MICROMOLD ™
ENGINEERED PLASTIC FLUID-FLOW PRODUCTS

PROPERTIES OF

Polytetrafluoroethylene (PTFE)

Representative Values

Values represent typical test results compiled from industry sources. Values for virgin and compounded PTFE vary depending upon resin characteristics, resin processing methods, resin test methods, fabrication techniques, and application conditions. Without further evaluation these data are not intended for use in specifications or as design criteria. Customers should make their own determination of PTFE's suitability for their application. Please refer to the DISCLAIMER following this table.

If you are making design decisions that depend on the precision or accuracy of this data, we recommend that you contact Micromold Products to discuss your requirements. We will be happy to provide further information and design assistance.

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Property Group

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PROPERTY	REFERENCE	UNITS	VALUES
Mechanical Properties			
Tensile Strength			
• 23°C (73°F)	ASTM D638 / DIN53455	MPa (psi)	13.8 to 41.4 (2,000) to (6,000) Tests under DIN53455 show significantly higher values than those under ASTM D638. Tests of ram extruded PTFE show significantly lower values than those of molded or paste extruded materials.
• 250°C (482°F)	ASTM D638	MPa (psi)	12.4 (1,800)
• -253°C (-423°F)		MPa (psi)	123 (17,900)
Break Elongation			
• 23°C (73°F)	ASTM D638/ DIN53455	%	150 – 600 Tests under DIN53455 show significantly higher values than those under ASTM D638. Tests of ram extruded PTFE show significantly lower values than those of molded or paste extruded materials.
• 250°C (482°F)	ASTM D638	% min	480
• -253°C (-423°F)		% min	3
Impact Strength, Izod			
• -60°C (-76°F)	ASTM D256	J/m (ft-lb/in)	10.9 (2.0)
• +23°C (+73°F)	ASTM D256	J/m (ft-lb/in)	16.3 (3.0)
• +80°C (+176°F)	ASTM D256	J/m (ft-lb/in)	32.7 (6.0)
• -253°C (-423 °F)		J/m (ft-lb/in)	7.6 (1.4)
Hardness			
• 23°C (73°F)	ASTM D2240	Shore D	60
• 300°C (572°F)	ASTM D2240	Shore D	20
Compressive Strength (10 x 20 mm sample)			
• 0.2% offset	ASTM D695	MPa (psi)	7.6 (1,100)
• 1% strain	ASTM D695	MPa (psi)	5.0 (725)
• 25% strain	ASTM D695	MPa (psi)	28.2 (4,089)
Modulus of Elasticity	ASTM D638	MPa (psi)	390 to 600 (56,000 to 87,000)
Flexural Modulus			
• 20°C (68°F)	ASTM D790	MPa (psi)	427 to 510 (62,000 to 74,000)
• -253°C (-423°F)		MPa (psi)	510 (74,000)

PROPERTY	REFERENCE	UNITS	VALUES
Compressive Modulus			
• 20°C (68°F)		MPa (psi)	690 (100,000)
• -253°C (-423°F)		MPA (psi)	6,200 (900,000)
Flexural Strength	ASTM D790		No Break
Poisson's Ratio			
• 23°C (73°F)			0.46
• Higher temperatures			0.50
Deformation Under Load			
• 23°C (73°F), 3.4 MPa (500 psi), 24 hours	ASTM D621	%	<0.5
• 23°C (73°F), 6.9 MPa (1000 psi), 24 hours	ASTM D621	%	2
• 23°C (73°F), 14 MPa (2000 psi), 24 hours	ASTM D621	%	10
Specific Gravity	ASTM D792	g/cm^3	2.13 – 2.19
Water Absorption, 24 hrs, 1/8 in thick	ASTM D570	%	0.01
Refractive Index	ASTM D542		1.35
Weldability (Also see below for discussion of Modified vs. Plain Virgin PTFE)			• Satisfactory PTFE butt and lap joints can be made by heat fusing thin films • Also, high quality, full strength fused joints may be made using FEP or PFA thin films. • In contrast, quality FEP or PFA stick welds are more difficult to achieve.
Surface Properties			
Static Coefficient of Friction, 21 – 327°C (70 – 621°F)			0.05 – 0.08
Angle of Contact			0°=Perfect Wetting, 180°=Perfect Non-Wetting
• Toluene			43°
• Water			108°
• Mercury			150°
Critical Surface Tension	ASTM D2578	m^2/mJ	19.4
PV (Pressure–Velocity) Limit			
• 3.05 m/min (10 ft/min)		kg/cm^2-m/min (lb/in^2-ft/min)	277 (1,200)

