



Torlon® 4435

polyamide-imide

Torlon 4435, a wear-resistant grade of polyamide-imide (PAI), has been formulated to give outstanding wear resistance in non-lubricated wear applications at very high pressure and velocity conditions. The low coefficient of thermal expansion provides the ability to meet close tolerances over a wide temperature range.

Torlon PAI has the highest strength and stiffness of any thermoplastic up to 275°C (525°F). It has outstanding resistance to wear, creep, and chemicals.

Potential applications for Torlon 4435 polyamide-imide include thrust washers, seal rings, sliding vanes, bobbins, bushings, clutch rollers, and pistons. Due to its electrically dissipative property, this grade may also be considered for anti-static functions.

It is available in high flow (HF), low flow (LF), and extrusion (E) grades.

Typical Properties⁽¹⁾ by ASTM Test Methods

Property	Test Method	US Customary Units		SI Units	
MECHANICAL					
Tensile Strength	D 638	13.6	kpsi	94	MPa
	D 1708 ⁽²⁾	16.0	kpsi	110	MPa
Tensile Modulus	D 638	2,100	kpsi	14.5	GPa
	D 1708 ⁽²⁾	1,410	kpsi	9.7	GPa
Tensile Elongation	D 638	1	%	1	%
	D 1708 ⁽²⁾	6	%	6	%
Flexural Modulus	D 790				
	at 23°C (73°F)	2,100	kpsi	14.8	GPa
	at 232°C (450°F)	1,500	kpsi	10.3	GPa
Flexural Strength	D 790				
	at 23°C (73°F)	22.0	kpsi	152	MPa
	at 232°C (450°F)	13.0	kpsi	91	MPa
Izod Impact Strength, Notched	D 256	0.8	ft-lb/in	40	J/m
Izod Impact Strength, Unnotched	D 4812	4.1	ft-lb/in	220	J/m
Compressive Strength	D 695	20.0	kpsi	138	MPa
Compressive Modulus	D 695	1,240	kpsi	8.6	GPa
Poisson's Ratio		0.42		0.42	

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Typical Properties⁽¹⁾ by ASTM Test Methods (continued)

Property	Test Method	US Customary Units		SI Units	
THERMAL					
Heat Deflection Temperature	D 648				
at 264 psi (1.8 MPA)		532	°F	278	°C
Thermal Conductivity	C 177	5.6	Btu in/hr-ft ² °F	0.8	W/mK
Coefficient of Thermal Expansion, FD	E 831	8	ppm/°F	14	ppm/°C
ELECTRICAL					
Volume Resistivity	D 257	2 x 10 ⁷	ohm-cm	2 x 10 ⁷	ohm-cm
Surface Resistivity	D 257	6 x 10 ⁶	ohm	6 x 10 ⁶	ohm
GENERAL					
Specific Gravity	D 792	1.59		1.59	
Water Absorption, 24 hours	D 570	0.12	%	0.12	%
Mold Shrinkage	D 955	0.14	%	0.14	%
FRICTION AND WEAR					
Coefficient of Friction ⁽³⁾ at 50 fpm	D 3702	0.29		0.29	
Coefficient of Friction ⁽⁴⁾ at 800 fpm	D 3702	0.27		0.27	
Wear Factor ⁽³⁾ at 50 fpm	D 3702	21	10 ⁻¹⁰ in ³ -min/ft-lb-hr	42	10 ⁻⁸ mm ³ /N-m
Wear Factor ⁽⁴⁾ at 800 fpm	D 3702	17	10 ⁻¹⁰ in ³ -min/ft-lb-hr	34	10 ⁻⁸ mm ³ /N-m

⁽¹⁾ Property values for individual batches will vary within specification limits. Values shown are typical for uncolored resin; colorants may alter values.

⁽²⁾ ASTM Test Method D1708 has been used to measure the tensile properties of PAI and similar materials because the small test specimen conserved material. Today the most widely used specimen is the Type 1 bar of ASTM D638.

These D1708 values are included for historical purposes and they should not be compared to the D638 values.

