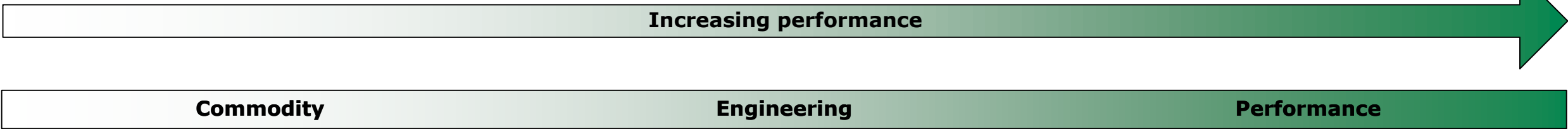


Tangram Technology Periodic Table of Thermoplastics

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.

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.



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).

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).

Commodity	Engineering	Performance																																																		
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60 MPa EAB: 30 - 400% TM: 1.0 - 2.0 GPa LTST: 74 - 147°C HDT = 38 - 55°C Cost: ◆◆◆</td> <td>PA 12 Polyamide 12 (Nylon 12) TS: 50 MPa EAB: 200% TM: 1.2 - 1.6 GPa LTST: 70 - 80°C HDT = 55°C Cost: ◆◆◆</td> </tr> <tr> <td>PBT Polybutylene-terephthalate TS: 30 - 105 MPa EAB: 250% TM: 1.5 - 5.2 GPa LTST: 65 - 120°C HDT: 70°C Cost: ◆◆</td> <td>PA 6 Polyamide 6 (Nylon 6) TS: 40 - 50 MPa EAB: 150 - 250% TM: 1.2 - 2.8 GPa LTST: 60 - 120°C HDT = 90 - 90°C Cost: ◆◆</td> <td>PA 6/6 Polyamide 6/6 (Nylon 6/6) TS: 40 - 86 MPa EAB: 4.8 - 300% TM: 0.7 - 5.5 GPa LTST: 42 - 190°C HDT = 50 - 150°C Cost: ◆◆◆</td> <td>PA 6/10 Polyamide 6/10 (Nylon 6/10) TS: 50 - 60 MPa EAB: 150 - 250% TM: 1.5 - 2.8 GPa LTST: 60 - 110°C HDT = 65 - 85°C Cost: ◆◆◆</td> <td>PA 6/12 Polyamide 6/12 (Nylon 6/12) TS: 17 - 60 MPa EAB: 4 - 600% TM: 0.29 - 5.5 GPa LTST: 42 - 190°C HDT = 50 - 90°C Cost: ◆◆◆</td> </tr> <tr> <td>PET Crystalline Polyethylene-terephthalate TS: 57 - 75 MPa EAB: 50 - 200% TM: 2.47 - 3.0 GPa LTST: 63 - 100°C HDT: 63 - 100°C Cost: ◆◆</td> <td>PA 6/10 Polyamide 6/10 (Nylon 6/10) TS: 50 - 60 MPa EAB: 150 - 250% TM: 1.5 - 2.8 GPa LTST: 60 - 110°C HDT = 65 - 85°C Cost: ◆◆◆</td> <td>POM Polyoxymethylene (Acetal Copolymer) TS: 62 - 70 MPa EAB: 20 - 75% TM: 2.8 - 3.1 GPa LTST: 104°C HDT = 110°C Cost: ◆◆</td> <td>POM Polyoxymethylene (Acetal Homopolymer) TS: 67 - 85 MPa EAB: 15 - 70% TM: 2.9 - 3.6 GPa LTST: 85 °C HDT = 124°C Cost: ◆◆</td> <td></td> </tr> </table>	PE-X Crosslinked Polyethylene TS: 18 MPa EAB: 350% TM: 0.6 GPa LTST: 90°C HDT = 60°C Cost: ◆◆◆	PB Polybutene-1 (Polybutylene) TS: 12 - 17 MPa EAB: 300 - 380% TM: 0.21 - 0.26 GPa LTST: 110°C HDT = 54 - 60°C Cost: ◆◆◆	PE-UHMW Ultra-high Molecular Weight Polyethylene TS: 35 MPa EAB: 500% TM: 0.5 GPa LTST: 55°C HDT = 42°C Cost: ◆◆◆	PA 11 Polyamide 11 (Nylon 11) TS: 20 - 60 MPa EAB: 30 - 400% TM: 1.0 - 2.0 GPa LTST: 74 - 147°C HDT = 38 - 55°C Cost: ◆◆◆	PA 12 Polyamide 12 (Nylon 12) TS: 50 MPa EAB: 200% TM: 1.2 - 1.6 GPa LTST: 70 - 80°C HDT = 55°C Cost: ◆◆◆	PBT Polybutylene-terephthalate TS: 30 - 105 MPa EAB: 250% TM: 1.5 - 5.2 GPa LTST: 65 - 120°C HDT: 70°C Cost: ◆◆	PA 6 Polyamide 6 (Nylon 6) TS: 40 - 50 MPa EAB: 150 - 250% TM: 1.2 - 2.8 GPa LTST: 60 - 120°C