced PEEK, the carbon fibres considerably reduce thermal expansion and provide 3.5 times higher thermal conductivity – dissipating heat from the bearing surface faster, improving bearing life and pressure-velocity capabilities.

black

## KETRON PEEK-TX



(PEEK + solid lubricant)

This new member of the KETRON PEEK family has been developed especially for the food industry. Like KETRON PEEK-1000, this new internally lubricated material has a food contact compliant composition, but offers far superior wear and frictional performance, making it especially suitable for a wide variety of bearing and wear applications in the 100 to 200°C service temperature range.

blue

Within its portfolio of Life Science Grade Engineering Plastic Products – specifically developed for applications in the medical, pharmaceutical and biotechnology industries – Quadrant offers **KETRON PEEK-CLASSIX™ LSG white**, **KETRON PEEK-CA30 LSG**, **KETRON PEEK-GF30 LSG blue (RAL 5019)** and **KETRON PEEK LSG natural / black** biocompatible Engineering Plastic Stock Shapes for machining with certified USP Class VI and ISO 10993 compliance (see also page 32).



**TECH NOTES:** Like most reinforced materials, KETRON PEEK-HPV, -GF30, -CA30 and -TX exhibit a moderate toughness and impact strength. Therefore, all "internal" corners of parts made from these materials should be radiused (R > 1 mm) and edges chamfered to maximise part toughness.

# TECHTRON® HPV PPS POLYPHENYLENE SULFIDE (PPS)

TECHTRON HPV PPS is a reinforced, internally lubricated semi-crystalline polymer developed to close the gap both in performance and price between the standard thermoplastic materials (e.g. PA, POM, PET) and the high-end advanced engineering plastics (e.g. PBI, PI, PAI, PEEK).

## MAIN CHARACTERISTICS

- Very high maximum allowable service temperature in air (220°C continuously, up to 260°C for short periods of time)
- High mechanical strength, stiffness and creep resistance, also at elevated temperatures
- Excellent chemical and hydrolysis resistance
- Excellent wear and frictional behaviour
- Very good dimensional stability
- Physiologically inert (suitable for food contact)
- Excellent resistance to high energy radiation (gamma- and X-rays)
- Good UV-resistance
- Inherent low flammability
- Good electrical insulating and dielectric properties

Within its portfolio of Life Science Grade Engineering Plastic Products – specifically developed for applications in the medical, pharmaceutical and biotechnology industries – Quadrant offers **TECHTRON HPV LSG** biocompatible Engineering Plastic Stock Shapes for machining with certified USP Class VI and ISO 10993 compliance (see also page 32).



**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:** In the past only exotic materials would have worked in this elevated temperature application where lubrication was not possible and chemicals were present during cleaning. TECHTRON HPV PPS combines the excellent chemical resistance of PPS with the wear resistance and performance of premium bearing materials.

deep blue

## TECHTRON HPV PPS



(PPS + solid lubricant)

TECHTRON HPV PPS demonstrates an excellent combination of properties including wear resistance, load-bearing capabilities and dimensional stability when exposed to chemicals and high temperature environments.

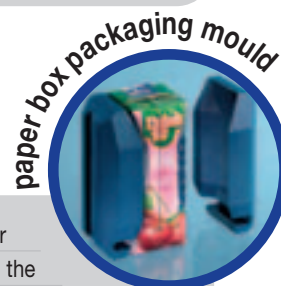
TECHTRON HPV PPS is found in applications where PA, POM, PET and other plastics fall short or where PI, PEEK and PAI are over-engineered and a more economical solution must be found.

Thanks to the uniformly dispersed internal lubricant, TECHTRON HPV PPS exhibits an 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 a glass fibre reinforced PPS which causes premature wear of the counterface in moving-part applications.

TECHTRON HPV PPS can be used in all kinds of industrial equipment such as industrial drying and food processing ovens (bearings, rollers, ...), chemical process equipment (pump-, valve & compressor components) and electrical insulating systems.



**TECH NOTES:** From 100°C onwards (above the glass transition temperature), the mechanical properties of TECHTRON HPV PPS drop off significantly and the coefficient of linear thermal expansion increases considerably. KETRON® PEEK and DURATRON® PAI may be suitable alternatives to overcome these inconveniences.



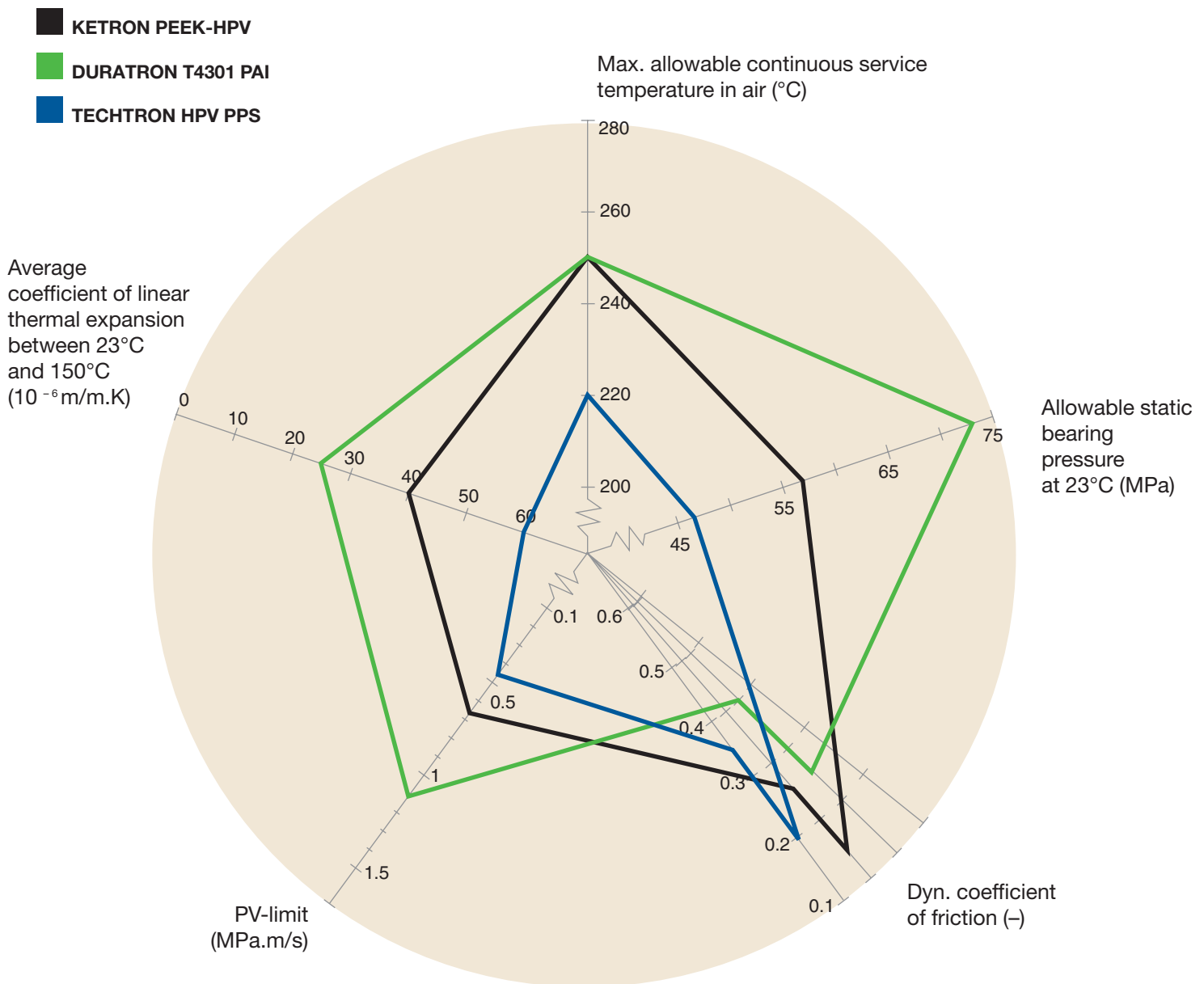
**Challenges:** A packager needed a mould to form the paper box in its equipment for liquids. The mould needed high mechanical strength to resist the compression forces as well as dimensional stability under load and temperature. Wear resistance, low weight and chemical resistance during the Clean-In-Place operation were also required.

