

Tangram Technology Periodic Table of Thermoplastics

The Periodic Table of the elements by Mendeleev was a historic achievement in chemistry and enabled chemists to see the relationship between structure and properties of the basic elements.
 Polymers also have a strong relationship between structure and properties and this Periodic Table of Polymers is a first attempt to provide a simple codification of the basic polymer types and structures.
 The diversity of polymer types makes it impossible to include all of the variations in one simple table and this table only includes the most common polymers.

Increasing performance →


KEY
TS = Tensile Strength at Yield @ 23°C
EAB = Elongation at break
TM = Tensile Modulus @ 23°C
LTST = Long Term Service Temperature
HDT = Heat Deflection Temperature @ 1.8 MPa
Cost = Relative Cost

All properties are for the natural injection moulding grade resin only and do not include polymers with reinforcements or other functional fillers.

Commodity Engineering Performance

Amorphous

Random molecular orientation in both molten and solid phases.




General Characteristics
 Soften gradually.
 Generally transparent.
 Lower Tensile Strength and Tensile Modulus.
 Lower Density.
 Low Creep Resistance.
 High Dimensional Stability.
 Low fatigue resistance.
 Easy to bond using adhesives and solvents (high surface energy).

PS-HI High Impact Polystyrene TS: 19 - 33 MPa EAB: 40 - 50% TM: 1.8 GPa LTST: 55 - 60°C HDT = 60 - 80°C Cost: ◆	PS-GP General Purpose Polystyrene TS: 40 - 50 MPa EAB: < 3% TM: 3.2 - 3.5 GPa LTST: 70 - 85°C HDT: 72 - 82°C Cost: ◆	ABS Acrylonitrile Butadiene Styrene (Copolymer) TS: 40 - 60 MPa EAB: 3 - 20% TM: 2.0 - 2.6 GPa LTST: 80 - 95°C HDT = 80 - 100°C Cost: ◆	SAN Styrene Acrylonitrile (Copolymer) TS: 47 - 72 MPa EAB: 2.0 - 10% TM: 2.3 - 4.1 GPa LTST: 55 - 60°C HDT = 84 - 95°C Cost: ◆◆	PMMA Polymethylmethacrylate (Acrylic) TS: 50 - 70 MPa EAB: 3.0 - 3.5% TM: 3.0 GPa LTST: 80 - 95°C HDT = 85 - 95°C Cost: ◆◆◆	PPO (Modified) Polyphenylene Oxide TS: 40 - 80 MPa EAB: 10 - 60% TM: 2.0 - 5.4 GPa LTST: 80 - 260°C HDT = 129°C Cost: ◆◆◆	PC Polycarbonate TS: 55 - 75 MPa EAB: 110 - 120% TM: 1.6 - 2.4 GPa LTST: 130 - 150°C HDT = 135 - 140°C Cost: ◆◆