HDT = 90 - 90°C Cost: ◆◆	PA 6/6 Polyamide 6/6 (Nylon 6/6) TS: 40 - 86 MPa EAB: 4.8 - 300% TM: 0.7 - 5.5 GPa LTST: 42 - 190°C HDT = 50 - 150°C Cost: ◆◆◆	PA 6/10 Polyamide 6/10 (Nylon 6/10) TS: 50 - 60 MPa EAB: 150 - 250% TM: 1.5 - 2.8 GPa LTST: 60 - 110°C HDT = 65 - 85°C Cost: ◆◆◆	PA 6/12 Polyamide 6/12 (Nylon 6/12) TS: 17 - 60 MPa EAB: 4 - 600% TM: 0.29 - 5.5 GPa LTST: 42 - 190°C HDT = 50 - 90°C Cost: ◆◆◆	PET Crystalline Polyethylene-terephthalate TS: 57 - 75 MPa EAB: 50 - 200% TM: 2.47 - 3.0 GPa LTST: 63 - 100°C HDT: 63 - 100°C Cost: ◆◆	PA 6/10 Polyamide 6/10 (Nylon 6/10) TS: 50 - 60 MPa EAB: 150 - 250% TM: 1.5 - 2.8 GPa LTST: 60 - 110°C HDT = 65 - 85°C Cost: ◆◆◆	POM Polyoxymethylene (Acetal Copolymer) TS: 62 - 70 MPa EAB: 20 - 75% TM: 2.8 - 3.1 GPa LTST: 104°C HDT = 110°C Cost: ◆◆	POM Polyoxymethylene (Acetal Homopolymer) TS: 67 - 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166°C HDT = 63 - 67°C Cost: ◆◆◆◆</td> <td>PCTFE Polychlorotrifluoroethylene TS: 30 - 40 MPa EAB: 175% TM: 1.3 GPa LTST: 140 - 150°C HDT = 67 - 75°C Cost: ◆◆◆◆</td> <td>PTFE Polytetrafluoroethylene TS: 17 - 21 MPa EAB: 140 - 400% TM: 0.35 - 0.75 GPa LTST: 250 - 260°C HDT = 50 - 60°C Cost: ◆◆◆</td> </tr> <tr> <td>EVOH Ethylene-vinyl Alcohol TS: 37 - 205 MPa EAB: 100 - 330% TM: 1.9 - 3.5 GPa LTST: 80 - 90°C HDT = 70 - 90°C Cost: ◆◆◆◆</td> <td>PPS Polyphenylene Sulphide TS: 69 - 124 MPa EAB: 1 - 5% TM: 2.2 - 5.5 GPa LTST: 190 - 260°C HDT = 174°C Cost: ◆◆◆</td> <td>FEP Fluorinated ethylene-propylene TS: 15 - 21 MPa EAB: 240 - 350% TM: 0.35 - 0.50 GPa LTST: 160 - 204°C HDT = 48 - 60°C Cost: ◆◆◆◆</td> <td>ETFE Ethylene-tetrafluoroethylene TS: 35 - 45 MPa EAB: 200 - 500% TM: 1.00 GPa LTST: 150°C HDT = 90°C Cost: ◆◆◆◆</td> <td>PVDF Polyvinylidene fluoride TS: 30 - 55 MPa EAB: 50% TM: 1.3 GPa LTST: 150°C HDT = 75 - 82°C Cost: ◆◆◆</td> </tr> </table>	PA 12 Polyamide 12 (Nylon 12) TS: 50 MPa EAB: 200% TM: 1.2 - 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PE-LD Low Density Polyethylene TS: 7.0 - 25 MPa EAB: 50 - 400% TM: 0.15 - 0.35 GPa LTST: 40 - 70°C HDT = 35°C Cost: ◆	PE-LLD Linear Low Density Polyethylene TS: 8.0 - 20 MPa EAB: 50 - 500% TM: 0.2 - 1.0 GPa LTST: 44 - 50°C HDT = 37 - 44°C Cost: ◆	PE-MD Medium Density Polyethylene TS: 14 - 25 MPa EAB: 50 - 300% TM: 0.25 - 0.70 GPa LTST: 38 - 70°C HDT = 38 - 43°C Cost: ◆◆	PMP Polymethyl pentene TS: 25 - 28 MPa EAB: 15 - 30% TM: 1.0 - 2.2 GPa LTST: 55 - 60°C HDT = 40 - 50°C Cost: ◆◆◆	EVA Ethylene-vinyl Acetate (12% VA) TS: 10 - 19 MPa EAB: 50 - 750% TM: 0.04 - 0.14 GPa LTST: 50°C HDT = 20 - 23°C Cost: ◆◆◆																																																
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