



INTERNATIONAL CERAMIC ENGINEERING

Sapphire Property Data Sheet

General

Chemical Formula: Al_2O_3 (aluminum oxide)
Names: Corundum, Sapphire, Alpha-alumina
Crystal System: Trigonal
Class: Hexagonal-scalenohedral

Thermal

Melting Point: 2053°C (3727°F)
Maximum Useful Temperature: $\approx 2000^\circ\text{C}$
Specific Heat: $0.181 \text{ cal/gm}^\circ\text{K}$ (25°C)
 $0.300 \text{ cal/gm}^\circ\text{K}$ (1000°C)
Thermal Conductivity: $0.4 \text{ watts/cm}^\circ\text{K}$ (25°C)
 $0.1 \text{ watts/cm}^\circ\text{K}$ (1000°C)
Thermal Expansion Coefficient: ($25 - 1000^\circ\text{C}$)
 8.8×10^{-6} ; parallel to C-axis
 7.9×10^{-6} ; perpendicular to C-axis

Physical/Mechanical

Density: 3.97 gm/cm^3 (0.143 lb/in^3) (25°C)
Young's Modulus: 435 GPa ($63 \times 10^6 \text{ psi}$) parallel to C-axis (25°C)
 386 GPa ($56 \times 10^6 \text{ psi}$) parallel to C-axis (1000°C)
Modulus of Rigidity (Shear Modulus): 175 GPa ($26 \times 10^6 \text{ psi}$)
Poisson's Ratio: $0.27 - 0.30$ orientation dependent
Flexural Strength: 1035 MPa (150 kpsi) parallel to C-axis (25°)
 760 MPa (110 kpsi) perpendicular to C-axis (25°)
Compressive Strength: $\approx 2 \text{ GPa}$ (300 kpsi) 25°C
Hardness: 9 Moh's scale
 1900 Knoop parallel to C-axis
 2200 Knoop perpendicular to C-axis

Optical

Uniaxial Negative Refractive Index: Ordinary ray (C-axis)
 $N_o = 1.768$
Extraordinary ray
 $N_e = 1.760$
Birefringence: 0.008
Temperature Coefficient of Refractive Index: $13 \times 10^{-6} \text{ }^\circ\text{C}^{-1}$ (visible range)
Spectral Emittance: 0.1 (1600°C)
Spectral Absorption Coefficient: $0.1 - 0.2 \text{ cm}^{-1}$ ($0.66 \mu\text{m}$, 1600°C)

Electrical

Volume Resistivity: 10^{16} ohm-cm (25°C)
 10^{11} ohm-cm (500°C)
 10^6 ohm-cm (1000°C)
Dielectric Strength: $480,000 \text{ volts/cm}$ ($1,200 \text{ volts/mil}$)
Dielectric Constant: 11.5 ($10^3 - 10^9 \text{ Hz}$, 25°C) parallel to C-axis
 9.3 ($10^3 - 10^9 \text{ Hz}$, 25°C) perpendicular to C-axis
Loss Tangent: 8.6×10^{-5} ($@10^{10} \text{ Hz}$, 25°C) parallel to C-axis
 3.0×10^{-5} ($@10^{10} \text{ Hz}$, 25°C) perpendicular to C-axis
Magnetic Susceptibility: -0.21×10^{-6} parallel to C-axis
 -0.25×10^{-6} perpendicular to C-axis

Chemical

Weathering Resistance: Unaffected by atmospheric exposure
Sea Water Resistance: Unaffected by marine exposure
Biological Resistance: Unaffected by in-vivo exposure
Non-thrombogenic
Non-reactive with body fluids

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