**Solution:** TECHTRON HPV PPS was chosen due to its better wear resistance over PEEK or aluminium. The plastic has excellent dimensional stability under load, with no moisture pick-up and a low coefficient of linear thermal expansion.

**Benefits:** Reduced maintenance costs, no corrosion problems, low weight and in-use noise level, increased hygiene.

# Key Features of AEP “Bearing Grades”

**RADAR CHART (Indicative and comparative values)**



# QUADRANT® PPSU

POLYPHENYLENE SULFONE (PPSU)



QUADRANT PPSU is an amorphous high performance thermoplastic, offering better impact strength and chemical resistance than polysulfone and polyetherimide. QUADRANT PPSU also has superior hydrolysis resistance as measured by steam autoclaving cycles to failure, making it especially suited for repeated steam sterilisation applications.

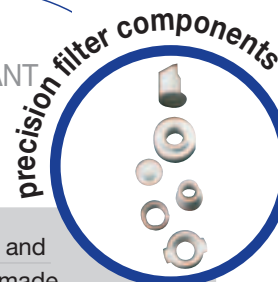
## MAIN CHARACTERISTICS

- High maximum allowable service temperature in air (180°C continuously)
- Good chemical and excellent hydrolysis resistance (suitable for repeated steam sterilisation)
- High stiffness over a wide temperature range
- Very high impact strength
- Physiologically inert (suitable for food contact)
- High dimensional stability
- Very good resistance against high energy radiation (gamma- and X-rays)
- Good electrical insulating and dielectric properties

## APPLICATIONS

QUADRANT PPSU is increasingly used for the manufacture of sterilisation trays, dental and surgical instrument handles, and in fluid handling couplings and fitting applications. Showing a very high deflection temperature under load (205°C acc. to ISO 75 / Method A), QUADRANT PPSU is suitable for use in electronic assembly equipment and devices that must withstand solder temperatures.

Within its portfolio of Life Science Grade Engineering Plastic Products - specifically developed for applications in the medical, pharmaceutical and biotechnology industries - Quadrant offers **QUADRANT LSG PPSU black** biocompatible Engineering Plastic Stock Shapes for Machining with certified USP Class VI and ISO 10993 compliance (see also page 32).



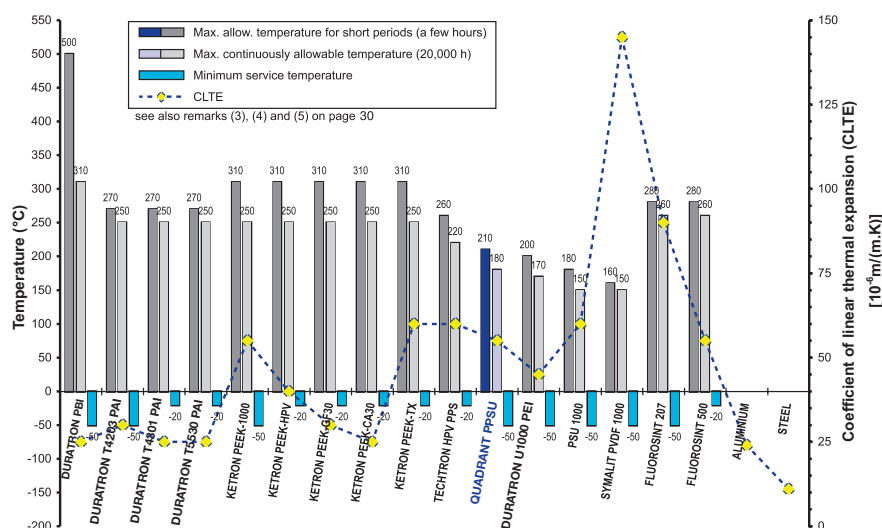
**Challenges:** Weight and cleaning processes made stainless steel filter equipment impractical and inefficient.

**Solution:** Varied housings and end caps were machined from lightweight, steam resistant QUADRANT PPSU.

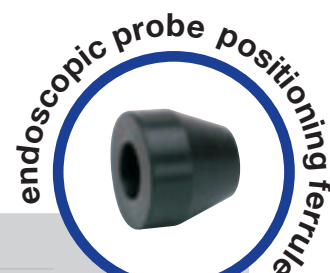
**Benefits:** Drastically reduced part weight yielding a more useful end product. QUADRANT PPSU allowed unlimited hot water and steam cleaning without part replacement.

**Fig. 10 MINIMUM AND MAXIMUM SERVICE TEMPERATURE IN AIR & COEFFICIENT OF LINEAR THERMAL EXPANSION**

(average value between 23°C and 150°C)



**TECH NOTES:** Since unfilled/unreinforced amorphous thermoplastics inherently possess a low wear resistance and high coefficient of friction, QUADRANT PPSU is not recommended for use in friction & wear applications (this also applies to DURATRON® U1000 PEI and PSU 1000).



### Challenges:

The coated stainless steel wore the mating parts and required constant maintenance.

**Solution:** Intricately machined QUADRANT LSG PPSU ferrules eliminated the wear while offering other benefits.

**Benefits:** Low moisture absorption and good dimensional stability were critical. Easy cleaning and improved impact resistance were additional benefits.

# PSU 1000 POLYSULFONE (PSU)



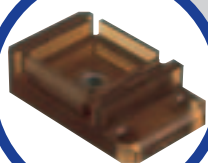
PSU 1000 is a translucent (non-optical quality) amorphous thermoplastic material, offering a combination of excellent mechanical, thermal and electrical properties. It often replaces polycarbonate whenever higher temperature resistance, improved chemical resistance or autoclavability is required.

