

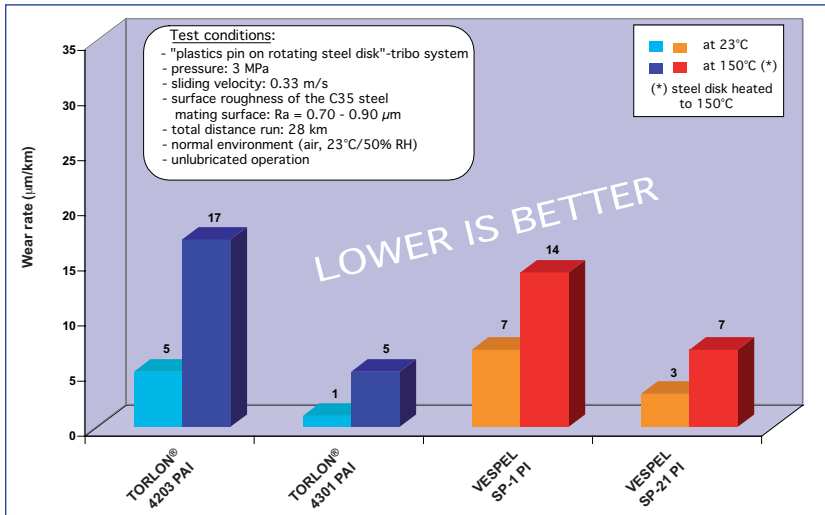


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COMPARE BEARING AND WEAR PERFORMANCE.

Quadrant's expertise in bearing and wear additive technology led to TORLON® 4301, developed to outlast most advanced materials with its combination of high PV and low wear factor.

COMPARE COST :

From 150°C to 260°C, TORLON® PAI delivers high strength, stability and wear resistance extremely cost-effectively. Comparable sizes of shapes for machining cost up to 4-5 times less for TORLON® PAI than for PI. For higher temperatures, consider Quadrant's DURATRON® PI – where performance is in line with cost.

Typical Applications:



Semiconductor production equipment :

- Test sockets, wafer retention rings, mechanical components
- Electrically insulative and dissipative grades.



Process and production equipment :

- Extreme wear resistance and high pressure-velocity capability can eliminate lubrication and extend part life at temperatures over 150°C.



Industrial and defense electrical/electronics :

- Dimensionally stable connectors, fixtures, structural and dynamic wear components.



Aircraft, transportation equipment :

- Seals, electrical connectors, load-bearing mechanical and wear components.



Chemical and gas handling:

- Wear resistance over specialty alloys improves Mean Time Between Replacement (MTBR) for seats, seals and rings.

TORLON® PAI grades overview

TYPES	PRODUCT NAMES	ADDITIVES	APPLICATIONS
Wear Resistant Grades	TORLON® 4301 & 4501 PAI	12% graphite 3% PTFE	Sleeve and slide bearings (bushings, thrust washers, slideways, guides, ...) valve seats and seals
High Strength Grades	TORLON® 4203 & 4503 PAI	TiO ₂	Broad electrical, structural use such as connectors, insulators, bushings, sockets
	TORLON® 5530 PAI	30% glass fibres	High strength use in semicon test sockets, aerospace and aircraft components, rigid insulators
	TORLON® 4XG PAI	30% glass fibres	
	TORLON® 4XCF PAI	30% carbon fibres	Extreme strength use, replacing metals in seals, housings, impellers, valves
Specialty Grades	SEMISTRON® Esd 520HR	Static dissipative	Static dissipative test sockets, use in precision electronics manufacturing

PHYSICAL PROPERTIES OF THE TORLON® PAI GRADES (INDICATIVE VALUES*)

