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) |

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| 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<br>• Also, high quality, full strength fused joints may be made using FEP or PFA thin films.<br>• 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) |

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| • -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 | 2015/863/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

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