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General Properties of Sapphire サファイア材の物理・光学特性(1)

Physical Properties	
Chemical Formula	Al_2O_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

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General Properties of Sapphire サファイア材の物理・光学特性(2)

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			
Wavelength (μ)	Refractive Index	Wavelength (μ)	Refractive Index
0.265	1.833	0.7065	1.763
0.280	1.824	0.8944	1.757
0.2967	1.815	1.0139	1.755
0.3130	1.809	1.1286	1.753
0.3466	1.798	1.6932	1.743
0.3650	1.793	2.2492	1.732
0.4046	1.785	3.3026	1.702
0.5460	1.770	4.2553	1.663
0.5790	1.765	5.777	1.586
Transmission Range		0.2 - 5.5 microns	
Transmission (thickness of disc 1mm)			
Visible light		>85%	
Infrared	0.75 to 5 μm	85%	
	5.5 μm	70%	
Ultraviolet	400 - 300 nm	80%	
	280 nm	60%	
	200 nm	50%	
Reflection loss		14% at 1 micron (2 surfaces)	
Restrahlen Peak		13.5 microns	
dN/dT		$+13 \times 10^{-6}$°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_2SO_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.