

Ti:Sapphire – Ti: Al₂O₃

Ti:Sapphire was demonstrated as an active solid-state laser material in the 1980's. With a broad visible absorption band it is conveniently pumped with green wavelength lasers to produce a tunable output from 700 to 900 nm. The broad fluorescence enables production of modern ultrafast lasers. Ti:Sapphire is one of the most robust solid-state laser materials with a thermal shock resistance three times that of Nd:YAG.

Structural & Thermal Properties

Formula:	Ti ³⁺ : Al ₂ O ₃
Crystal System:	Hexagonal
Unit Cell Dimensions (as if hexagonal) ¹	a = 4.759 Å c = 12.99 Å
X-Ray Density:	3.98 g/cm ³
Melting Point: ¹	2050°C
Thermal Expansion: at 323 K ¹	⊥ c 5 x 10 ⁻⁶ K ⁻¹ c 6.6 x 10 ⁻⁶ K ⁻¹
Thermal Conductivity: 300K ¹	⊥ c 30 W / m•K c 32 W / m•K
Hardness: ¹	Mohs: 9, Knoop: ⊥ c 2200 kg mm ⁻² c 1900 kg mm ⁻²
Young's Modulus: ¹	345 GPa
Specific Heat: at 293K ¹	770 J kg ⁻¹ K ⁻¹
Thermal Shock parameter, R_T:	34 W / cm

General Specifications

Diameter Tolerance:	+0.000" / -0.002"
Chamfer:	0.005" ± 0.003" @ 45°
Barrel Finish:	55 μinches
Perpendicularity:	within 5 arc minutes
Parallelism:	10 arc-seconds or less
Rod End Face Flatness:	within λ/10 wave at 633 nm wavelength
Surface Quality:	<1.5 Å rms surface roughness
Wave Front Distortion:	less than 1/2 wave per inch of length (measured at 1 micron)
Standard Coating:	Anti-Reflection with R < 0.25%

Optical Properties

Absorption coefficient (Ti³⁺), α cm⁻¹ (at 532 nm):	0.50 to 6.0 cm ⁻¹
Figure of Merit, FOM (α_{532nm}/α_{800nm})	>150
Refractive index at 1.06 μm²	n _o = 1.75449 n _e = 1.74663
Refractive Index Temperature Coefficient: visible wavelengths near 25°C³	13 x 10 ⁻⁶ K ⁻¹
Brewster angle:	60.4°
Fluorescence lifetime at 300K:	3.0 μs

¹ Sapphire: Material, Manufacturing, Applications, Elena Dobrovinskaya et al., Springer (2009)

² Handbook Optical Constants, ed Palik, V3, ISBN 0-12-544423-0

³ Malitson, J.Opt.Soc.Am., V52, 1377-1379 (1962)