TORLON®
Polyamide-imide (PAI)

Main Characteristics:
- Very high max. allowable service temperature in air (250°C continuously)
- Excellent retention of mechanical strength, stiffness and creep resistance over a wide range of temperatures
- Extremely low coefficient of linear thermal expansion up to 250°C
- Excellent wear and frictional behaviour (particularly TORLON® 4301 PAI)
- Excellent UV resistance
- Inherent low-flammability
- Exceptional resistance against high energy radiation (gamma and X rays)

The TORLON® PAI grades, combining excellent retention of mechanical strength, stiffness and creep resistance over a wide temperature range with extremely low thermal expansion up to 250°C, are top-rank materials for high temperature applications.

We distinguish five grades:

TORLON® 4501 PAI
(PAI + graphite + PTFE)
Colour: Black
This compression moulded material is similar in composition to TORLON® 4301 PAI, and is selected when larger shapes are required.

TORLON® 5530 PAI
(PAI + GF30)
Colour: Khaki grey
This compression moulded, 30% glass fibre reinforced grade offers higher stiffness, mechanical strength and creep resistance than TORLON® 4203 PAI and TORLON® 4503 PAI. It is well suited for structural applications supporting static loads for long periods of time at high temperatures. The suitability of TORLON® 5530 PAI for sliding parts, however, is to be carefully examined since the glass fibres tend to abrade the mating surface.

TORLON® 4203 PAI
(PAI)
Colour: Yellow ochre
TORLON® 4203 PAI offers the best toughness and impact strength of all TORLON® PAI grades. Because of its intrinsic high temperature resistance, high dimensional stability and good machinability, this extruded TORLON® 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.

TORLON® 4503 PAI
(PAI)
Colour: Yellow ochre
This compression moulded material is similar in composition to TORLON® 4203 PAI, and is selected when larger shapes are required.

TORLON® 4301 PAI
(PAI + graphite + PTFE)
Colour: Black
The addition of graphite and PTFE provides higher wear resistance and lower coefficient of friction compared to the unfilled grade as well as little or no stick-slip in use. This extruded grade excels in severe wear applications such as non-lubricated bearings, seals, bearings cages and reciprocating compressor parts.

TORLON® 4203 PAI

Polyamide-imide (PAI)

TORLON® 4203 PAI offers the best toughness and impact strength of all TORLON® PAI grades. Because of its intrinsic high temperature resistance, high dimensional stability and good machinability, TORLON® 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.

- High maximum service temperature (250°C)
- Inherent low flammability
- Outstanding dimensional stability (to +250°C)
- Excellent retention of mechanical strength / stiffness over a wide range of temperatures
- Excellent resistance against high energy radiation
- Exceptional wear resistance
- Excellent dielectric and insulating properties

Common Applications:
Connectors; Switches; Relays; Thrust washers; Valve seats; Piston rings; Mechanical linkages; Bushes; Electrical and thermal insulators.

Delivery Programme

	min	max
Rod 2440mm long diameter (mm)	2.38	50.8
Plate 1220mm long width (mm)	305	
thickness (mm)	6.35	25.4

Colour: Yellow ochre

Technical Specification

Property	ISO Method	Units	Values
Density	1183	g/cm^3	1.41
Water absorption*1			
· after 24h immersion in water (23°C)	62	mg	29
	62	%	0.35
· Saturation in air (23°C/50% RH)	~	%	2.5
· Saturation in water (23°C)	~	%	4.4
Melting temperature	~	°C	N/A
Glass transition temperature	~	°C	280
Thermal conductivity at 23˚C	~	W/(K.m)	0.26
Coefficient of linear thermal expansion			
· average value between 23 - 100˚C	~	m/(m-K)	30.10^{-6}
· average value between 23 - 150˚C	~	m/(m-K)	30.10^{-6}
· average value above 150˚C	~	m/(m-K)	30.10^{-6}
Temperature of deflection under load			
· method A: 1.8 MPa	75	°C	280
Max allowable service temperature in air			
· for short periods*2	~	°C	270
· continuously for 20,000 hrs*3	~	°C	250
Flammability*4			
· "Oxygen Index"	4589	%	45
· according to UL94 (1.5/3mm thickness)	~	~	V-0/V-0
Tension Test*5			
· Stress at yield*6	527	MPa	120
· Strain at break*6	527	%	10
· Tensile modulus of elasticity*7	527	MPa	4500
Compression Test*8			
· Stress at 1/2% nominal strain*7	604	MPa	27/53
Impact - Charpy*9	179/1eU	kJ/m^2	no break
Impact - Charpy notched	179/1eA	kJ/m^2	10
Ball Indentation hardness*10	2039-1	N/mm^2	200
Hardness Rockwell*10	2039-2	~	E80 M120
Electric Strength*11	60243	KV/mm	24
Volume resistivity	60093	Ω.cm	>10^{14}
Surface resistivity	60093	Ω	>10^{13}
Relative Permittivity at 1 Mhz	60250	~	3.9
Dielectric dissipation factor "	60250	~	0.031