PVC-P Plasticized Polyvinylchloride TS: 6 - 20 MPa EAB: 50 - 460% TM: 0.002 - 0.020 GPa LTST: 50°C HDT: 20°C Cost: ◆	SBS Styrene-Butadiene-Styrene (Copolymer) TS: 35 - 40 MPa EAB: 40% TM: 1.8 - 2.0 GPa LTST: 60°C HDT = 67°C Cost: ◆◆	SMA Styrene-Maleic Anhydride (Copolymer) TS: 40 - 52 MPa EAB: 1 - 8% TM: 2.0 GPa LTST: 100°C HDT = 105°C Cost: ◆◆	ASA Acrylonitrile Styrene Acrylate (Copolymer) TS: 38 - 70 MPa EAB: 15 - 45% TM: 2.3 - 2.9 GPa LTST: 82 - 100°C HDT = 82 - 120°C Cost: ◆◆	SB Styrene-Butadiene (Copolymer) TS: 26 - 30 MPa EAB: 20 - 80% TM: 1.6 GPa LTST: 65 - 77°C HDT = 70 - 77°C Cost: ◆◆	PET-G Glycolised Polyethylene terephthalate TS: 80 - 100 MPa EAB: 300% TM: 2.5 - 3.0 GPa LTST: 60 - 70°C HDT: 70°C Cost: ◆◆◆	PVC-UX Crosslinked Unplasticized PVC TS: 28 - 40 MPa EAB: 150% TM: 0.8 - 1.5 GPa LTST: 70 - 85°C HDT: 120°C Cost: ◆◆◆
PVC-U Unplasticized Polyvinylchloride TS: 30 - 55 MPa EAB: 25 - 60% TM: 2.50 - 3.02 GPa LTST: 60 - 70°C HDT: 64 - 70°C Cost: ◆	CA Cellulose Acetate TS: 30 - 55 MPa EAB: 5 - 55% TM: 1.6 GPa LTST: 45 - 70°C HDT: 45 - 65°C Cost: ◆	CAB Cellulose Acetate Butyrate TS: 25 - 50 MPa EAB: 8 - 80% TM: 0.7 - 1.5 GPa LTST: 75 - 100°C HDT: 60 - 75°C Cost: ◆◆	CAP Cellulose Acetate Propionate TS: 25 - 47 MPa EAB: 30 - 100% TM: 0.8 - 1.5 GPa LTST: 68 - 100°C HDT: 61 - 73°C Cost: ◆◆	CP Cellulose Propionate TS: 30 - 45 MPa EAB: 45 - 65% TM: 0.8 - 1.5 GPa LTST: 68 - 100°C HDT: 61 - 73°C Cost: ◆◆	PVC-C Chlorinated Polyvinylchloride TS: 53 - 58 MPa EAB: 25 - 45% TM: 2.6 - 2.7 GPa LTST: 90 - 110°C HDT: 100°C Cost: ◆◆◆	PA 6/3/T Amorphous polyamide TS: 60 - 100 MPa EAB: > 50% TM: 1.4 - 2.3 GPa LTST: 125°C HDT = 102 - 123°C Cost: ◆◆◆
PVC-U High Impact Unplasticized PVC TS: 45 - 55 MPa EAB: 25 - 60% TM: 2.5 - 3.0 GPa LTST: 60 - 70°C HDT: 64 - 70°C Cost: ◆	PE-LD Low Density Polyethylene TS: 7.0 - 25 MPa EAB: 50 - 400% TM: 0.15 - 0.35 GPa LTST: 40 - 70°C HDT = 55°C Cost: ◆	PE-LD Linear Low Density Polyethylene TS: 8.0 - 20 MPa EAB: 50 - 600% TM: 0.15 - 0.35 GPa LTST: 44 - 50°C HDT = 37 - 44°C Cost: ◆	PE-MD Medium Density Polyethylene TS: 14 - 25 MPa EAB: 60 - 300% TM: 0.25 - 0.70 GPa LTST: 38 - 70°C HDT = 38 - 43°C Cost: ◆	PMP Polymethyl pentene TS: 25 - 25 MPa EAB: 15 - 30% TM: 0.04 - 0.14 GPa LTST: 50°C HDT = 50°C Cost: ◆◆◆	EVA Ethylene-vinyl Acetate (12% VA) TS: 10 - 18 MPa EAB: 50 - 750% TM: 0.04 - 0.14 GPa LTST: 50°C HDT = 50°C Cost: ◆◆◆	PE-X Crosslinked Polyethylene TS: 18 MPa EAB: 300% TM: 0.6 GPa LTST: 90°C HDT = 90°C Cost: ◆◆◆
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Semicrystalline