PROPERTY	REFERENCE	UNITS	VALUES
• 30.5 m/min (100 ft/min)		kg/cm^2-m/min (lb/in^2-ft/min)	415 (1,800)
• 305 m/min (1000 ft/min)		kg/cm^2-m/min (lb/in^2-ft/min)	578 (2,500)
Wear Factor (K)		$10^{-8} mm^3/Nm$ ($10^{-10} in^3$-min/ft-lb-hr)	5,035 (2,500)
Abrasion resistance	Sand Slurry Abrasion Test, 1750 rpm in 50/50 sand/ water mix	relative weight loss (Carbon steel is rated at 100)	78
Electrical Properties			
Dielectric Strength, min.			
• Short time, 0.25mm (10 mil) thick	ASTM D149	volts/mm (volts/mil)	80,000 (2,000)
• Short time, 3.2mm (1/8 in) thick	ASTM D149	volts/mm (volts/mil)	24,000 (600)
• Step-by-Step, 3.2mm (1/8 in) thick	ASTM D149	volts/mm (volts/mil)	17,200 (430)
Arc Resistance	ASTM D495	seconds	> 300 (doesn't track)
Volume Resistivity	ASTM D257	cm-ohm	$>10^{18}$
Surface Resistance		ohms	10^{17}
Relative Permittivity (Dielectric Constant), max, 1kHz	ASTM D150		< 2.1
Dissipation Factor, max, 1kHz	ASTM D150		< 0.0005
Thermal Properties			
Coefficient of Linear Thermal Expansion			
• -184 – 10°C (-300 – 50°F)	ASTM D696	10^{-5}mm/mm/°C (10^{-5}in/in/°F)	7.1 (3.9)
• 10 - 20°C (50 – 68°F)	ASTM D696	10^{-5}mm/mm/°C (10^{-5}in/in/°F)	15.2 (8.4)
• 20 - 25°C (68 – 77°F)	ASTM D696	10^{-5}mm/mm/°C (10^{-5}in/in/°F)	79.0 (43.9)
• 25 – 149°C (77 – 300°F)	ASTM D696	10^{-5}mm/mm/°C (10^{-5}in/in/°F)	13.5 (7.5)
• 149 - 288°C (300 – 550°F)	ASTM D696	10^{-5}mm/mm/°C (10^{-5}in/in/°F)	28.7 (15.9)
Thermal Conductivity			
-128 – 182°C (-198 – 360°F)	ASTM C177	W/m-K (BTU/hr/ft^2/°F/in)	0.25 (1.7)

PROPERTY	REFERENCE	UNITS	VALUES
• -253°C (-429°F)	ASTM C177	W/m-K (BTU/hr/ft^2/°F/in)	0.13 (0.88)
Heat Distortion Temperature			
• 0.46 MPa (66 psi)	ASTM D648	°C (°F)	121 (250)
• 1.82 MPa (264 psi)	ASTM D648	°C (°F)	55 (132)
Specific Heat			
• 20°C (68°F)	ASTM D4591	kJ/kg-K (BTU/lb-°F)	1.4 (0.33)
• 260°C (500°F)		kJ/kg-K (BTU/lb-°F)	1.5 (0.37)
Maximum Continuous Service Temperature - with minimal load		°C (°F)	315 (600)
Glass Transition Temperature		°C (°F)	126 (260)
Relative Temperature Index	UL-746	°C (°F)	180 (356)
Melting Point		°C (°F)	Does not melt. There is no liquid phase.
Gel Point		°C (°F)	327 (621)
Cryogenic Properties			
• Above -268°C (-450°F)			Strong, tough, flexible, low coefficient of friction
• Above -79°C (-110 °F)			Very flexible
Chemical Resistance			
Resistant to all chemicals, including any acid, base, solvent, or any other corrosive or aggressive chemical except the following			No chemicals attack PTFE even at extremes of 0 to 14 pH, except those below
Turbulent liquid or gaseous fluorine			Elemental fluorine and a few compounds that release it at high temperatures are not compatible with PTFE
Molten or dissolved alkali metals: sodium, potassium, lithium, calcium, magnesium			Alkali metals attack PTFE
Permeability			Approximately 10% of 600 industrial chemicals may permeate PTFE products. Tests show that, in many cases, permeation of PTFE is less than permeation of similar fluoroplastics such as PFA and FEP. Design and processing can reduce permeation.