**Challenges:** Cleaning aluminium parts was tedious and costly.

**Solution:** Parts fabricated from PSU 1000 easily replaced ineffective aluminium.

**Benefits:** The PSU 1000 parts were able to be steam cleaned and more easily dealt with laboratory chemicals and radiation.

medical carrier

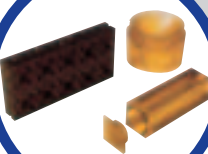


**Challenges:** Smaller and lighter equipment is being requested from medical device designers.

**Solution:** PSU 1000 replaced the stainless steel parts used on early designs.

**Benefits:** PSU 1000 is nearly 7 times lighter than stainless steel. The plastic material easily withstands repeated autoclave cycles.

dialysis equipment



## MAIN CHARACTERISTICS

- High maximum allowable service temperature in air (150°C continuously)
- Good hydrolysis resistance (suitable for repeated steam sterilisation)
- High strength and stiffness over a wide temperature range
- Good dimensional stability
- Physiologically inert (suitable for food contact)
- Very good resistance against high energy radiation (gamma- and X-rays)
- Good electrical insulating and dielectric properties

## APPLICATIONS

PSU 1000 is commonly used in food processing equipment (milk machines, pumps, valves, filtration plates, heat exchangers), for analytical instrumentation and all kinds of components which are subjected to repeated cleaning and sterilisation.

Within its portfolio of Life Science Grade Engineering Plastic Products - specifically developed for applications in the medical, pharmaceutical and biotechnology industries - Quadrant offers PSU LSG natural biocompatible Engineering Plastic Stock Shapes for machining with certified USP Class VI and ISO 10993 compliance (see also page 32).



Table 2: FOOD CONTACT COMPLIANCE STATUS (1)

QUADRANT AEP STOCK SHAPES	BASE POLYMERS	EUROPEAN UNION Directive 2002/72/EC	GERMANY BfR	USA FDA Code of Federal Regulations (21 CFR) & FDA FCN
DURATRON® PBI	Polybenzimidazole	-	p	-
DURATRON® PAI (all grades)	Polyamide-imide	-	p	-
KETRON® PEEK-1000 natural (*)	Polyetheretherketone	+	p	+
KETRON® PEEK-1000 black	Polyetheretherketone	+	p (+)	+
KETRON® PEEK-HPV	Polyetheretherketone	-	p	-
KETRON® PEEK-GF30 natural	Polyetheretherketone	-	p	-
KETRON® PEEK-CA30	Polyetheretherketone	-	p	-
KETRON® PEEK-TX	Polyetheretherketone	+	p (+)	+
TECHTRON® HPV PPS	Polyphenylene sulfide	+	p (+)	+(**)
QUADRANT PPSU black	Polyphenylene sulfone	+	p (+)	+(**)
DURATRON® U1000 PEI natural	Polyetherimide	+	p	+
PSU 1000 natural	Polysulfone	+	p	+
SYMALIT® PVDF 1000 natural (*)	Polyvinylidene fluoride	+	p	+
FLUOROSINT® 207	Polytetrafluoroethylene	+	+	+
FLUOROSINT® 500	Polytetrafluoroethylene	-	-	-
SEMITRON® ESD (all grades)	several	-	-	-

1) This table gives the compliance of the **raw materials** used for the manufacture of the Quadrant EPP Stock Shapes **with respect to their composition** as set out in the regulations that apply in the Member States of the European Union (Directive 2002/72/EC, as amended), in Germany (BfR) and in the United States of America (FDA) for plastic materials and articles intended to come into contact with foodstuffs.

+: complies with the requirements of the regulations

-: does **not** comply with the requirements of the regulations

p: there is no specific BfR recommendation for the base polymer

p (+): there is no specific BfR recommendation for the base polymer ; the additives used (colorants and fillers) comply with the relevant BfR recommendations.

(\*) : 3-A Dairy compliant

(\*\*) : refers to the FDA Food Contact Notifications (FCN) No. 40 (PPS) or No. 83 (PPSU), FDA regulation 21 CFR §178.3297 iColorant s for polymers" and other relevant FDA regulations.

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



**TECH NOTES:** Amorphous thermoplastics like PSU 1000 are sensitive to stress cracking when in contact with polar organic solvents (e.g. ethyl alcohol).

Environments, which might be completely harmless to unstressed parts, may cause stress cracking with highly stressed parts (this also applies to DURATRON U1000 PEI and to a lesser extent also to QUADRANT PPSU).



# DURATRON® U1000 PEI POLYETHERIMIDE (PEI)



DURATRON U1000 PEI is an amber translucent (non-optical quality) amorphous thermoplastic material, offering high strength and heat resistance. It performs continuously to 170°C, making it ideal for high strength / high heat applications, and also for applications requiring consistent dielectric properties over a wide frequency and temperature range.

insulators



## MAIN CHARACTERISTICS

- High maximum allowable service temperature in air (170°C continuously)
- Very good hydrolysis resistance (suitable for repeated steam sterilisation)
- High strength and stiffness over a wide temperature range
- Inherent low flammability and low levels of smoke evolution during combustion
- Good dimensional stability
- Physiologically inert (suitable for food contact)
- Very good resistance against high energy radiation (gamma- and X-rays)
- Very good electrical insulating and dielectric properties

## APPLICATIONS

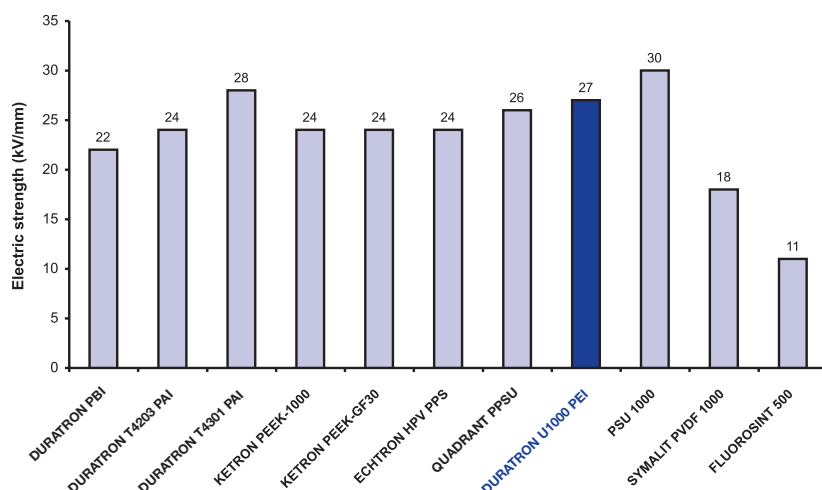
DURATRON U1000 PEI is extremely suitable for electrical / electronic insulators (including many semiconductor process components) and a variety of structural components requiring high strength and rigidity at elevated temperatures. Thanks to its good hydrolysis resistance, DURATRON U1000 PEI is capable of withstanding repeated autoclaving cycles.

Within its portfolio of Life Science Grade Engineering Plastic Products - specifically developed for applications in the medical, pharmaceutical and biotechnology industries - Quadrant offers **DURATRON LSG PEI natural** biocompatible Engineering Plastic Stock Shapes for machining with certified USP Class VI and ISO 10993 compliance (see also page 32).



**Fig. 11 ELECTRIC STRENGTH**

(IEC 60243 ; 1 mm thick test specimens)



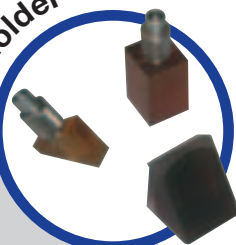
**TECH NOTES:** Cooling liquids of the soluble oil type should not be used when machining DURATRON U1000 PEI since they are likely to induce environmental stress cracking. For this material, the most suitable coolants are pure water or compressed air (this also applies to QUADRANT PPSU and PSU 1000).

