

Material Comparison Chart 1

| Properties | X | XX | XXX | XP | XPC | XXP | XXXP | C | CE | L | LE | N-1 | FR-2 | FR-3 | A | AA | G-3 | G-5 | G-7 | G-9 | G-10 G-11 FR-4 | GPO-1 | GPO-2 | GPO-3 | |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|---|------------------------|------------------------|------------------------|--|
| Tensile Strength, psi | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lengthwise | 25,000 | 15,000 | 13,500 | 14,000 | 12,000 | 14,000 | 12,000 | 17,000 | 17,000 | 15,000 | 15,000 | 10,000 | 12,000 | 25,000 | 13,000 | 18,000 | 40,000 | 44,000 | 20,000 | 55,000 | 55,000 | 18,000 | 18,000 | 18,000 | |
| Crosswise | 32,000 | 14,000 | 11,800 | 13,000 | 10,000 | 12,000 | 10,500 | 16,000 | 14,000 | 13,000 | 9,500 | 10,500 | 23,000 | 11,000 | 16,000 | 30,000 | 38,000 | 18,000 | 35,000 | 45,000 | 15,000 | 18,000 | 18,000 | 18,000 | |
| Bonding Strength | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pounds, 1/2" th., Condition A | 700 | 800 | 950 | --- | --- | --- | --- | 1,800 | 1,800 | 1,500 | 1,600 | 1,000 | --- | --- | 700 | 1,800 | 850 | 1,570 | 850 | 1,700 | 5-10, 1,000 G-11, 1,800 FR-4, 1,000 | 850 | 850 | 850 | |
| Impact, ft.-lbs./inch of notch 1/8 Edgewise, Crosswise | 0.50 | 0.35 | 0.35 | 0.50 | 0.55 | 0.40 | 0.30 | 1.90 | 1.40 | 1.10 | 1.00 | 2.00 | 0.45 | 0.59 | 0.60 | 3.0 | 5.50 | 5.5 | 7.50 | 8.00 | 5.50 | 8.0 | 8.0 | 8.0 | |
| Water Absorption, % 24hrs 1/16" 1/8" 1/2" | 0.50 | 0.35 | 0.35 | 0.50 | 0.55 | 0.40 | 0.30 | 1.90 | 1.40 | 1.10 | 1.00 | 2.00 | 0.45 | 0.59 | 0.60 | 3.0 | 5.50 | 5.5 | 7.50 | 8.00 | 5.50 | 8.0 | 8.0 | 8.0 | |
| Dielectric Breakdown, kv, 1/16" Parallel to Lamination Step x Step, Cond. A. | --- | 40 | 50 | 40 | --- | 60 | 60 | 15 | 35 | 15 | 40 | 60 | 60 | 5 | --- | --- | 23 | 32 | 60 | 45 | 40 | 40 | 40 | 40 | |
| Arc Resistance, Seconds, Cond. A. | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 120 | 110 | --- | --- | --- | 180 | 180 | 180 | --- | 100 | 100 | 150 | |
| Dissipation Factor, 1MHz Cond. A. | --- | 0.045 | 0.038 | --- | --- | 0.040 | 0.035 | --- | --- | --- | 0.055 | 0.038 | 0.035 | --- | --- | --- | 0.020 | 0.003 | 0.017 | 0.025 | 0.03 | --- | --- | --- | |
| Dielectric constant, 1MHz Cond. A. | --- | 5.5 | 5.3 | --- | --- | 5.0 | 4.6 | --- | --- | --- | 5.8 | 3.9 | 4.6 | 4.6 | --- | --- | --- | 7.8 | 4.2 | 7.2 | 5.2 | 4.3 | --- | --- | |
| Tensile Strength, psi | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lengthwise | 20,000 | 16,000 | 15,000 | 12,000 | 10,500 | 11,000 | 12,400 | 10,000 | 9,000 | 13,000 | 12,000 | 8,500 | 12,500 | 14,000 | 10,000 | 12,000 | 23,000 | 37,000 | 23,000 | 37,000 | 40,000 | 12,000 | 10,000 | 10,000 | |
| Crosswise | 16,000 | 13,000 | 12,000 | 9,000 | 8,500 | 8,500 | 9,500 | 8,000 | 7,000 | 9,000 | 8,500 | 8,000 | 8,500 | 12,000 | 8,000 | 10,000 | 20,000 | 30,000 | 18,000 | 30,000 | 35,000 | 10,000 | 9,000 | 9,000 | |
| Compressive Strength, psi | | | | | | | | | | | | | | | | | | | | | | | | | |
