

Physical properties of single crystal Sapphire	
Chemical Formula	Al ₂ O ₃
Structure	hexagonal-rhombohedral
Molecular weight	101.96
Lattice Constants Å	a=4.765, c=13,000
Density (g/cm ³)	3.98
Hardness	9 Mohs 1800 knoop parallel to C-axis 2200 knoop perpendicular to C-axis
Water Absorption	nil
Young Modulus (Gpa)	379 at 30° to C-axis 352 at 45° to C-axis 345 at 60° to C-axis 386 at 75° to C-axis
Shear Modulus (Gpa)	145
Bulk Modulus (Gpa)	240
Bending Modulus/ Modulus of Rupture (MPa)	350 to 690
Tensile strength (MPa)	400 at 25°C 275 at 500°C 345 at 1000°C
Elastic Coefficients	C11=496, C12=164, C13=115, C33=498, C44=148
Apparent Elastic Limit (MPa)	448 to 689
Flexural Strength (GPa)	2.5 - 4.0
Poisson ratio	0.25 - 0.30
Friction Coefficient	0.15 on steel 0.10 on sapphire
Abrasion resistance	8 times higher than steel
Thermal properties	
Melting Point (°C)	2040
Maximum use temperature (°C)	1800
Specific Heat J/(kg × K)	105 at 91 K 761 at 291 K
Thermal coefficient of linear expansion at 323 K (K ⁻¹)	6.66 × 10 ⁻⁶ parallel to optical axis 5 × 10 ⁻⁶ perpendicular to optical axis
Thermal conductivity (W/m °K) at 20° C	41.9
Thermal Expansion (20 - 1000°C)	Parallel to C-axis: 9.03 × 10 ⁻⁶ °C Perpendicular to C-axis: 8.31 × 10 ⁻⁶ °C 60° to C-axis: 8.4 × 10 ⁻⁶ °C
Optical properties	
Transmission Range	0.2 - 5.5 microns

		Transmission (thickness of disc 1mm)	
		Visible light	>85%
		Infrared	0.75 to 5 μm
			5.5 μm
			70%
		Ultraviolet	400 - 300 nm
			280 nm
			60%
			200 nm
			50%
Reflection loss		14% at 1 micron (2 surfaces)	
Reststrahlen Peak		13.5 microns	
dN/dT		$+13 \times 10^{-6} \text{ } ^\circ\text{C}$	
Electrical properties			
Resistivity, Ohm·cm at 20-500° C		$10^{11} - 10^{16}$	
Dielectric Constant		11.5 parallel to C axis 9.4 perpendicular to C axis	
Dielectric strength (V/cm)		4×10^5	
Loss Tangent		10^{-4}	
Stability parameters			
Solubility			
In water		insoluble	
In HNO ₃ , H ₂ SO ₄ , HCl, HF		insoluble up to 300° C	
In alkalis		insoluble up to 800° C	
In melts of metals: Mg, Al, Cr, Co, Ni, Na, K, Bi, Zn, Cs		insoluble up to 800 - 1000° C	
Radiation stability		No change in transmission above 2.5 micron after exposure to 10^7 Rads. No visible coloration after exposure to 10^8 Rads/hr for 60 minutes at -195° C	
Proton radiation stability		No change in transmission below 0.3 micron after exposure 10^{12} proton/cm ² total dose.	