

# Ti:Sapphire – Ti: Al<sub>2</sub>O<sub>3</sub>

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

|  |   |  |
|--|---|--|
| <b>Formula:</b>  | Ti <sup>3+</sup> : Al <sub>2</sub> O <sub>3</sub> |  |
| <b>Crystal System:</b>                                     | Hexagonal   |  |
| <b>Unit Cell Dimensions (as if hexagonal) <sup>1</sup></b> | a = 4.759 Å<br>c = 12.99 Å                        |  |
| <b>X-Ray Density:</b>                                      | 3.98 g/cm <sup>3</sup>                            |  |
| <b>Melting Point: <sup>1</sup></b>                         | 2050°C  |  |
| <b>Thermal Expansion: at 323 K <sup>1</sup></b>            | ⊥ c   | 5 x 10 <sup>-6</sup> K <sup>-1</sup>                         |
|  | ∥ c   | 6.6 x 10 <sup>-6</sup> K <sup>-1</sup>                       |
| <b>Thermal Conductivity: 300K <sup>1</sup></b>             | ⊥ c   | 30 W / m•K   |
|  | ∥ c   | 32 W / m•K   |
| <b>Hardness: <sup>1</sup></b>                              | Mohs: 9, Knoop:                                   | ⊥ c 2200 kg mm <sup>-2</sup><br>∥ c 1900 kg mm <sup>-2</sup> |
| <b>Young's Modulus: <sup>1</sup></b>                       | 345 GPa   |  |
| <b>Specific Heat: at 293K <sup>1</sup></b>                 | 770 J kg <sup>-1</sup> K <sup>-1</sup>            |  |
| <b>Thermal Shock parameter, R<sub>T</sub>:</b>             | 34 W / cm   |  |

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**SYNOPTICS**



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## General Specifications

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

## Optical Properties

|   |                                    |
|---|------------------------------------|
| <b>Absorption coefficient (Ti<sup>3+</sup>), <math>\alpha</math> cm<sup>-1</sup> (at 532 nm):</b> | 0.50 to 6.0 cm <sup>-1</sup>       |
| <b>Figure of Merit, FOM (<math>\alpha_{532nm}/\alpha_{800nm}</math>)</b>                          | >150                               |
| <b>Refractive index at 1.06 <math>\mu</math>m<sup>2</sup></b>                                     | $n_o = 1.75449$<br>$n_e = 1.74663$ |
| <b>Refractive Index Temperature Coefficient:<br/>visible wavelengths near 25°C<sup>3</sup></b>    | $13 \times 10^{-6} \text{ K}^{-1}$ |
| <b>Brewster angle:</b>  | 60.4°                              |
| <b>Fluorescence lifetime at 300K:</b>   | 3.0 $\mu$ s                        |

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

<sup>2</sup> Handbook Optical Constants, ed Palik, V3, ISBN 0-12-544423-0

<sup>3</sup> Malitson, J.Opt.Soc.Am., V52, 1377-1379 (1962)