⁽³⁾ V-50 fpm (0.25 m/s), P-500 psi (3.4 MPa)

⁽⁴⁾ V-800 fpm (4 m/s), P-31.25 psi (0.215 MPa)

Drying

Drying Torlon resin to a moisture content of 500 ppm or lower is required to avoid molding problems, such as brittle parts and foaming. The resin should be dried in a circulating air oven equipped with a desiccant system. Place the resin on drying trays in layers no more than 5 to 8 cm (2 to 3") deep. Minimum drying times are 3 hours at 175°C (350°F), 4 hours at 150°C (300°F), or 16 hours at 120°C (250°F). If drying at 175°C (350°F), limit drying time to 16 hours. Dessicant hopper dryers are recommended for the injection molding press.

Standard Packaging and Labeling

Torlon 4435 resin is packaged in lined cardboard boxes containing 25 kg (55.115 pounds) of material. Individual packages will be plainly marked with the product number, color, lot number, and net weight.

Injection Molding

The injection molding press should be equipped with a screw having a length to diameter (L/D) ratio between 18:1 and 24:1 and a compression ratio between 1:1 and 1.5:1. Check devices are not recommended.

Recommended barrel temperatures are 305°C (580°F) in the feed zone increasing to 370°C (700°F) at the nozzle. The mold temperature should be adjusted until the temperature of the surface measures between 200°C (390°F) and 215°C (420°F).

Set the injection pressure to achieve a rapid fill. On most machines, this will be near the maximum injection pressure available. Fill the entire mold with primary injection boost and then drop off to a hold pressure. Begin hold pressure at a high setting of 41 to 55 MPa (6,000 to 8,000 psi), for several seconds, then drop off to 21 to 35 MPa (3,000 to 5,000 psi), for the duration of the hold pressure sequence. This will help minimize or eliminate any internal porosity or sink. If part defects, such as blistering at the gate, color change and degradation, splay and surface delamination, or gas burning at the knit lines and vents, are encountered, the injection fill rate may be too high.

Use moderate back pressure, about 7 MPa (1,000 psi), and lower screw recovery speeds (50-100 rpm). Avoid intermittent feeding and screw slippage which can lead to overheating and possible polymer degradation.

Total cycle time should be as short as possible to reduce residence time in the barrel. Excessive residence time will cause an increase in melt viscosity, reducing flow.

Cycle time consistency is very important for successful molding for Torlon parts and automatic operation is highly recommended.

Molds should be designed for smooth part ejection, avoiding undercuts and providing adequate draft.

Heat Treatment (Post-Cure) After Molding

Torlon polymers are unique in that they are supplied at a relatively low molecular weight to facilitate processing, and the molded parts must be heat treated to achieve a high molecular weight and optimum properties. The heat treatment process is commonly called post-cure and involves placing the molded articles in a forced air oven and subjecting them to a series of elevated temperatures for specific times. Consult the Torlon polyamide-imide Molding Guide for standard post-cure cycles or contact your Solvay Advanced Polymers' representative for the recommended heat treatment program for post-curing your molded article.

For assistance with an emergency involving products of Solvay Advanced Polymers, such as a spill, leak, fire, or explosion, call day or night:

Emergency Health Information

USA +1.800.621.4590

International +1.770.772.8577

Emergency Spill Information

USA +1.800.424.9300 / +1.703.527.3887 (CHEMTREC)

Europe +44 208.762.8322 (CARECHEM)

China +86.10.5100.3039

All other Asian countries +65.633.44.177

For additional product information, technical assistance, and Material Safety Data Sheets (MSDS), call:

USA +1.800.621.4557 / +1.770.772.8760

Europe +49.211.5135.9000

Japan +81.3.5425.4300

China & Southeast Asia +86.21.5080.5080

World Headquarters

Solvay Advanced Polymers, LLC
4500 McGinnis Ferry Road
Alpharetta, Georgia 30005 USA
Phone: +1.800.621.4557 (USA Only)
+1.770.772.8760

SOLVAY
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