**Challenges:** Costly, brittle ceramics were constantly being broken during installation of these microwave communication insulators.

**Solution:** Durable DURATRON U1000 PEI was easily machined into the parts required.

**Benefits:** DURATRON U1000 PEI has drastically greater impact resistance than the original ceramic and shows excellent dielectric properties.

probe holder



### Challenges:

In ultrasonic scanning equipment, a plastic support is used to hold the piezo crystals and to guide the ultrasonic sound into the tested material. For the scanning of warm surfaces, standard plastic grades become too soft and sticky.

**Solution:** High temperature resistant DURATRON U1000 PEI withstands these temperatures and is transparent to ultrasonic waves.

**Benefits:** DURATRON U1000 PEI shows uniform properties in all directions, permits a higher output thanks to very low internal reflection rates and has a low damping factor.



# SYMALIT® PVDF 1000 - FLUOROSINT®

FLUOROPOLYMERS

These fluoropolymers exhibit excellent mechanical properties combined with exceptional chemical resistance. Quadrant EPP also offers a complete range of fluoropolymer lining materials.

**Challenges:** Seals made from aluminium, bronze or Babbitt caused mating part wear that decreased the efficiency of turbo compressors.

**Solution:** Redesigned abradable seals machined from FLUOROSINT 500 tube dramatically improved efficiency and helped protect other parts from damage.

**Benefits:** FLUOROSINT's excellent chemical resistance and forgiving composition can greatly improve the performance of rotating equipment while dealing with shaft movement and pressure changes that can damage metallic seals.

labyrinth and shroud seals

## MAIN CHARACTERISTICS

- High maximum allowable service temperature in air (260°C continuously for FLUOROSINT and 150°C for PVDF 1000)
- Excellent chemical and hydrolysis resistance
- Outstanding UV- and weather resistance
- Physiologically inert (suitable for food contact, except FLUOROSINT 500)
- Inherent low flammability
- Good electrical insulating properties

### SYMALIT PVDF 1000



(PVDF)

natural

SYMALIT PVDF 1000 is a highly crystalline unreinforced fluoropolymer combining good mechanical, thermal and electrical properties with excellent chemical resistance. It also shows good resistance to high-energy radiation (considerably better than other fluoropolymers).

In addition, the composition of the raw material used for the production of SYMALIT PVDF 1000 stock shapes complies with the regulations of the European Union (Directive 2002/72/EC, as amended) and the United States of America (FDA) for plastic materials and articles intended to come into contact with foodstuffs.

SYMALIT PVDF 1000 is a versatile engineering material especially suitable for the manufacture of components for the petro-chemical, chemical, metallurgical, food, paper, textile, pharmaceutical and nuclear industries.

### FLUOROSINT 500

(PTFE + mica)

ivory

Reinforced with a proprietary synthetic mica, this material exhibits, in addition to its inherent outstanding chemical and hydrolysis resistance, very good mechanical and tribological properties.

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 aluminium and is 1/5 that of virgin PTFE, often eliminating fit and clearance problems. It is considerably harder than virgin PTFE, has better wear characteristics and maintains low frictional properties. FLUOROSINT 500 is also non-abrasive to most mating materials.

### FLUOROSINT 207



(PTFE + mica)

white

This material has a food contact compliant composition which, in combination with the good mechanical performance, dimensional stability, sliding and wear properties and inherent outstanding chemical and hydrolysis resistance of FLUOROSINT, opens numerous application possibilities in food, pharmaceutical and chemical processing industries.

**Challenges:** PTFE seals can easily deform or change shape after machining and installation.

**Solution:** Seats and seals machined from FLUOROSINT 207 can maintain the required dimensions and provide the sealing performance needed in challenging services like steam and hot air.

**Benefits:** FLUOROSINT's dimensional stability is significantly better than that of virgin or low-tech filled PTFE's.

It also offers excellent chemical resistance and non-permeability to hot air and steam.

valve seats and seals



**TECH NOTES:** The mechanical performance of SYMALIT PVDF 1000, FLUOROSINT 207 and 500 is not as good as the one of other advanced engineering plastic products profiled in this application guide such as KETRON® PEEK and DURATRON® PAI.

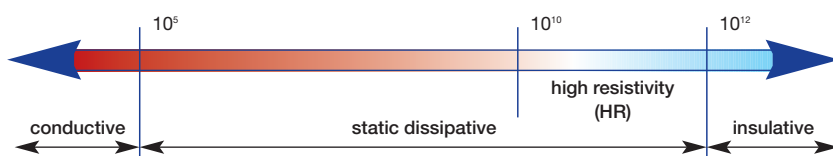
# SEMITRON® ESd

The SEMITRON ESd family of static dissipative plastics is designed for applications where electrical discharge in operation is a problem. They provide a controlled bleed-off of static charges.

## MAIN CHARACTERISTICS

- Permanently static dissipative
- Dissipate static charges (5 kV) in less than 2 seconds
- No metal or graphite powder used
- Depending on the base polymer, thermal performance from 90 to 260°C (continuous use)

**Fig.12 SURFACE RESISTIVITY (OHM/SQ.) AND CONDUCTIVITY SPECTRUM**



**Table 3: ELECTRICAL AND THERMAL PROPERTIES OF SEMITRON ESd MATERIALS**

SEMITRON ESd grades	Surface resistivity (Ohm/sq.) acc. to ANSI/ESD STM 11.11	Max. allowable service temperature in air (°C) for short periods / continuously (*)
SEMITRON ESd 225	$10^9 - 10^{11}$	140 / 90
SEMITRON ESd 410C	$10^9 - 10^9$	200 / 170
SEMITRON ESd 500HR	$10^{10} - 10^{12}$	280 / 260
SEMITRON ESd 520HR	$10^{10} - 10^{12}$	270 / 250

(\*): for more details, see the property list on pages 30 & 31

electronics fixture



**Challenges:** While manufacturing computer hard disks a nearby sensor was picking up static charges that were causing problems with process electronics.

**Solution:** The unfilled plastic part was replaced by a machined fixture made of SEMITRON ESd 520HR.

**Benefits:** The SEMITRON ESd 520HR sensor could safely withstand the 200°C process temperatures and maintain the precise position required all while safely bleeding away static charges.

wafer combs



**Challenges:** Delicate complete and in-process wafers were destroyed by electrostatic discharges.

**Solution:** SEMITRON ESd 225, a static dissipative POM, was able to replace the unfilled nylon and polyacetal grades that couldn't handle the static charges present in the manufacturing environment.

**Benefits:** Economical SEMITRON ESd 225 safely bleeds away static charges created during handling while offering the wear resistance of unfilled PA and POM materials.



**TECH NOTES:** The SEMITRON ESd products are inherently dissipative and do not rely on atmospheric phenomena (e.g. humidity) to activate, nor are surface treatments used to achieve dissipation.