| Flatwise | 36,000 | 34,000 | 32,000 | 25,000 | 22,000 | 25,000 | 25,000 | 37,000 | 39,000 | 35,000 | 37,000 | --- | 25,000 | 28,000 | 40,000 | 38,000 | 50,000 | 70,000 | 45,000 | 70,000 | 60,000 | 30,000 | 30,000 | 30,000 | |
| Edgewise | 19,000 | 23,000 | 25,500 | --- | --- | --- | 23,500 | 24,500 | 23,500 | 25,000 | --- | --- | --- | --- | 17,000 | 21,000 | 17,500 | 25,000 | 14,000 | 25,000 | 30,000 | 20,000 | 20,000 | 20,000 | |
| Modulus of Elasticity in Pressure | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lengthwise, psi | 1.8 x 10 ⁵ | 1.4 x 10 ⁵ | 1.5 x 10 ⁵ | 1.2 x 10 ⁵ | 1.0 x 10 ⁵ | 0.8 x 10 ⁵ | 1.0 x 10 ⁵ | 0.8 x 10 ⁵ | 1.1 x 10 ⁵ | 0.8 x 10 ⁵ | 1.0 x 10 ⁵ | 0.8 x 10 ⁵ | 1.2 x 10 ⁵ | 1.4 x 10 ⁵ | 1.0 x 10 ⁵ | 1.2 x 10 ⁵ | 1.8 x 10 ⁵ | 1.4 x 10 ⁵ | 1.0 x 10 ⁵ | 1.8 x 10 ⁵ | 2.0 x 10 ⁵ | 1.0 x 10 ⁵ | 1.0 x 10 ⁵ | 1.0 x 10 ⁵ | |
| Crosswise, psi | 1.5 x 10 ⁵ | 1.1 x 10 ⁵ | 1.0 x 10 ⁵ | 0.8 x 10 ⁵ | 0.8 x 10 ⁵ | 0.8 x 10 ⁵ | 0.8 x 10 ⁵ | 0.8 x 10 ⁵ | 0.8 x 10 ⁵ | 0.8 x 10 ⁵ | 0.8 x 10 ⁵ | 0.8 x 10 ⁵ | 1.0 x 10 ⁵ | 1.2 x 10 ⁵ | 1.0 x 10 ⁵ | 1.2 x 10 ⁵ | 1.8 x 10 ⁵ | 1.4 x 10 ⁵ | 1.0 x 10 ⁵ | 1.8 x 10 ⁵ | 2.0 x 10 ⁵ | 1.0 x 10 ⁵ | 1.0 x 10 ⁵ | 1.0 x 10 ⁵ | |
| Shear Strength, psi | 12,000 | 11,000 | 10,000 | 8,000 | --- | 11,000 | 11,000 | 12,000 | 11,000 | 12,000 | 11,500 | 14,000 | 11,000 | 11,000 | 9,000 | 12,000 | 18,000 | 20,000 | 17,000 | 20,000 | 19,000 | 14,000 | 14,000 | 14,000 | |
| Notch Impact, ft.-lbs./inch of notch, 1/2" Flatwise, Crosswise | 4.0 | 1.3 | 1.0 | --- | --- | --- | --- | 3.2 | 2.3 | 2.5 | 1.8 | 4.0 | --- | --- | 1.8 | 3.6 | 6.5 | 12.0 | 8.5 | 12.0 | 7.0 | 8.0 | 8.0 | 8.0 | |
| Rockwell Hardness, M Scale | 110 | 105 | 110 | 95 | 75 | 100 | 105 | 103 | 105 | 105 | 105 | 105 | 105 | 100 | 111 | 103 | 100 | 120 | 100 | 120 | 110 | --- | --- | --- | |
| Specific Gravity | 1.36 | 1.34 | 1.32 | 1.33 | 1.34 | 1.32 | 1.30 | 1.36 | 1.33 | 1.35 | 1.33 | 1.15 | 1.38 | 1.45 | 1.72 | 1.70 | 1.80 | 1.90 | 1.85 | 1.90 | 1.82 | 1.9 | 1.9 | 1.95 | |
| Insulation Resistance, Megohms Condition 96 hrs, 90% R.H., 95°F | --- | 80 | 1000 | --- | --- | 500 | 20,000 | --- | --- | --- | 30 | 50,000 | 5000 | 190,000 | --- | --- | --- | 100 | 200,000 | 10,000 | 200,000 | --- | --- | --- | |
| Coefficient of Thermal Expansion (CM./CM.) °C/CM | 2 x 10 ⁻⁵ | 2 x 10 ⁻⁵ | 2 x 10 ⁻⁵ | 2 x 10 ⁻⁵ | 2 x 10 ⁻⁵ | 2 x 10 ⁻⁵ | 2 x 10 ⁻⁵ | 2 x 10 ⁻⁵ | 2 x 10 ⁻⁵ | 2 x 10 ⁻⁵ | 2 x 10 ⁻⁵ | 8 x 10 ⁻⁵ | 2 x 10 ⁻⁵ | 1.7 x 10 ⁻⁴ | 1.8 x 10 ⁻⁴ | 1.5 x 10 ⁻⁴ | 1.5 x 10 ⁻⁴ | 1.0 x 10 ⁻⁴ | 1.0 x 10 ⁻⁴ | 1.0 x 10 ⁻⁴ | 1.0 x 10 ⁻⁴ | 2.0 x 10 ⁻⁴ | 2.0 x 10 ⁻⁴ | 2.0 x 10 ⁻⁴ | |
| Thermal Conductivity Calorim./Sec./Cm² °C/Cm | 7 x 10 ⁻⁴ | 7 x 10 ⁻⁴ | 7 x 10 ⁻⁴ | 7 x 10 ⁻⁴ | 7 x 10 ⁻⁴ | 7 x 10 ⁻⁴ | 7 x 10 ⁻⁴ | 7 x 10 ⁻⁴ | 7 x 10 ⁻⁴ | 7 x 10 ⁻⁴ | 7 x 10 ⁻⁴ | 7 x 10 ⁻⁴ | --- | 7 x 10 ⁻⁴ | 7 x 10 ⁻⁴ | 5 x 10 ⁻⁴ | 5 x 10 ⁻⁴ | --- | 7 x 10 ⁻⁴ | 7 x 10 ⁻⁴ | 7 x 10 ⁻⁴ | --- | --- | --- | |
| Max. Constant Operating Temp., °F | 280 | 280 | 280 | 280 | 280 | 280 | 270 | 250 | 250 | 250 | 250 | 185 | 265 | 250 | 300 | 310 | 350 | 280 | 460 | 280 | 2-10, 280 2-11, 280 FR-4, 225 | --- | 130°C | 120°C | |

