

Properties of Sapphire

Sapphire has excellent optical, thermal, mechanical, and electrical properties, and is a material used in a variety of fields. The recent increase in the size of sapphire crystals has led to an increase in the number of applications for applying sapphire, and the replacement and improvement from other materials is progressing.

* Physical Properties

Formula : $\alpha\text{-Al}_2\text{O}_3$ (Corundum)

System : Trigonal ($R\bar{3}c$)

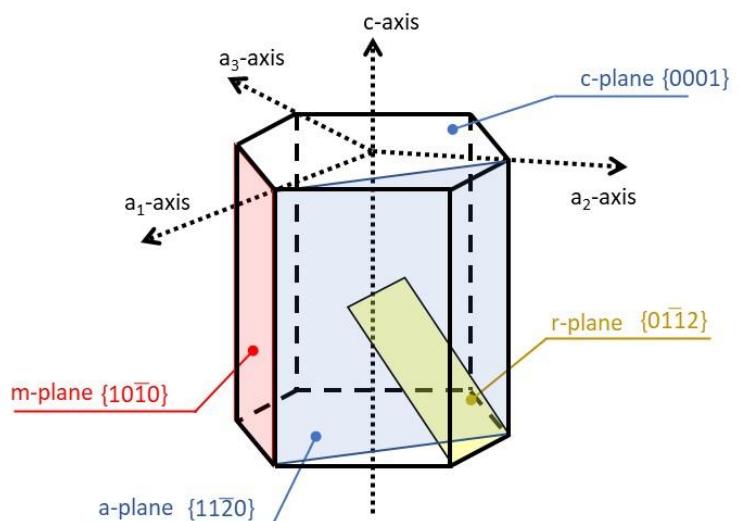
(It is generally treated as a hexagonal.)

Lattice constant : $a = 0.47588\text{nm}$

$c = 1.2992\text{nm}$

Density = 3.987g/cm^3

Melting point = 2040°C



Schematic of crystal planes of sapphire

* Thermal Properties

Thermal conductivity : $115\text{ W/m}\cdot\text{K}$ (-120°C)

$41\text{ W/m}\cdot\text{K}$ (0°C)

$20\text{ W/m}\cdot\text{K}$ (220°C)

$13\text{ W/m}\cdot\text{K}$ (500°C)

Specific heat : $0.75\text{kJ/kg}\cdot\text{^\circ C}$

Thermal expansion :

$\langle \perp \text{ c-axis} \rangle$ $6.9 \times 10^{-6}/\text{^\circ C}$ (200°C)

$8.9 \times 10^{-6}/\text{^\circ C}$ (1000°C)

$\langle // \text{ c-axis} \rangle$ $7.6 \times 10^{-6}/\text{^\circ C}$ (200°C)

$10.0 \times 10^{-6}/\text{^\circ C}$ (1000°C)

* Electrical Properties

Relative permittivity : 9.41 (c-axis, 30GHz)

Loss tangent ($\tan \delta$) : 3×10^{-5} (c-axis, 30GHz)

Resistivity : $10^{11} \Omega\text{cm}$ (500°C)

$10^6 \Omega\text{cm}$ (1000°C)

Dielectric strength : 480kV/cm (60Hz)

If you want to know more details, please contact us.

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* Mechanical Properties and Elasticity

Bending strength : 470MPa (c-plane Length direction : //a-axis)
 910MPa (a-plane Length direction : //c-axis)

Hardness : <Mohs> 9 (※Diamond = 10 Quartz = 7)

<Vickers> c-plane : 1377 a-plane : 1622

Young's modulus : 425GPa (Stress : \perp c-axis)
 460GPa (Stress : // c-axis)

Poisson's ratio : 0.30 (\perp c / \perp c)
 0.16 (/c / \perp c)
 0.18 (\perp c / //c)

* Chemical Properties

Chemical resistance:

(Weight change of sapphire specimen, □25×0.5 mm, after 6 days of immersion)

- No change in weight ($\Delta = 0\text{g}$)

HCl (35%, 20°C)

HNO₃ (50%, 20°C)

H₃PO₄ (60%, 100°C)

H₂SO₄ (95%, 100°C)

NaOH (30%, 100°C)

- Weight change micro

HF (46%, 60°C) ($\Delta = 0.0038\text{g/day}$)

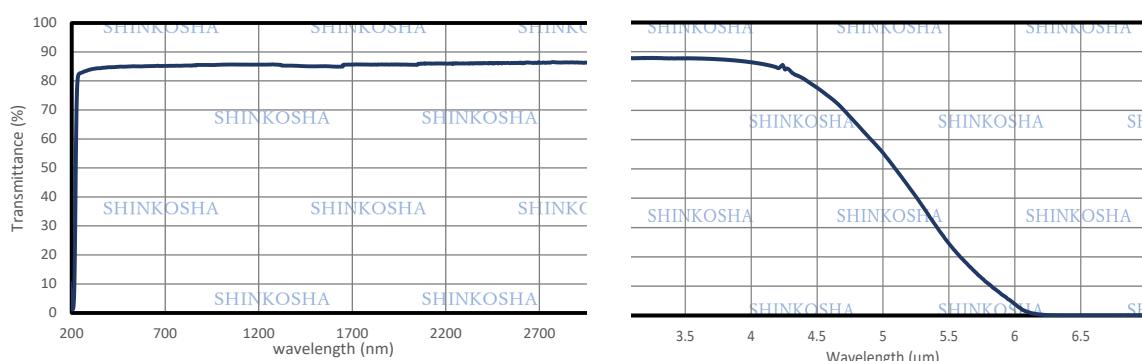
* Optical Properties

Transmittance : 0.23~5.5 μ m (>50% 5mm Optical-Grade)

0.15 μ m~ (>50% 1mm VUV-Grade)

Refractive index : no=1.7680 ne=1.7598 (at 577nm)

Transmittance of sapphire (c-plane 5mm Optical-Grade)



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