

Technical Characteristics of Synthetic Ruby Verneuil Crystals

Synthetic Ruby is an anisotropic crystal, hexagonal system, composed of unicrystalline alpha aluminum oxide, essentially 100% pure. Various properties are a function of crystallographic direction (related to the optic axis of the crystal). Ruby is available in two discrete chromium dopant levels, 0.03% and 0.05% by weight substitution of Cr₂O₃ for Al₂O₃. The most common is 0.05%. Lasers operating at or near threshold power take advantage of the lower threshold and better slope efficiency of the 0.03% material in this narrow region.

Physical and Optical Properties of Ruby

Density		3.98 g/cc	Refractive index at 700 nm	1.7638 Ordinary Ray
Melting Point		2040° C		1.7556 Extraordinary Ray
Young's Modulus		345 Gpa	Birefringence	0.008
MOR		425 MPa	Refractive Index vs. Chromium Concentration	$3 \times 10^{-3} (\Delta n / \% \text{Cr}_{2}\text{O}_{3})$
Compressive Strength		2.0 Gpa	Fluorescent Lifetime at 0.05% Cr ₂ O ₃	3 ms at 300 K
Hardness		9 Mhos, 2000 Knoop	Fluorescent Linewidth (R ₁)	5.0 Å at 300K
Thermal Expansion	20° to 50° C	$5.8 \times 10^{-6} / ^\circ \text{C}$	Output Wavelength (R ₁)	6.94.3 nm
	20° to 200° C	$7.7 \times 10^{-6} / ^\circ \text{C}$	Major Pump Bands	404 nm and 554 nm
Thermal Conductivity	at 0° C	46.02 W / (m•K)	All values are for 60° orientation material	
	at 100° C	25.10 W / (m•K)		
	at 400° C	12.55 W / (m•K)		

Other Physical Properties:

Crystalline Structure: rhomboedral hexagonal single

Composition: Al₂O₃

Purity: 99,99 %

Main impurities: Na₂O, Si, Ca, Fe, Ga, Mg, Ti, Mn, Pb, Cu, Zn, Ni

Cleavage: conchoidal

Dislocation density: 10⁹ – 10⁸ /m²

Other Thermal Properties:

Melting point: 2320 K

Softening point: 2070 K

Specific heat: $7.5 \cdot 10^2$ j/kg·K at 300 K

Thermal conductivity: 40 W/m · K ⊥ at 300 K

Thermal expansion: $6.2 \cdot 10^{-6}$ /K // C-axis; $5.4 \cdot 10^{-6}$ /K // C-axis

Other Mechanical Properties:

Hardness: Mohs 9

Knoop: 2200 face // C-axis

Knoop: 1800 face ⊥ C-axis

Young's modulus: $4.4 \cdot 10^{11}$ Pa at 300 K

Modulus of rupture: $4.0 \cdot 10^8$ Pa at 300 K

Compressive strength: $2.1 \cdot 10^9$ Pa at 300 K

Tensile strength: $1.9 \cdot 10^8$ Pa at 300 K

Poisson's constant: 0.30

Coefficient of friction: 0.15 with highly polished high carbon steels (with or without lubricants)

Other Chemical Properties:

Acids and alkalis attack: 0 at 570 K

Porosity: 0

Other Electrical Properties:

Dielectric constant: 10.6 electric field // C-axis at 300 K; 8.6 electric field ⊥ C-axis at 300

Electrical resistivity: 109Ω·m at 770 K; 104Ω·m at 1270 K; 10Ω·m at 2270 K

Ball Tolerances and Surface Finish:

Standard Balls supplied as: A.F.B.M.A. Grade 10

Basic Diameter Tolerance: +/- 100 μ" (+/- .0001")

Deviation From Spherical Form: 10 μ" (.00001")

Surface Roughness Arithmetical Average: 1.0 μ" (.000001")