PROPERTY	REFERENCE	UNITS	VALUES
Radiation Resistance			
UV Radiation			
• UV-A, wavelengths 400 – 315 nm		nm	Transmits UV-A rays– No degradation
• UV-B, wavelengths 315 – 280 nm		nm	Transmits UV-B rays– No degradation
• UV-C, wavelengths 280 – 100 nm		nm	Longer than 200, UV-C is mostly transmitted, and absorption appears insufficient to cause degradation. Shorter than 200, we know PTFE degrades at 185 (the shorter of the two wavelengths emitted by mercury vapor lamps). However, as wavelengths shorten, there is decreasing transmittance. We can speculate that, in the shorter regions - say less than 160 - degradation is limited to surface erosion, and commercial applications of parts thicker than film may be feasible.
High Energy Radiation (e.g., x-rays, gamma rays, electron beam)			
• More than 2 – 7 x 10^4 rads exposure in air			Breaks carbon-carbon bonds resulting in physical damage
• More than 2 – 7 x 10^5 rads exposure in a vacuum			Breaks carbon-carbon bonds resulting in physical damage
Selected Flammable Classifications			NOTE: ***The following classifications are frequently under review and revision. Please contact Micromold for the current status***
Flash Ignition Temperature Method	ASTM D1929	°C (°F)	530-550 (986-1,022)
Self Ignition Temperature Method	ASTM D1929	°C (°F)	520-560 (968-1,040)
Auto Ignition Temperature Method	ASTM D1929		High temperature
Limiting Oxygen Index	ASTM D2863		>95
Flame Spread	NFPA 262-1990, UL-910 Plenum Test		Limited
Smoke Generation	NFPA 262-1990, UL-910 Plenum Test		Low

PROPERTY	REFERENCE	UNITS	VALUES
Limited Combustible Material	NFPA 220		Complies
Hazard Classification	NFPA	Flammability	1
Hazard Classification	HMIS® III, ACA (American Coatings Association)	Flammability	1
Flammability	UL-94		V-0
Sanitary Classifications			
• FDA	21 CFR 177.1550, Perfluorocarbon Resins		PTFE resins processed by Micromold comply
• USDA			PTFE resins processed by Micromold comply
• NSF	NSF 14, 61, et al		Selected products made from or containing PTFE resins comply
• 3A	3-A Standard 20		Selected products made from or containing PTFE resins comply
• USP	Class VI		Selected products made from or containing PTFE resins comply
Other Regulatory Classifications			
OSHA Hazard Communication Standard	29 CFR 1910.1200		Not classified as hazardous
EU RoHS (Restriction of Hazardous Substances) directive	2011/65/EU		Products supplied by Micromold can be certified as compliant with the EU RoHS directives. Please contact the factory.
EU REACH (Registration, Evaluation, Authorization and Restriction of Chemicals) regulation	(EC) No 1907/2006		Products supplied by Micromold can be certified as compliant with the REACH regulations. Please contact the factory.
Modified vs. Plain Virgin PTFE	ASTM D 4894, Type III		A small amount (<1%) of perfluoropropylvinylether (PPVE) is polymerized with PTFE. That impedes crystallinity, increases the amount of and improves the properties of the amorphous content. With amounts so small, modified resins remain classified as Virgin PTFE
Deformation Under Load			
• 23°C (73°F)			Reduced by about 40 to 50%

PROPERTY	REFERENCE	UNITS	VALUES
• 150°C (302°F)			Reduced by 60% or more
Permeability			For many gases and vapors, reduced by 20 to 30%
Dielectric Strength			About the same or slightly improved
Fusing and Welding			High quality welds with strong joints are possible using fusing and FEP or PFA stick welding
Tensile Strength			About the same or slightly improved
Elongation at Break			Increased by 25% or more at ambient and lower temperatures
Modulus of Elasticity			Especially at higher temperatures, increased 60 to 100% or more
Surface Finish			Smoother machined finishes are possible
Effect of Compounding Virgin PTFE Resin with Fillers			
Deformation under load			Reduced by up to 50%
Compressive Strength			Increased 5 to 10 times
Wear Resistance			Increased up to 1000 times
Coefficient of Linear Thermal Expansion			Reduced by up to 80%
Thermal Conductivity			Can be increased by up to 5 times
Volume Resistivity and Surface Resistance			Can be Reduced
Tensile Strength			Generally reduced
Break Elongation			Generally reduced
Regulatory compliance			Some, but not all, compounds are FDA / USDA compliant
Compounding of Modified PTFE			Most of the properties improved by compounding are even more so when the base resin is modified PTFE
Effects of Crystallinity			
High Crystallinity via slow cooling affects …			
• Flexural modulus			Increased
• Permeability			Reduced
• Deformation Under Load			Reduced
Low Crystallinity via rapid cooling (*Practical only in thin sections*) affects …			
• Flex life			Increased
• Tensile strength			Increased

We welcome comments, suggestions, and questions concerning this table. Please email mpi@micromold.com

DISCLAIMER: The information in the table above comes from many sources, some from tests made years ago but which Micromold believes to be accurate within reason. **HOWEVER, WE MAKE NO WARRANTY, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS OF THIS MATERIAL FOR THE USER'S PARTICULAR PURPOSE OR APPLICATION**.