*1 - According to method 1 of ISO62 and done on discs Ø 50 x 3mm
*2 - Only for short time exposure (a few hours) in applications where no or only a very low load is applied to the material
*3 - Temperature resistance over a period of min. 20,000 hours. After this there is a decrease in tensile strength of about 50% as compared with the original value. The temperature value given here is thus based on the thermal-oxidative degradation which takes place and causes a reduction in properties. Note however, that the max. allowable service temp. depends in many cases essentially on the duration and the magnitude of the mechanical stresses to which the material is subjected.
*4 - These mostly estimated ratings, derived from raw material supplier data, are not intended to reflect hazards presented by the materials under actual fire conditions. There is no UL yellow card available for TORLON 4203 stock shapes.
*5 - Test specimens: Type 1B
*6 - Test Speed: 5mm/min
*8 - Test specimens: cylinders ø 12 x 30mm
*10 - Test specimens: 10mm thick
*7 - Test Speed: 1mm/min
*9 - Pendulum used: 4 J
*11 - Test specimens: 1mm thick

PRODUCT DATA SHEET

TORLON® 4203 PAI

TORLON® 4503 PAI

Polyamide-imide (PAI)

This compression moulded material is similar in composition to TORLON® 4203 PAI, and is selected when larger shapes are required.

- High maximum service temperature (250°C)
- Inherent low flammability
- Outstanding dimensional stability (to +250°C)
- Excellent retention of mechanical strength / stiffness over a wide range of temperatures
- Excellent resistance against high energy radiation
- Exceptional wear resistance
- Excellent dielectric and insulating properties

Common Applications:
Connectors; Switches; Relays; Thrust washers; Valve seats; Piston rings; Mechanical linkages; Bushes; Electrical and thermal insulators.

Delivery Programme

	min	max
Rod 153mm long		
diameter (mm)	57.15	381.0
Tube 203m long		
outer diameter (mm)	42.86	193.68
inner diameter (mm)	19.05	107.95
Tube 153m long		
outer diameter (mm)	196.85	882.65
inner diameter (mm)	50.80	736.6

Colour: Yellow ochre

Technical Specification

Property	ISO Method	Units	Values
Density	1183	g/cm^3	1.41
Water absorption*1			
· after 24h immersion in water (23°C)	62	mg	29
	62	%	0.35
· Saturation in air (23°C/50% RH)	~	%	2.5
· Saturation in water (23°C)	~	%	4.4
Melting temperature	~	°C	N/A
Glass transition temperature	~	°C	280
Thermal conductivity at 23˚C	~	W/(K.m)	0.26
Coefficient of linear thermal expansion			
· average value between 23 - 100°C	~	m/(m-K)	30.10^{-6}
· average value between 23 - 150°C	~	m/(m-K)	30.10^{-6}
· average value above 150°C	~	m/(m-K)	30.10^{-6}
Temperature of deflection under load			
· method A: 1.8 MPa	75	°C	280
Max allowable service temperature in air			
· for short periods*2	~	°C	270
· continuously for 20,000 hrs*3	~	°C	250
Flammability *4			
· "Oxygen Index"	4589	%	45
· according to UL94 (1.5/3mm thickness)	~	~	V-0/V-0
Tension Test*5			
· Stress at yield*6	527	MPa	120
· Strain at break*6	527	%	10
· Tensile modulus of elasticity*7	527	MPa	4500
Compression Test*8			
· Stress at 1/2% nominal strain*7	604	MPa	27/53
Impact - Charpy*9	179/1eU	kJ/m^2	no break
Impact - Charpy notched	179/1eA	kJ/m^2	10
Ball Indentation hardness*10	2039-1	N/mm^2	200
Hardness Rockwell*10	2039-2	~	E80 M120
Electric Strength*11	60243	KV/mm	24
Volume resistivity	60093	Ω.cm	>10^{14}
Surface resistivity	60093	Ω	>10^{13}
Relative Permittivity at 1 Mhz	60250	~	3.9
Dielectric dissipation factor "	60250	~	0.031

