



Single crystal sapphire possesses a unique combination of excellent optical, physical and chemical properties. The hardest of the oxide crystals, sapphire retains its high strength at high temperatures, has good thermal properties and excellent transparency. It is chemically resistant to common acids and alkali at temperatures up to 1000 °C as well as to HF below 300 °C. These properties encourage its wide use in hostile environments where optical transmission in the range from the visible to the near infrared is required.

OPTICAL PROPERTIES

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|---------------------|---|
| Transmission Range | 0.17 to 5.5 microns |
| Refractive Index | 1.75449 (o) 1.74663 (e) at 1.06 microns |
| Reflection Loss | at 1.06 μm (2 surfaces) for o-ray – 11.7%; for e-ray – 14.2% |
| Index of Absorption | 0.3 x 10 ⁻³ cm ⁻¹ at 2.4μm |
| Reststrahlen Peak | 13.5μm |
| dN/dT | 13.7 x 10 ⁻⁶ at 5.4μm |
| dN/dμ = 0 | 1.5μm |

PHYSICAL PROPERTIES

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|------------------------|---|
| Density | 3.97 g/cm ³ |
| Melting Point | 2040°C |
| Thermal Conductivity | 27.21 W/(m? K) at 300K |
| Thermal Expansion | 5.6 (paral) & 5.0 (perp) x 10 ⁻⁶ /K |
| Hardness | Knoop 2000 with 2000g indenter |
| Specific Heat Capacity | 419 J/(kg? K) |
| Dielectric Constant | 11.5 (paral) 9.4 (perp) at 1MHz |
| Young's Modulus (E) | 335 GPa |
| Shear Modulus (G) | 148.1 GPa |
| Bulk Modulus (K) | 240 GPa |
| Elastic Coefficients | C ₁₁ =496 C ₁₂ =164 C ₁₃ =115 C ₃₃ =498 C ₄₄ =148 |
| Apparent Elastic Limit | 275 MPa (40,000 psi) |
| Poisson Ratio | 0.25 |

CHEMICAL PROPERTIES

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|------------------|-----------------------------------|
| Solubility | 98? 10 ⁻⁶ g/100g water |
| Molecular Weight | 101.96 |
| Class/Structure | Trigonal (hex), R3c |

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|---|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Wavelength, μm | 0.193 | 0.213 | 0.222 | 0.226 | 0.244 | 0.248 | 0.257 | 0.266 | 0.280 |
| Refractive Index n_o | 1.929 | 1.889 | 1.875 | 1.870 | 1.851 | 1.847 | 1.839 | 1.833 | 1.824 |
| Refractive Index n_e | 1.917 | 1.878 | 1.865 | 1.860 | 1.841 | 1.837 | 1.830 | 1.824 | 1.815 |

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|---|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Wavelength, μm | 0.308 | 0.325 | 0.337 | 0.351 | 0.355 | 0.442 | 0.458 | 0.488 | 0.515 |
| Refractive Index n_e | 1.811 | 1.805 | 1.801 | 1.797 | 1.796 | 1.780 | 1.778 | 1.775 | 1.773 |
| Refractive Index n_e | 1.802 | 1.796 | 1.792 | 1.788 | 1.787 | 1.772 | 1.770 | 1.767 | 1.765 |

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|---|-------|-------|-------|-------|-------|-------|-------|-------|
| Wavelength, μm | 0.532 | 0.590 | 0.633 | 0.670 | 0.694 | 0.755 | 0.780 | 0.800 |
| Refractive Index n_o | 1.772 | 1.768 | 1.766 | 1.764 | 1.763 | 1.761 | 1.761 | 1.760 |
| Refractive Index n_e | 1.764 | 1.760 | 1.758 | 1.756 | 1.755 | 1.753 | 1.753 | 1.752 |

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|---|--------|-------|-------|-------|-------|-------|-------|-------|
| Wavelength, μm | 0.820 | 0.980 | 1.064 | 1.320 | 1.550 | 2.010 | 2.249 | 2.703 |
| Refractive Index n_e | 1.760 | 1.756 | 1.754 | 1.750 | 1.746 | 1.737 | 1.732 | 1.719 |
| Refractive Index n_e | 1.7528 | 1.748 | 1.747 | 1.742 | 1.738 | 1.729 | 1.724 | 1.711 |

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|---|-------|-------|-------|-------|-------|-------|-------|-------|
| Wavelength, μm | 2.941 | 3.333 | 3.704 | 4.000 | 4.348 | 4.762 | 5.000 | 5.263 |
| Refractive Index n_e | 1.712 | 1.701 | 1.687 | 1.674 | 1.658 | 1.636 | 1.623 | 1.607 |
| Refractive Index n_e | 1.704 | 1.693 | 1.679 | 1.666 | 1.65 | 1.628 | 1.615 | 1.599 |