

Sapphire

	Metric	English
Chemical Formula	Al ₂ O ₃	
Crystal Structure	Hexagonal System (hk•l)	
Unit Cell Dimension	a = 4.785 Å c = 12.991 Å	
Density	3.98 g/cc	0.144 lb/in ³
Hardness	1525 - 2000 Knoop 9 Mohs	
Melting Point	2310 K (2040°C)	3700°F
Tensile Strength	275 MPa to 400 MPa	40,000 to 58,000 psi
at 20°C	400 MPa	58,000 psi (design min.)
at 500°C	275 MPa	40,000 psi (design min.)
at 1000°C	355 MPa	52,000 psi (design min.)
Flexural Strength	480 MPa to 895 MPa	70,000 to 130,000 psi
Compression Strength	2.0 GPa (ultimate)	300,000 psi (ultimate)
Young's Modulus, E (Modulus of Elasticity)	250 GPa	50 x 10 ⁶ psi
Bulk Modulus, k (Modulus of Compression)	250 GPa	36 x 10 ⁶ psi
Shear Modulus, G (Modulus of Rigidity)	145 GPa	21 x 10 ⁶ psi
MOR ⁺	350 MPa to 690 MPa	50,000 to 100,000 psi
Poisson's Ratio	Indeterminant	
Thermal Conductivity (60° orientation)		
at 0°C	46.06 W/(m•K)	319.4 BTU in/hr ft ² °F
at 100°C	25.12 W/(m•K)	174.2 BTU in/hr ft ² °F
at 400°C	12.56 W/(m•K)	87.1 BTU in/hr ft ² °F
Specific Heat at 20°C	0.10 cal/(g•°C)	0.10 BTU/lb °F
Heat Capacity		
at 20°C	18.63 cal/(mole•°C)	18.6 BTU/lbmol °F
at 1000°C	29.86 cal/(mole•°C)	29.9 BTU/lbmol °F
TEC (Average) ⁺⁺ (60° orientation)		
20° to 50°C	5.8 x 10 ⁻⁶ /°C	3.2 x 10 ⁻⁶ /°F

20° to 500°C	$7.7 \times 10^{-6}/^{\circ}\text{C}$	$4.3 \times 10^{-6}/^{\circ}\text{F}$
Electrical	E⊥ to C Axis	E to C Axis
(frequency)	Dielectric Loss	Dielectric Loss
	Constant Tangent	Constant Tangent
1 MHz	9.39 0.0001	11.58 0.0001
3 GHz	9.39 <0.0001	11.58 <0.0001
8.5 GHz	9.39 <0.00002	11.58 <0.00005
Volume Resistivity		
at 25°C	$10^{14} \text{ ohm} \cdot \text{cm}$	

+ Modulus of Rupture Sapphire is an Anistropic Crystal. These are average values.

++ Thermal Expansion Coefficient.

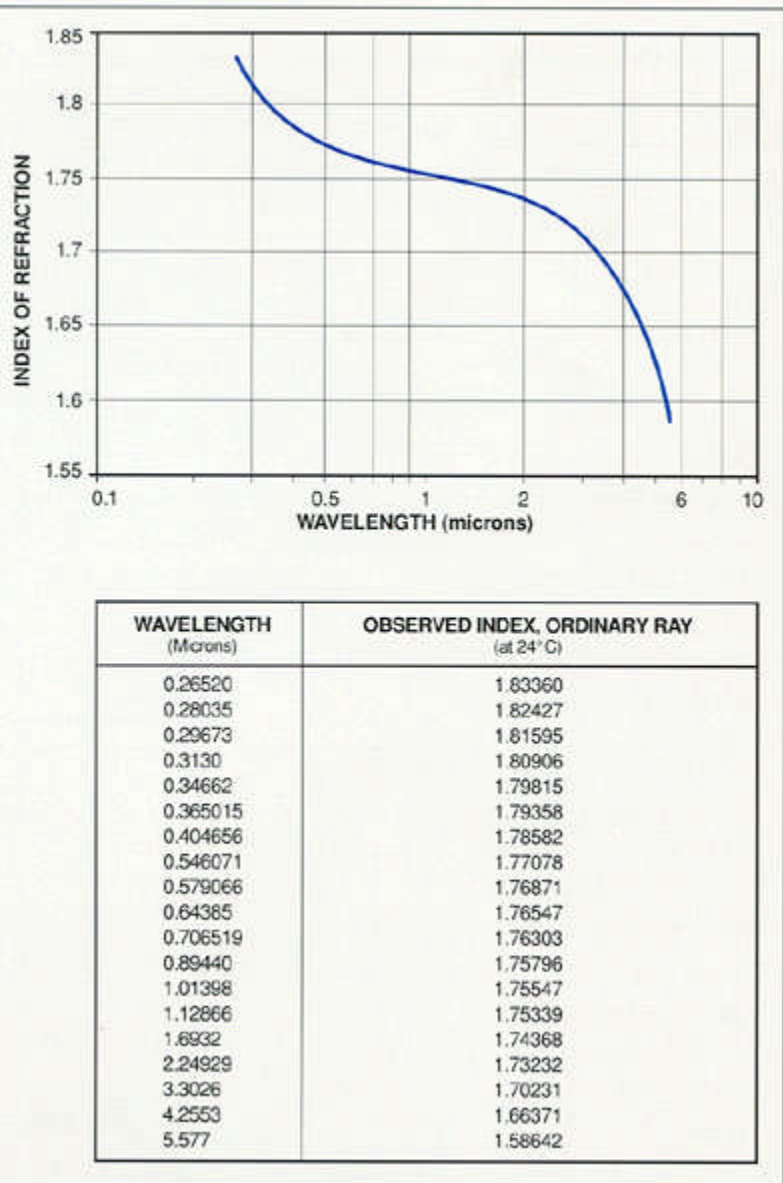


Figure 1. Observed Indices of Refraction for Sapphire versus Wavelength¹