*1 - According to method 1 of ISO62 and done on discs Ø 50 x 3mm
*2 - Only for short time exposure (a few hours) in applications where no or only a very low load is applied to the material
*3 - Temperature resistance over a period of min. 20,000 hours. After this there is a decrease in tensile strength of about 50% as compared with the original value. The temperature value given here is thus based on the thermal-oxidative degradation which takes place and causes a reduction in properties. Note however, that the max. allowable service temp. depends in many cases essentially on the duration and the magnitude of the mechanical stresses to which the material is subjected.
*4 - These mostly estimated ratings, derived from raw material supplier data, are not intended to reflect hazards presented by the materials under actual fire conditions. There is no UL yellow card available for TORLON 4503 stock shapes.
*5 - Test specimens: Type 1B
*6 - Test Speed: 5mm/min
*8 - Test specimens: cylinders ø 12 x 30mm
*10 - Test specimens: 10mm thick
*12 - It has to be noted that the figures given for the properties of this TORLON grade have been derived form tests run on test specimens from extruded material.
*7 - Test Speed: 1mm/min
*9 - Pendulum used: 4 J
*11 - Test specimens: 1mm thick

PRODUCT DATA SHEET

TORLON® 4503 PAI

TORLON® 4301 PAI

Polyamide-imide (PAI + graphite+PTFE)

The addition of graphite and PTFE provides higher wear resistance and lower coefficient of friction compared to the unfilled grade as well as little or no stick-slip in use. This extruded grade excels in severe wear applications such as non-lubricated bearing, seals, bearings cages and reciprocating compressor parts.

- High maximum service temperature (250°C)
- Inherent low flammability
- Outstanding dimensional stability (to +250°C)
- Excellent retention of mechanical strength / stiffness over a wide range of temperatures
- Excellent resistance against high energy radiation
- Exceptional wear and frictional behaviour
- Excellent dielectric and insulating properties

Common Applications:
Bearings; Seals; Bearing cages; Reciprocating compressor parts; Thrust washers; Valve seats; Piston rings; vanes; Wear pads.

Delivery Programme

	min	max
Rod 2400mm long		
diameter (mm)	6.35	50.80
Plate 1220mm long		
width (mm)	305	
thickness (mm)	6.35	25.40

Colour: Black

Technical Specification

Property	ISO Method	Units	Values
Density	1183	g/cm^3	1.45
Water absorption*1			
· after 24h immersion in water (23°C)	62	mg	26
	62	%	0.3
· Saturation in air (23°C/50% RH)	~	%	1.9
· Saturation in water (23°C)	~	%	3.8
Melting temperature	~	°C	N/A
Glass transition temperature	~	°C	280
Thermal conductivity at 23˚C	~	W/(K.m)	0.54
Coefficient of linear thermal expansion			
· average value between 23 - 100˚C	~	m/(m-K)	25.10^{-6}
· average value between 23 - 150˚C	~	m/(m-K)	25.10^{-6}
· average value above 150˚C	~	m/(m-K)	25.10^{-6}
Temperature of deflection under load			
· method A: 1.8 MPa	75	°C	280
Max allowable service temperature in air			
· for short periods*2	~	°C	270
· continuously for 20,000 hrs*3	~	°C	250
Flammability*4			
· "Oxygen Index"	4589	%	44
· according to UL94 (1.5/3mm thickness)	~	~	V-0/V-0
Tension Test*5			
· Stress at break*6	527	MPa	80
· Strain at break*6	527	%	5
· Tensile modulus of elasticity*7	527	MPa	5800
Compression Test*8			
· Stress at 1/2% nominal strain*7	604	MPa	31/58
Impact - Charpy notched	179/1eA	kJ/m^2	4
Ball Indentation hardness*9	2039-1	N/mm^2	200
Hardness Rockwell*9	2039-2	~	M105
Volume resistivity	60093	Ω.cm	>10^{13}
Surface resistivity	60093	Ω	>10^{13}
Relative Permittivity at 1 Mhz	60250	~	5.4
Dielectric dissipation factor "	60250	~	0.042