Random molecular orientation in molten phase, densely packed crystallites in solid phase.



General Characteristics
 Sharp melting point.
 Generally translucent or opaque.
 Higher Tensile Strength and Tensile Modulus.
 Higher Density.
 High Creep Resistance.
 Low Dimensional Stability.
 High fatigue resistance.
 Difficult to bond using adhesives and solvents (low surface energy).

PE-LD Low Density Polyethylene TS: 7.0 - 25 MPa EAB: 50 - 400% TM: 0.15 - 0.35 GPa LTST: 40 - 70°C HDT = 55°C Cost: ◆	PE-LD Linear Low Density Polyethylene TS: 8.0 - 20 MPa EAB: 50 - 600% TM: 0.15 - 0.35 GPa LTST: 44 - 50°C HDT = 37 - 44°C Cost: ◆	PE-MD Medium Density Polyethylene TS: 14 - 25 MPa EAB: 60 - 300% TM: 0.25 - 0.70 GPa LTST: 38 - 70°C HDT = 38 - 43°C Cost: ◆	PMP Polymethyl pentene TS: 25 - 25 MPa EAB: 15 - 30% TM: 0.04 - 0.14 GPa LTST: 50°C HDT = 50°C Cost: ◆◆◆	EVA Ethylene-vinyl Acetate (12% VA) TS: 10 - 18 MPa EAB: 50 - 750% TM: 0.04 - 0.14 GPa LTST: 50°C HDT = 50°C Cost: ◆◆◆	PE-X Crosslinked Polyethylene TS: 18 MPa EAB: 300% TM: 0.6 GPa LTST: 90°C HDT = 90°C Cost: ◆◆◆	PB Polybutene-1 (Polybutylene) TS: 12 - 17 MPa EAB: 300 - 380% TM: 0.1 - 0.26 GPa LTST: 110°C HDT = 64 - 69°C Cost: ◆◆◆	PE-UHMW Ultra-high Molecular Weight Polyethylene TS: 35 MPa EAB: 500% TM: 1.2 - 1.6 GPa LTST: 90°C HDT = 85 - 90°C Cost: ◆◆◆	PA 11 Polyamide 11 (Nylon 11) TS: 20 - 60 MPa EAB: 30 - 400% TM: 1.4 - 2.3 GPa LTST: 74 - 147°C HDT = 38 - 55°C Cost: ◆◆◆	PA 12 Polyamide 12 (Nylon 12) TS: 63 MPa EAB: 200% TM: 1.3 - 2.6 GPa LTST: 70 - 80°C HDT = 55°C Cost: ◆◆◆	PPA Polyphthalamide TS: 85 MPa EAB: 2.6% TM: 3.7 GPa LTST: 140°C HDT = 130°C Cost: ◆◆◆	PA 4/6 Polyamide 4/6 (Nylon 4/6) TS: 100 MPa EAB: 40% TM: 3.1 - 8.3 GPa LTST: 130°C HDT = 100°C Cost: ◆◆◆	PEK Polyetherketone TS: 52 - 214 MPa EAB: 1.3 - 330% TM: 1.5 - 1.8 GPa LTST: 90 - 334°C HDT = 63 - 334°C Cost: ◆◆◆◆	PEEK Polyetheretherketone TS: 90 - 110 MPa EAB: 2.5 - 100% TM: 3.1 - 8.3 GPa LTST: 154 - 315°C HDT = 154 - 295°C Cost: ◆◆◆◆◆
PE-LD Low Density Polyethylene TS: 7.0 - 25 MPa EAB: 50 - 400% TM: 0.15 - 0.35 GPa LTST: 40 - 70°C HDT = 55°C Cost: ◆	PE-LD Linear Low Density Polyethylene TS: 8.0 - 20 MPa EAB: 50 - 600% TM: 0.15 - 0.35 GPa LTST: 44 - 50°C HDT = 37 - 44°C Cost: ◆	PE-MD Medium Density Polyethylene TS: 14 - 25 MPa EAB: 60 - 300% TM: 0.25 - 0.70 GPa LTST: 38 - 70°C HDT = 38 - 43°C Cost: ◆	PMP Polymethyl pentene TS: 25 - 25 MPa EAB: 15 - 30% TM: 0.04 - 0.14 GPa LTST: 50°C HDT = 50°C Cost: ◆◆◆	EVA Ethylene-vinyl Acetate (12% VA) TS: 10 - 18 MPa EAB: 50 - 750% TM: 0.04 - 0.14 GPa LTST: 50°C HDT = 50°C Cost: ◆◆◆	PE-X Crosslinked Polyethylene TS: 18 MPa EAB: 300% TM: 0.6 GPa LTST: 90°C HDT = 90°C Cost: ◆◆◆	PB Polybutene-1 (Polybutylene) TS: 12 - 17 MPa EAB: 300 - 380% TM: 0.1 - 0.26 GPa LTST: 110°C HDT = 64 - 69°C Cost: ◆◆◆	PE-UHMW Ultra-high Molecular Weight Polyethylene TS: 35 MPa EAB: 500% TM: 1.2 - 1.6 GPa LTST: 90°C HDT = 85 - 90°C Cost: ◆◆◆	PA 11 Polyamide 11 (Nylon 11) TS: 20 - 60 MPa EAB: 30 - 400% TM: 1.4 - 2.3 GPa LTST: 74 - 147°C HDT = 38 - 55°C Cost: ◆◆◆	PA 12 Polyamide 12 (Nylon 12) TS: 63 MPa EAB: 200% TM: 1.3 - 2.6 GPa LTST: 70 - 80°C HDT = 55°C Cost: ◆◆◆	PPA Polyphthalamide TS: 85 MPa EAB: 2.6% TM: 3.7 GPa LTST: 140°C HDT = 130°C Cost: ◆◆◆	PA 4/6 Polyamide 4/6 (Nylon 4/6) TS: 100 MPa EAB: 40% TM: 3.1 - 8.3 GPa LTST: 130°C HDT = 100°C Cost: ◆◆◆	PEK Polyetherketone TS: 52 - 214 MPa EAB: 1.3 - 330% TM: 1.5 - 1.8 GPa LTST: 90 - 334°C HDT = 63 - 334°C Cost: ◆◆◆◆	PEEK Polyetheretherketone TS: 90 - 110 MPa EAB: 2.5 - 100% TM: 3.1 - 8.3 GPa LTST: 154 - 315°C HDT = 154 - 295°C Cost: ◆◆◆◆◆
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KEY TO MAJOR POLYMER FAMILIES: Styrenes, Polyolefins, Vinyls, Cellulosics, Polyesters, Polyamides, Acrylics, Polycarbonates, Acetals, Polysulphones, Imides, Fluoropolymers