# Grades

SEMITRON® ESd

**Challenges:** A material was needed that prevents the integrated circuits from damage caused by handling and external static electrical load.

**Solution:** SEMITRON ESd 410C is static dissipative and exhibits excellent dimensional stability, ideal for handling equipment in the semiconductor industries.

**Benefits:** IC handling trays manufactured from SEMITRON ESd 410C dissipate static charges reliably and prevent the integrated circuits from damage.

ic handling trays



There are four SEMITRON ESd grades servicing static dissipative needs over a broad range of temperatures and mechanical loading conditions. The SEMITRON ESd materials are commonly used in manufacturing and handling equipment of sensitive electronic components such as integrated circuits, hard disk drives and circuit boards. They are also an excellent choice for material handling applications, and components in high speed electronic printing and reproducing equipment.

## **SEMITRON ESd 225** (static dissipative POM)

SEMITRON ESd 225 is an acetal based static dissipative material ideal for material handling applications. It is also an excellent choice for fixturing used in the manufacturing of hard disk drives or for handling in-process silicon wafers.

beige

## **SEMITRON ESd 410C** (static dissipative PEI)

Having an excellent mechanical performance up to 210°C, SEMITRON ESd 410C provides ESd-solutions at higher temperatures. Additionally, SEMITRON ESd 410C exhibits excellent dimensional stability (low coefficient of linear thermal expansion and small water absorption), ideal for handling equipment in the electrical/electronic or semiconductor industries.

black

## **SEMITRON ESd 500HR** (static dissipative PTFE)

Reinforced with a proprietary synthetic mica, SEMITRON ESd 500HR offers an excellent combination of low frictional properties, good dimensional stability and electrostatic dissipation. Whenever virgin PTFE causes electrical discharge problems, SEMITRON ESd 500HR will provide a controlled bleed-off of static charges while maintaining typical PTFE-properties such as broad chemical resistance and low coefficient of friction.

white

## **SEMITRON ESd 520HR** (static dissipative PAI)

SEMITRON ESd 520HR has an industry first combination of electrostatic dissipation (ESd), high strength and heat resistance. This new ESd material is ideal for making nests, sockets and contactors for test equipment and other device handling components in the semiconductor industry. The key feature of SEMITRON 520HR is its unique ability to resist dielectric breakdown at high voltages (>100 V). Whereas e.g. typical carbon fibre enhanced products become irreversibly more conductive when exposed to even moderate voltages, SEMITRON ESd 520HR maintains its electrical performance throughout the voltage range 100 to 1000 V, while offering the mechanical performance needed to excel in demanding applications.

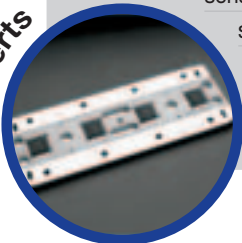
khaki grey

**Challenges:** In the semiconductor industry integrated circuits need to be transported to different locations for tests and measurements. The product holders need an accurate local protection and have to dissipate the static charges.

**Solution:** Inserts made of SEMITRON ESd 500HR have been integrated in the product holder. By using inserts of SEMITRON ESd 500HR both issues, protection and dissipation of static charges, were solved.

**Benefits:** Static dissipative SEMITRON ESd 500HR inserts reduce damage to sensitive devices due to static discharge and therefore ensure a longer life time of the device.

inserts



# Advanced Engineering Plastic Stock Shapes

PROPERTIES	Test methods	Units	DURATRON PBI	DURATRON T4203 PAI (15)	DURATRON T4301 PAI (15)	DURATRON T5530 PAI	KETRON PEEK-1000	KETRON PEEK-HPV
Colour	-	-	black	yellow-ochre	black	khaki grey	natural (brownish grey) / black	black
Density	ISO 1183-1	g/cm <sup>3</sup>	1.30	1.41	1.45	1.61	1.31	1.45
Water absorption:								
- after 24/96 h immersion in water of 23°C (1)	ISO 62	mg	38 / -	29 / -	26 / -	25 / -	5 / 10	4 / 9
	ISO 62	%	0.50 / -	0.35 / -	0.30 / -	0.26 / -	0.06 / 0.12	0.05 / 0.11
- at saturation in air of 23°C / 50% RH	-	%	7.5	2.5	1.9	1.7	0.20	0.16
- at saturation in water of 23°C	-	%	14	4.4	3.8	3.0	0.45	0.35
<b>Thermal Properties</b>								
Melting temperature (DSC, 10°C/min)	ISO 11357-1/-3	°C	NA	NA	NA	NA	340	340
Glass transition temperature (DSC, 20°C/min) - (2)	ISO 11357-1/-2	°C	225	280	280	280	-	-
Thermal conductivity at 23°C	-	W/(K.m)	0.40	0.26	0.54	0.36	0.25	0.78
Coefficient of linear thermal expansion:								
- average value between 23 and 100°C	-	m/(m.K)	25 x 10 <sup>-6</sup>	30 x 10 <sup>-6</sup>	25 x 10 <sup>-6</sup>	25 x 10 <sup>-6</sup>	50 x 10 <sup>-6</sup>	35 x 10 <sup>-6</sup>
- average value between 23 and 150°C	-	m/(m.K)	25 x 10 <sup>-6</sup>	30 x 10 <sup>-6</sup>	25 x 10 <sup>-6</sup>	25 x 10 <sup>-6</sup>	55 x 10 <sup>-6</sup>	40 x 10 <sup>-6</sup>
- average value above 150°C	-	m/(m.K)	25 x 10 <sup>-6</sup>	30 x 10 <sup>-6</sup>	25 x 10 <sup>-6</sup>	25 x 10 <sup>-6</sup>	130 x 10 <sup>-6</sup>	85 x 10 <sup>-6</sup>
Temperature of deflection under load:								
- method A: 1.8 MPa	ISO 75-1/-2	°C	425	280	280	280	160	195
Max. allowable service temperature in air :								
- for short periods (3)	-	°C	500	270	270	270	310	310
- continuously : for min. 20,000 h (4)	-	°C	310	250	250	250	250	250
Min. service temperature (5)	-	°C	-50	-50	-20	-20	-50	-20
Flammability (6):								
- "Oxygen Index"	ISO 4589-1/-2	%	58	45	44	50	35	43
- 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
<b>Mechanical Properties at 23°C (7)</b>								
Tension test (8):								
- tensile stress at yield /tensile stress at break (9)	ISO 527-1/-2	MPa	NA / 130	150 / -	NA / 110	NA / 125	115 / -	NA / 85
- tensile strength (9)	ISO 527-1/-2	MPa	130	150	110	125	115	85
- tensile strain at break (9)	ISO 527-1/-2	%	3	20	5	3	17	3
- tensile modulus of elasticity (10)	ISO 527-1/-2	MPa	5800	4200	5500	6400	4300	5900
Compression test (11):								
- compressive stress at 1 / 2% nominal strain (10)	ISO 604	MPa	49 / 96	34 / 67	39 / 72	55 / 104	38 / 75	44 / 86
Charpy impact strength - unnotched (12)	ISO 179-1/1eU	kJ/m <sup>2</sup>	-	no break	45	30	no break	25
Charpy impact strength - notched	ISO 179-1/1eA	kJ/m <sup>2</sup>	3.5	15	4	3.5	3.5	3
Ball indentation hardness (13)	ISO 2039-1	N/mm <sup>2</sup>	375	200	200	275	190	215
Rockwell hardness (13)	ISO 2039-2	-	E 120	E 80 (M 120)	M 106 (E 70)	E 85 (M125)	M 105	M 85
<b>Electrical Properties at 23 °C</b>								
Electric strength (14)	IEC 60243-1	kV/mm	22	24	-	28	24	-
Volume resistivity	IEC 60093	Ohm.cm	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>13</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	-
Surface resistivity	ANSI/ESD STM 11.11	Ohm/sq.	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	-
Relative permittivity ε <sub>r</sub> : - at 100 Hz	IEC 60250	-	3.3	4.2	6.0	4.4	3.2	-
- at 1 MHz	IEC 60250	-	3.2	3.9	5.4	4.2	3.2	-
Dielectric dissipation factor tan δ: - at 100 Hz	IEC 60250	-	0.001	0.026	0.037	0.022	0.001	-
- at 1 MHz	IEC 60250	-	-	0.031	0.042	0.050	0.002	-
Comparative tracking index (CTI)	IEC 60112	-	-	-	-	-	150	-