PROPERTIES	Test methods	Units	TORLON®	TORLON®	TORLON®	TORLON®	TORLON®	SEMITRON
			4203 PAI (12)	4301 PAI (12)	5530 PAI	4XG	4XCF	Esd 520HR
			EXTRUDED	EXTRUDED	COMPRESSION MOULDED	EXTRUDED	EXTRUDED	COMPRESSION MOULDED
Colour	-	-	yellow-ochre	black	khaki grey	khaki grey	black	khaki grey
Density	ISO 1183-1	g/cm ³	1.41	1.45	1.61	1.60	1.47	1.58
Water absorption:								
- after 24 h immersion in water of 23°C (1)	ISO 62	%	0.35	0.30	0.26	0.26	0.28	0.60
- at saturation in air of 23 °C / 50% RH	-	%	2.5	1.9	1.7	1.7	1.7	2.6
- at saturation in water of 23 °C	-	%	4.4	3.8	3.2	3.2	3.1	4.6
Thermal Properties								
Glass transition temperature (DSC, 20°C/min)	ISO 11357-1/-2	°C	280	280	280	280	280	280
Coefficient of linear thermal expansion:								
- average value between 23 and 150 °C	-	m/(m.K)	40 x 10 ⁻⁶	35 x 10 ⁻⁶	35 x 10 ⁻⁶	25 x 10 ⁻⁶	20 x 10 ⁻⁶	35 x 10 ⁻⁶
- average value between 150 and 250 °C	-	m/(m.K)	50 x 10 ⁻⁶	40 x 10 ⁻⁶	40 x 10 ⁻⁶	30 x 10 ⁻⁶	25 x 10 ⁻⁶	40 x 10 ⁻⁶
Temperature of deflection under load:								
- method A: 1.8 MPa	ISO 75-1/-2	°C	280	280	280	280	280	280
Max. allowable service temperature in air :								
- for short periods (2)	-	°C	270	270	270	270	270	270
- continuously : for about 20,000 h (3)	-	°C	250	250	250	250	250	250
Flammability (4):								
- "Oxygen Index"	ISO 4589-1/-2	%	45	44	50	51	52	48
- 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
Mechanical Properties at 23 °C								
Tension test (5):								
- tensile stress at yield/tensile stress at break (6)	ISO 527-1/-2	MPa	150 / -	NYP / 110	NYP / 125	NYP / 140	NYP / 135	NYP / 83
- tensile strength (6)	ISO 527-1/-2	MPa	150	110	125	140	135	83
- tensile strain at break (6)	ISO 527-1/-2	%	20	5	3	4	2.5	3
- tensile modulus of elasticity (7)	ISO 527-1/-2	MPa	4200	5500	6400	7000	8400	5500
Compression test (8):								
- compressive stress at 1 / 2% nominal strain (7)	ISO 604	MPa	34 / 67	39 / 72	55 / 104	58 / 110	65 / 124	42 / 80
Charpy impact strength - unnotched (9)	ISO 179-1/1eU	kJ/m ²	no break	45	30	60	35	20
Charpy impact strength - notched	ISO 179-1/1eA	kJ/m ²	15	4	3.5	5	4	4
Ball indentation hardness (10)	ISO 2039-1	N/mm ²	200	200	275	300	350	250
Rockwell hardness (10)	ISO 2039-2	-	E 80 (M 120)	M 106 (E 70)	E 85 (M 125)	E 87	E 91	M 110 (E 73)
Electrical Properties at 23 °C								
Electric strength (11)	IEC 60243-1	kV/mm	24	-	28	28	-	-
Surface resistivity	ANSI/ESD STM 11.11	Ohm/sq.	> 10 ¹³	> 10 ¹³	> 10 ¹³	> 10 ¹³	< 10 ⁵	10 ¹⁰ - 10 ¹²
Relative permittivity ε _r : - at 100 Hz								
- at 1 MHz	IEC 60250	-	4.2	6.0	4.4	4.4	-	-
Dielectric dissipation factor tan δ : - at 100 Hz								
- at 1 MHz	IEC 60250	-	0.026	0.037	0.022	0.022	-	-
- at 1 MHz	IEC 60250	-	0.031	0.042	0.050	0.050	-	-

Note: 1 g/cm³ = 1,000 kg/m³; 1 MPa = 1 N/mm²; 1 kV/mm = 1 MV/m

NYP: there is no yield point

Legend:

- According to method 1 of ISO 62 and done on discs ∅ 50 x 3 mm.
- Only for short time exposure (a few hours) in applications where no or only a very low load is applied to the material.
- Temperature resistance over a period of about 20,000 hours. After this period of time, there is a decrease in tensile strength – measured at 23°C – of about 50% as compared with the original value. The temperature values given here are therefore 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.
- These estimated ratings, derived from raw material supplier data, are not intended to reflect hazards presented by the materials under actual fire conditions. There are no 'UL File Numbers' available for the TORLON® PAI stock shapes.
- Test specimens: Type 1 B
- Test speed: 5 or 50 mm/min [chosen acc. to ISO 10350-1 as a function of the ductile behaviour of the material (tough or brittle) ; only TORLON® 4203 PAI was tested at 50 mm/min].
- Test speed: 1 mm/min
- Test specimens: cylinders ∅ 8 x 16 mm
- Pendulum used: 4 J
- Measured on 10 mm thick test specimens.
- Electrode configuration: ∅ 25 / ∅ 75 mm coaxial cylinders ; in transformer oil according to IEC 60296 ; 1 mm thick test specimens.
- It has to be noted that the property values of compression moulded TORLON® 4503 PAI, resp. TORLON® 4501 PAI stock shapes can significantly differ from those given in this table for extruded TORLON® 4203 PAI, resp. TORLON® 4301 PAI stock shapes. They have to be considered on an individual shape and dimension related basis. Please consult us.

* This table, mainly to be used for comparison purposes, 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 hence show an anisotropic behaviour (properties differ when measured parallel and perpendicular to the extrusion or compression direction).

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AVAILABILITY Our new wider range of shapes and sizes extend the application range for TORLON® PAI. We now offer TORLON® 4203 PAI rod up to 5.00" (127 mm) diameter and TORLON® 4301 PAI rod up to 3.00" (76.2 mm). Contact www.quadrantplastics.com for more information.

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