*1 - According to method 1 of ISO62 and done on discs Ø 50 x 3mm
*2 - Only for short time exposure (a few hours) in applications where no or only a very low load is applied to the material
*3 - Temperature resistance over a period of min. 20,000 hours. After this there is a decrease in tensile strength of about 50% as compared with the original value. The temperature value given here is thus based on the thermal-oxidative degradation which takes place and causes a reduction in properties. Note however, that the max. allowable service temp. depends in many cases essentially on the duration and the magnitude of the mechanical stresses to which the material is subjected.
*4 - These mostly estimated ratings, derived from raw material supplier data, are not intended to reflect hazards presented by the materials under actual fire conditions. There is no UL yellow card available for TORLON 4301 stock shapes.
*5 - Test specimens: Type 1B
*6 - Test Speed: 5mm/min
*8 - Test specimens: cylinders ø 12 x 30mm
*7 - Test Speed: 1mm/min
*9 - Test specimens: 10mm thick

TORLON® 4501 PAI

Polyamide-imide (PAI + graphite+PTFE)

This compression moulded material is similar in composition to TORLON® 4301 PAI, and is selected when larger shapes are required.

- High maximum service temperature (250°C)
- Inherent low flammability
- Outstanding dimensional stability (to +250°C)
- Excellent retention of mechanical strength / stiffness over a wide range of temperatures
- Excellent resistance against high energy radiation
- Exceptional wear and frictional behaviour
- Excellent dielectric and insulating properties

Common Applications:
Bearings; Seals; Bearing cages; Reciprocating compressor parts; Thrust washers; Valve seats; Piston rings; vanes; Wear pads.

Delivery Programme

	min	max
Rod 153mm long		
diameter (mm)	50.8	381.00
Tube 203m long		
outer diameter (mm)	42.86	193.68
inner diameter (mm)	19.05	107.95
Tube 153m long		
outer diameter (mm)	196.85	882.65
inner diameter (mm)	50.80	736.6
Plate 305mm long		
width (mm)	305	
thickness (mm)	9.53	50.80
Plate 610mm long		
width (mm)	305	
thickness (mm)	9.53	38.10

Colour: Black

Technical Specification

Property	ISO Method	Units	Values
Density	1183	g/cm^3	1.45
Water absorption*1			
· after 24h immersion in water (23°C)	62	mg	26
	62	%	0.3
· Saturation in air (23°C/50% RH)	~	%	1.9
· Saturation in water (23°C)	~	%	3.8
Melting temperature	~	°C	N/A
Glass transition temperature	~	°C	280
Thermal conductivity at 23°C	~	W/(K.m)	0.54
Coefficient of linear thermal expansion			
· average value between 23 - 100°C	~	m/(m-K)	25.10^{-6}
· average value between 23 - 150°C	~	m/(m-K)	25.10^{-6}
· average value above 150°C	~	m/(m-K)	25.10^{-6}
Temperature of deflection under load			
· method A: 1.8 MPa	75	°C	280
Max allowable service temperature in air			
· for short periods*2	~	°C	270
· continuously for 20,000 hrs*3	~	°C	250
Flammability*4			
· "Oxygen Index"	4589	%	44
· according to UL94 (1.5/3mm thickness)	~	~	V-0/V-0
Tension Test*5			
· Stress at break*6	527	MPa	80
· Strain at break*6	527	%	5
· Tensile modulus of elasticity*7	527	MPa	5800
Compression Test*8			
· Stress at 1/2% nominal strain*7	604	MPa	31/58
Impact - Charpy notched	179/1eA	kJ/m^2	4
Ball Indentation hardness*9	2039-1	N/mm^2	200
Hardness Rockwell*9	2039-2	~	M105
Volume resistivity	60093	Ω.cm	>10^{13}
Surface resistivity	60093	Ω	>10^{13}
Relative Permittivity at 1 Mhz	60250	~	5.4
Dielectric dissipation factor "	60250	~	0.042

*1 - According to method 1 of ISO62 and done on discs Ø 50 x 3mm
*2 - Only for short time exposure (a few hours) in applications where no or only a very low load is applied to the material
*3 - Temperature resistance over a period of min. 20,000 hours. After this there is a decrease in tensile strength of about 50% as compared with the original value. The temperature value given here is thus based on the thermal-oxidative degradation which takes place and causes a reduction in properties. Note however, that the max. allowable service temp. depends in many cases essentially on the duration and the magnitude of the mechanical stresses to which the material is subjected.
*4 - These mostly estimated ratings, derived from raw material supplier data, are not intended to reflect hazards presented by the materials under actual fire conditions. There is no UL yellow card available for TORLON 4501 stock shapes.
*5 - Test specimens: Type 1B
*6 - Test Speed: 5mm/min
*7 - Test Speed: 1mm/min
*8 - Test specimens: cylinders ø 12 x 30mm
*9 - Test specimens: 10mm thick
*10 - It has to be noted that the figures given for the properties of this TORLON grade have been derived form tests run on test specimens from extruded material.