Note: 1 g/cm<sup>3</sup> = 1,000 kg/m<sup>3</sup> ; 1 MPa = 1 N/mm<sup>2</sup> ; 1 kV/mm = 1 MV/m.

NA : Not applicable

## Legend:

- (1) According to method 1 of ISO 62 and done on discs Ø 50 x 3 mm.
- (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) 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.
- (6) These estimated ratings, based on 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-yellow cards available for these stock shapes.
- (7) Most of the figures given for the mechanical properties of the extruded materials are average values of tests run on test specimens machined out of rod 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 (parallel to the extrusion direction).
- (8) Test specimens: Type 1 B
- (9) Test speed: 5 or 50 mm/min (chosen acc. to ISO 10350-1 as a function of the ductile behaviour of the material ; all materials showing a tensile strain at break ≥ 10% were tested at 50 mm/min)
- (10) Test speed: 1 mm/min.
- (11) Test specimens: cylinders Ø 8 x 16 mm
- (12) Pendulum used: 4 J.
- (13) 10 mm thick test specimens

## PHYSICAL PROPERTIES (INDICATIVE VALUES<sup>1)</sup>)

KETRON PEEK-GF30	KETRON PEEK-CA30	KETRON PEEK-TX	TECHTRON HPV PPS	QUADRANT PPSU	PSU 1000	DURATRON U1000 PEI	SYMALIT PVDF 1000	FLUOROSINT 500	FLUOROSINT 207	SEMITRON ESd 225	SEMITRON ESd 410C	SEMITRON ESd 500HR	SEMITRON ESd 520HR
<i>natural (brownish grey)</i>	<i>black</i>	<i>blue</i>	<i>deep blue</i>	<i>black</i>	<i>natural (yellow, translucent)</i>	<i>natural (amber, translucent)</i>	<i>natural (white)</i>	<i>ivory</i>	<i>white</i>	<i>beige</i>	<i>black</i>	<i>white</i>	<i>khaki grey</i>
1.51	1.40	1.39	1.42	1.29	1.24	1.27	1.78	2.32	2.30	1.33	1.41	2.30	1.58
5 / 10	4 / 9	4 / 9	1 / 2	25 / 54	19 / 38	16 / 34	1 / 3	14 / -	4 / -	392 / 705	-	4 / -	56 / -
0.05 / 0.10	0.05 / 0.11	0.05 / 0.10	0.01 / 0.02	0.30 / 0.65	0.24 / 0.48	0.19 / 0.40	0.01 / 0.03	0.10 / -	0.03 / -	5 / 9	-	0.03 / -	0.60 / -
0.16	0.16	0.18	0.05	0.50	0.30	0.70	0.05	-	-	0.8	0.60	-	-
0.35	0.35	0.40	0.20	1.10	0.80	1.30	0.05	3.0	2.0	10	1.10	2.0	-
340	340	340	280	NA	NA	NA	175	327	327	165	NA	327	NA
-	-	-	-	225	190	220	-	-	-	-	220	-	280
0.43	0.92	0.25	0.30	0.30	0.26	0.24	0.19	0.77	-	-	0.35	-	0.36
30 x 10 <sup>-6</sup>	25 x 10 <sup>-6</sup>	55 x 10 <sup>-6</sup>	50 x 10 <sup>-6</sup>	55 x 10 <sup>-6</sup>	60 x 10 <sup>-6</sup>	45 x 10 <sup>-6</sup>	130 x 10 <sup>-6</sup>	50 x 10 <sup>-6</sup>	85 x 10 <sup>-6</sup>	150 x 10 <sup>-6</sup>	35 x 10 <sup>-6</sup>	85 x 10 <sup>-6</sup>	25 x 10 <sup>-6</sup>
30 x 10 <sup>-6</sup>	25 x 10 <sup>-6</sup>	60 x 10 <sup>-6</sup>	60 x 10 <sup>-6</sup>	55 x 10 <sup>-6</sup>	60 x 10 <sup>-6</sup>	45 x 10 <sup>-6</sup>	145 x 10 <sup>-6</sup>	55 x 10 <sup>-6</sup>	90 x 10 <sup>-6</sup>	-	35 x 10 <sup>-6</sup>	90 x 10 <sup>-6</sup>	25 x 10 <sup>-6</sup>
65 x 10 <sup>-6</sup>	55 x 10 <sup>-6</sup>	140 x 10 <sup>-6</sup>	100 x 10 <sup>-6</sup>	55 x 10 <sup>-6</sup>	-	45 x 10 <sup>-6</sup>	-	85 x 10 <sup>-6</sup>	155 x 10 <sup>-6</sup>	-	35 x 10 <sup>-6</sup>	155 x 10 <sup>-6</sup>	25 x 10 <sup>-6</sup>
230	230	155	115	205	170	195	105	130	100	-	200	100	280
310	310	310	260	210	180	200	160	280	280	140	200	280	270
250	250	250	220	180	150	170	150	260	260	90	170	260	250
-20	-20	-20	-20	-50	-50	-50	-50	-20	-50	-50	-20	-50	-20
40	40	40	44	38	30	47	44	? 95	? 95	< 20	47	? 95	48
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	V-0 / V-0	V-0 / V-0	V-0 / V-0	HB / HB	V-0 / V-0	V-0 / V-0	V-0 / V-0
NA / 87	NA / 144	90 / -	NA / 78	83 / -	88 / -	129 / -	60 / -	8 / -	10 / -	NA / 38	NA / 62	10 / -	NA / 83
87	144	90	78	83	88	129	60	8	10	38	62	10	83
3	5	8	3.5	> 50	10	13	30	10	50	15	2	50	3
7000	9200	3750	4000	2450	2850	3500	2200	2200	1800	1500	5850	1800	5500
54 / 103	69 / 125	31 / 61	33 / 65	21 / 41	25 / 49	31 / 61	20 / 37	17 / 24	13 / 18	12.5 / 22	-	13 / 18	-
25	50	30	25	no break	no break	no break	no break	10	50	no break	-	50	-
3	5	3.5	4	12	3.5	3.5	10	5	8	8	4	8	4
215	310	165	160	95	115	165	110	-	-	70	-	-	-
M 100	M 102	M93	M 82	M 90	M 89	M 115	M 78	R 55	R 50	R 106	M 115	R 50	M 108
24	-	22	24	26	30	27	18	11	8	-	-	-	-
> 10 <sup>14</sup>	< 10 <sup>5</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	10 <sup>9</sup> - 10 <sup>11</sup>	10 <sup>4</sup> - 10 <sup>6</sup>	10 <sup>10</sup> - 10 <sup>12</sup>	10 <sup>10</sup> - 10 <sup>12</sup>
> 10 <sup>13</sup>	< 10 <sup>5</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	10 <sup>9</sup> - 10 <sup>11</sup>	10 <sup>4</sup> - 10 <sup>6</sup>	10 <sup>10</sup> - 10 <sup>12</sup>	10 <sup>10</sup> - 10 <sup>12</sup>
3.2	-	3.2	3.3	3.4	3.0	3.0	7.4	-	-	-	-	-	-
3.6	-	3.2	3.3	3.5	3.0	3.0	6.0	2.85	2.65	-	-	-	-
0.001	-	0.001	0.003	0.001	0.001	0.002	0.025	-	-	-	-	-	-
0.002	-	0.002	0.003	0.005	0.003	0.002	0.165	0.008	0.008	-	-	-	-
175	-	150	100	-	150	175	600	-	-	-	-	-	-

