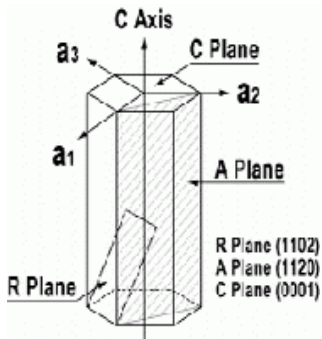




**UP TO  $\phi$ 100mm  
AVAILABLE**



## Sapphire Crystal ( $\text{Al}_2\text{O}_3$ )

As the hardest one of all the oxide crystals, Sapphire has the combination of optical and physical properties that makes it the best choice for a variety of demanding applications. Sapphire maintains its strength even at high temperature. It has good thermal properties, excellent electrical and dielectric properties and is resistant to chemical attack. These properties encourage the use of Sapphire in aggressive environments where long-term reliability, high optical transmission or good strength is required. Two methods are used in growth of sapphire crystal: Directional Temperature Gradient Technique (TGT) and Czochraski for the highest optical and substrate quality.

### TGT Sapphire Characteristics

- High transparency from the vacuum ultraviolet (VUV) through the visible, near infra-red (NIR). Absorption of  $35 \sim 65 \text{ ppm/cm}$  at  $\lambda = 1.06 \mu\text{m}$ .
- High optical homogeneity up to  $\Delta n = 5 \times 10^{-6}$  at 632nm.
- High structural quality: X-ray rocking curve FWHM =  $10''$ , dislocation density:  $10^3 \sim 10^4 / \text{cm}^2$ .
- Low  $dn/dt$  over a wide range of wavelengths.

### Basic Properties

Crystal Structure:	Hexagonal System
Lattice:	$a = 4.785 \text{ \AA}$ , $c = 12.991 \text{ \AA}$
Density:	$3.98 \text{ g/cm}^3$
Transmission Range:	150nm ~ 5500nm
Melting Point:	$2042^\circ\text{C}$
Specific Heat:	$0.418 \text{ W}\cdot\text{s/g}\cdot\text{k}$
Thermal Conductivity:	$25.12 \text{ W/m}\cdot\text{k}$ (at $100^\circ\text{C}$ )
Thermal Shock Resistance:	$790 \text{ W/m}$
Thermal Expansion Coefficient:	$5.8 \times 10^{-6} / \text{K}$
$dn/dt$ (@633nm)	$13 \times 10^{-6} / \text{K}$
Mohs Hardness:	9
Refractive Index( $n_o$ ):	1.83 @ 260nm; 1.76 @ 630nm; 1.58 @ 5570nm

## Main Applications

### 1. Applications in Microelectronics

Sapphire substrate with different orientations has different applications:

- (0 0 0 1) Basal Plane Sapphire Substrate:  
Epitaxial Gallium Nitride chip for blue LED  
IR detector
- (-1 1 0 2) R-Plane Sapphire Substrate:  
GaAs wafer carriers  
Microwave IC  
SOS (Silicon on Sapphire)- High Speed IC  
Pressure Transducer
- (1 -1 2 0) A Plane Sapphire Substrate:  
The growth of high Tc superconductors

### 2. Application in Aerospace

Windows for sensors  
Infrared countermeasure lamps

### 3. Application in Scientific Analysis

Very high pressure applications in replacement of glass or quartz tubes in NMR  
Quartz replacement to improving durability and reducing contamination in mass spectroscopy

### 4. Application in Medical Area

Surgical tips  
Endoscope lenses

### 5. Application in Optics

Illumination windows  
Sapphire light guides  
LCD projector windows  
Optical components such as lenses, prisms and other laser and infrared optics

*Quartz and other glass substrates/wafers/optics, and various crystal products are available. Contact us for more information!*

**PHOTONIK** hv

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## Sapphire Crystal (Al<sub>2</sub>O<sub>3</sub>)

### Selections of Sapphire Products

**UP TO  $\phi$ 100mm  
AVAILABLE**

#### Sapphire Substrate

##### Standard Specifications - Epi-Ready

<b>Diameter</b>	50.8 $\pm$ 0.05mm	76.2 $\pm$ 0.05mm
<b>Thickness</b>	330-430 $\pm$ 50 $\mu$ m C (0001) $\pm$ 0.2 $^\circ$	380-480 $\pm$ 50 $\mu$ m C (0001) $\pm$ 0.2 $^\circ$
<b>Orientation</b>	A (1120) $\pm$ 0.2 $^\circ$ R (1102) $\pm$ 0.2 $^\circ$	A (1120) $\pm$ 0.2 $^\circ$ R (1102) $\pm$ 0.2 $^\circ$
<b>TTV and Bow</b>	<20 $\mu$ m; or on request	<25 $\mu$ m; or on request
<b>Front Surface</b>	Epi polished	Epi polished
<b>Back Side</b>	Lapped or polished	Lapped or polished
<b>Flatness</b>	<5 $\mu$ m, or on request	<5 $\mu$ m, or on request
<b>Roughness (Ra)</b>	<0.5nm, or on request	<0.8nm, or on request
<b>ORF</b>	16.0 $\pm$ 1.0mm	22.0 $\pm$ 1.0mm
<b>Primary Flat Location</b>	A or M $\pm$ 0.5 $^\circ$	A or M $\pm$ 0.5 $^\circ$
<b>Secondary Flat Location</b>	90 $^\circ$ to primary	90 $^\circ$ to primary
<b>Package</b>	25-wafer cassette, or on request	25-wafer cassette, or on request

Note: Above shown are typical specs for reference. Users may specify application areas for confirmation of specs first.

#### Sapphire Windows & Mirrors

##### Standard Specifications

<b>Diameter Tolerance</b>	+ 0.00, - 0.10mm
<b>Thickness Tolerance</b>	$\pm$ 0.02mm
<b>Crystal Cut Orientation</b>	c-axis $\pm$ 0.5 $^\circ$ , or any other orientation per customers' request
<b>Flatness</b>	better than $\lambda$ per 10mm (@633nm)
<b>Parallelism</b>	better than 20"
<b>Surface Quality</b>	30-20 scratch and dig per MIL-O-13830A; or per customer specially specified.
<b>Bevel Processing</b>	0.05mm
<b>Wavefront Distortion</b>	< $\lambda/2$ per inch ( $\lambda$ @ 1064nm)

#### Custom Sapphire Disc/Washer/Wafer & Optics

Special high precision sapphire windows, and other AR or HR coated sapphire optics are available upon request. Sapphire boule grown by CZ and TGT method and cut sapphire blocks is also available.

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