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TORLON® 4501 PAI

TORLON® 5530 PAI

Polyamide-imide (PAI+GF30)

This compression moulded, 30% glass fibre reinforced grade offers higher stiffness, mechanical strength and creep resistance than TORLON® 4203 PAI and TORLON® 4503 PAI. It is well suited for structural applications supporting static loads for long periods of time at high temperatures. The suitability of TORLON® 5530 PAI for sliding parts, however, is to be carefully examined since the glass fibres tend to abrade the mating surface.

- High maximum service temperature (250°C)
- Inherent low flammability
- Outstanding dimensional stability (to +250°C)
- Excellent retention of mechanical strength / stiffness over a wide range of temperatures
- Excellent resistance against high energy radiation
- Exceptional wear and frictional behaviour
- Excellent dielectric and insulating properties

Common Applications:
Bearings; Seals; Bearing cages; Reciprocating compressor parts; Thrust washers; Valve seats; Piston rings; vanes; Wear pads.

Delivery Programme

	min	max
Rod 153mm long		
diameter (mm)	50.80	381.0
Tube 203m long		
outer diameter (mm)	42.86	193.68
inner diameter (mm)	19.05	107.95
Tube 153m long		
outer diameter (mm)	196.85	882.65
inner diameter (mm)	50.80	736.6
Plate 305mm long		
width (mm)	305	
thickness (mm)	9.53	50.80
Plate 610mm long		
width (mm)	305	
thickness (mm)	9.53	38.10

Colour: Khaki grey

Technical Specification

Property	ISO Method	Units	Values
Density	1183	g/cm^3	1.61
Water absorption*1			
· after 24h immersion in water (23°C)	62	mg	25
	62	%	0.26
· Saturation in air (23°C/50% RH)	~	%	1.7
· Saturation in water (23°C)	~	%	3.0
Melting temperature	~	°C	N/A
Glass transition temperature	~	°C	280
Thermal conductivity at 23°C	~	W/(K.m)	0.36
Coefficient of linear thermal expansion			
· average value between 23 - 100°C	~	m/(m-K)	25.10^{-6}
· average value between 23 - 150°C	~	m/(m-K)	25.10^{-6}
· average value above 150°C	~	m/(m-K)	25.10^{-6}
Temperature of deflection under load			
· method A: 1.8 MPa	75	°C	280
Max allowable service temperature in air			
· for short periods*2	~	°C	270
· continuously for 20,000 hrs*3	~	°C	250
Flammability*4			
· "Oxygen Index"	4589	%	50
· according to UL94 (1.5/3mm thickness)	~	~	V-0/V-0
Tension Test*5			
· Stress at break*6	527	MPa	95
· Strain at break*6	527	%	3
· Tensile modulus of elasticity*7	527	MPa	6200
Impact - Charpy notched	179/1eA	kJ/m^2	3.5
Hardness Rockwell*8	2039-2	~	E85 M125
Electric Strength*9	60243	KV/mm	28
Volume resistivity	60093	Ω.cm	$>10^{13}$
Surface resistivity	60093	Ω	$>10^{13}$
Relative Permittivity at 1 Mhz	60250	~	4.2
Dielectric dissipation factor "	60250	~	0.050

*1 - According to method 1 of ISO62 and done on discs Ø 50 x 3mm
*2 - Only for short time exposure (a few hours) in applications where no or only a very low load is applied to the material
*3 - Temperature resistance over a period of min. 20,000 hours. After this there is a decrease in tensile strength of about 50% as compared with the original value. The temperature value given here is thus based on the thermal-oxidative degradation which takes place and causes a reduction in properties. Note however, that the max. allowable service temp. depends in many cases essentially on the duration and the magnitude of the mechanical stresses to which the material is subjected.
*4 - These mostly estimated ratings, derived from raw material supplier data, are not intended to reflect hazards presented by the materials under actual fire conditions. There is no UL yellow card available for TORLON 5530 stock shapes.
*5 - Test specimens: Type 1B
*6 - Test Speed: 5mm/min
*8 - Test specimens: 10mm thick
*7 - Test Speed: 1mm/min
*9 - Test specimens: 1mm thick

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TORLON® 5530 PAI