(14) 1 mm thick test specimens

Please note that the electric strength of KETRON PEEK-1000 black and QUADRANT PPSU black can be considerably lower than the figures listed in the table which refer to non-black material.

(15) It has to be noted that the property values of compression moulded DURATRON T4503 PAI, resp. DURATRON T4501 PAI stock shapes can significantly differ from those given in this table for extruded DURATRON T4203 PAI, resp. DURATRON T4301 PAI stock shapes. They have to be considered on an individual shape and dimension related basis. Please consult us.

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

It has to be noted that several 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 the extrusion or compression direction).

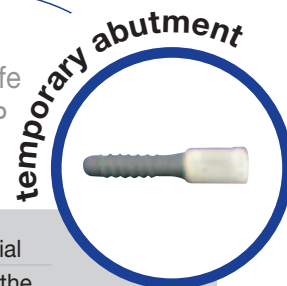
As a result of our internal continuous improvement programmes, availability and gathering of new and/or additional technical data, knowledge and experience, as well as changing market requirements and revised internationally recognised material & test standards, Quadrant Engineering Plastic Products is extending and updating its literature and technical information on a continuous basis. We therefore invite and recommend our customers to consult our website for the latest and up to date information on our materials.

# LIFE SCIENCE GRADES (LSG)

Quadrant EPP offers Life Science Grades which have been specifically developed for applications in the medical, pharmaceutical and biotechnology industries. The QEPP Life Science Grades portfolio includes plastics which comply with FDA, ISO 10993 and USP guidelines for biocompatibility testing of materials, saving testing costs and time while providing full traceability from raw material to stock shape.

## QUADRANT'S LIFE SCIENCE GRADES BIOCOMPATIBILITY TESTING

A comprehensive biocompatibility type testing programme was run by an independent, internationally renowned testing organisation on the QEPP Life Science Grades in order to check their compliance with both United States Pharmacopeia (USP) and ISO 10993-1 guideline requirements for Biocompatibility Testing of Materials. The test results reproduced in the table below indicate that, under the experimental conditions utilised in the testing, the examined QEPP Life Science Grades meet the requirements of the USP and ISO guidelines that are referenced. The table below also lists the results of heavy metal content tests run by means of Inductively Coupled Plasma Mass Spectrometry (ICP-MS).



**Challenges:** A material that better adapts to the gingiva form but is also biocompatible, was required by surgeons. Traditionally titanium has been used for both the healing cap and as a provisional implant to form the gingiva.

**Solution:** KETRON® PEEK-CLASSIX™ LSG is a high performance material offering excellent mechanical, thermal and chemical properties as well as biocompatibility.

**Benefits:** Enables completion of the abutment to the desired form, and the material can stay in the body for 30 days / 180 days with written approval.

MATERIALS	TESTS (1)(2)		1. Cytotoxicity	2. Sensitisation	3. Intracutaneous Reactivity	4. Systemic Toxicity	5. Implantation Test	6. Human blood compatibility	7. USP Physicochemical Test for Plastics	8. Heavy metal content (mg/kg)	USP Class VI
			Ref: ISO 10993-5 and USP <47>: Biological Reactivity Tests, In Vitro Elution Test	Ref: ISO 10993-10, Magnusson & Kjerman Maximization Method	Ref: ISO 10993-10 and USP <48>: Biological Reactivity Tests, In Vivo - Intracutaneous Test	Ref: ISO 10993-11 and USP <48>: Biological Reactivity Tests, In Vivo - Systemic Injection Test	Ref: USP <88>: Biological Reactivity Tests, In Vivo - Implantation Test (7 days)	Ref: ISO 10993-4, Indirect Hemolysis (in vitro)	Ref: USP <661>: Containers, Ultra Pure Water Extract, for 6Z4n	Testing the content of cadmium, chromium, lead and mercury by means of ICP-MS	(conclusion from tests 3, 4 and 5)
KETRON® PEEK-CLASSIX™ LSG white	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
KETRON® PEEK-CA30 LSG	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
KETRON® PEEK-GF30 LSG blue (RAL 5019)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
KETRON® PEEK LSG natural/black	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
TECHTRON® HPV LSG	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
QUADRANT LSG PPSU black	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DURATRON® LSG PEI natural	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PSU LSG natural	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PC LSG natural	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ACETRON® LSG	✓	NT	NT	NT	NT	NT	NT	✓	✓	✓	NT (3)

✓ This test was carried out and the material passed the test  
NT Not tested

- All tests were run on test specimens machined from rod diameter 50 mm shortly after manufacture.
- Quadrant EPP performs testing on its Life Science Grades in order to facilitate evaluation by its customers of their biocompatibility with regard to the requirements applicable to the specific use of the finished product. Quadrant EPP does not possess expertise in evaluating the suitability of its tested materials for use in specific medical, pharmaceutical, or biotechnological applications. **It remains the customer's sole responsibility to test and assess the suitability of Quadrant's Life Science Grades for its intended applications, processes and uses.**
- Please note that the virgin, natural coloured POM Copolymer resins used in the manufacture of all ACETRON® LSG stock shapes meet the requirements of USP Class VI (according to biocompatibility tests carried out on behalf of the resin suppliers), and that active Drug Master Files (DMF) on these resins are filed in the DMF-Database of the American Food and Drug Administration (FDA).

Quadrant Engineering Plastic Products makes no warranties or representations whatsoever that its materials are manufactured in accordance with the quality standards appropriate and necessary for materials intended for use in implantable medical device applications and in applications that are essential to the restoration or continuation of a bodily function important to the continuation of human life. Quadrant's Life Science Grades should not be used for applications involving medical devices that are intended to remain implanted in the human body continuously for a period exceeding 24 hours (30 days\*), or are intended to remain in contact with internal human tissue or bodily fluids for more than 24 hours (30 days\*), or as critical components of medical devices that are essential to the continuation of human life - \*: '30 days' applies to KETRON® PEEK-CLASSIX™ LSG white only.



# TIVAR®/PE 500

(Ultra) High Molecular Weight Polyethylene PE-UHMW & PE-HMW

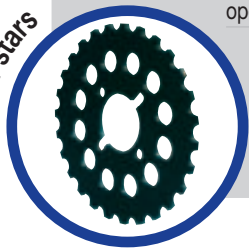
TIVAR is the brand name of Quadrant Engineering Plastic Products for its extensive range of virgin, partially reprocessed, coloured or modified Ultra High Molecular Weight Polyethylene stock shapes, manufactured by compression moulding or extrusion. In less demanding applications with respect to wear and impact resistance, PE 500 may present an economical alternative for the TIVAR standard grades.

**Challenges:** Bottling and canning lines require sliding elements with good sliding and wear properties. The material has to be resistant against impact and must withstand chemical cleaners.

**Solution:** Conveyor stars made of TIVAR 1000 show ideal features for applications in filling lines. TIVAR 1000 has excellent sliding properties and high wear resistance. Its high impact strength and mechanical damping ability protect bottles/cans and conveyor lines. A very good chemical resistance extends its lifetime and reduces downtimes.

**Benefits:** Filling, transportation and packaging lines profit from the outstanding sliding and wear properties of TIVAR 1000. Line operators appreciate its good working temperature range and vibration absorption capability (less noise).

conveyor stars



## MAIN CHARACTERISTICS

- Good wear and abrasion resistance
- High impact strength, even at low temperatures (particularly PE-UHMW)
- Excellent chemical resistance
- Low coefficient of friction
- Excellent release properties
- Very low water absorption
- Moderate mechanical strength, stiffness and creep resistance
- Very good electrical insulating and dielectric properties (except static dissipative grades)
- Excellent machinability
- Physiologically inert (several grades are suitable for food contact)

## APPLICATIONS

Gears, bearings, wear plates, support-, tension- and deflecting rollers, rope pulleys, chain sprockets, bumpers, scraper blades, piston rings and packings, seals, valves, hammerheads, conveyor screws, star wheels and bends, corner tracks, parcel chutes, pumps, filter plates, pickers, beater caps, linings for bunkers, silos, chutes and funnels for bulk materials, punching plates, cutting and chopping boards, ...

The following overview shows our available polyethylene grades. More detailed information available on request.

### TIVAR 1000



PE-UHMW combines very good wear and abrasion resistance with outstanding impact strength.

natural  
black  
colours

### TIVAR 1000 R

Partially reprocessed PE-UHMW; much better impact strength and wear resistance compared with virgin PE 500 - economical grade.

green  
black

### TIVAR 1000 ESD

PE-UHMW + carbon black: static dissipative.

black

### PE 500



PE-HMW

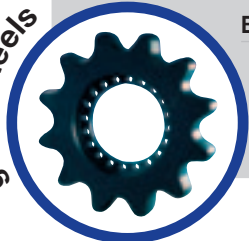
natural  
colours

**Challenges:** Grooming vehicles require gear wheels with high load bearing capacity, impact strength and wear resistance.

**Solution:** TIVAR TECH offers high wear properties, impact resistance and mechanical loading capability.




**Benefits:** Longer life time, less breakage and downtimes and therefore cost savings.

gear wheels

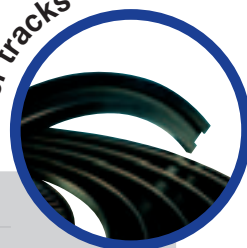


# TIVAR® Proprietary Grades

Quadrant Engineering Plastic Products focuses on innovation by modification of TIVAR 1000 standard materials in order to meet specific market requirements. The TIVAR Proprietary Grades offer improved sliding and wear properties, static dissipative characteristics, enhanced release properties or other improved characteristics.

black	<b>TIVAR DrySlide</b>	PE-UHMW + internal lubricant + other additives
grey-black	<b>TIVAR TECH</b>	PE-UHMW + MoS <sub>2</sub>
grey	<b>TIVAR Oil Filled</b> 	PE-UHMW + oil
natural	<b>TIVAR SurfaceProtect</b> 	PE-UHMW + additives
black	<b>TIVAR ChainLine</b>	Partially reprocessed PE-UHMW + internal lubricant + other additives
green	<b>TIVAR Cestigreen</b>	PE-UHMW + specific additives
grey yellow	<b>TIVAR DS</b>	PE-UHMW + additives
yellow-green	<b>TIVAR CeramP</b>	PE-UHMW + micro glass beads + other additives
grey	<b>TIVAR SuperPlus</b>	PE-UHMW, partially cross-linked + specific additives
pastel turquoise	<b>TIVAR Xtended Wear</b>	PE-UHMW, hybrid material
bicoloured	<b>TIVAR VisiLiner</b>	PE-UHMW + specific additives
bright white	<b>TIVAR H.O.T.</b> 	PE-UHMW + specific additives
black	<b>TIVAR Burnguard</b>	PE-UHMW + flame retardant + other additives
black	<b>TIVAR CleanStat</b>	PE-UHMW + specific additives
black	<b>TIVAR 1000 ASTL</b>	PE-UHMW + specific additives
black	<b>TIVAR 1000 EC</b>	PE-UHMW + specific additives
natural	<b>Borotron UH &amp; HM</b>	PE-UHMW (UH) or PE-HMW (HM) + boron based additives

corner tracks

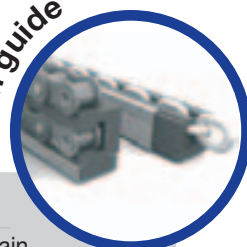


**Challenges:** Leading European bottlers needed conveying elements with excellent sliding properties. They also wanted to reduce the noise level in their factories.

**Solution:** TIVAR DrySlide is a PE-UHMW with built-in lubrication, providing smooth and low friction sliding movements as well as a considerable noise reduction around the filling and bottling line areas.

**Benefits:** Chains and belts benefit from the superior sliding properties of TIVAR DrySlide, even at high speeds. Its specific formulation makes it a perfect sliding material for numerous sliding and wear elements in bottling, packaging and conveying lines.

chain guide



**Challenges:** High-speed conveyor lines require chain guides with optimum sliding properties. Operating companies look for cost saving possibilities.

**Solution:** TIVAR ChainLine was developed to satisfy these requirements. Sliding properties are improved by the built-in lubrication. Cost saving is achieved by reprocessed PE-UHMW content.

**Benefits:** External lubrication of the chain guides is not necessary. Because of this, TIVAR ChainLine reduces downtime and helps save production costs. Its static dissipative properties are often an additional asset.



## Learn more online at [www.quadrantplastics.com](http://www.quadrantplastics.com)

Quadrant has extensive product and machining resources available online. Our website is a portal to a wealth of technical data and the easiest way to engage our application specialists. Our team stands ready to help offer solutions to your toughest problems.

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