Sapphire for Semiconductor Manufacturing Equipment

High purity single crystal (Al_2O_3), Sapphire is ideal for the precise and demanding requirements of semiconductor manufacturing, offering a transparent yet durable, particle-free, cost-effective solution in aggressive environments that prove too challenging for lower technology materials.

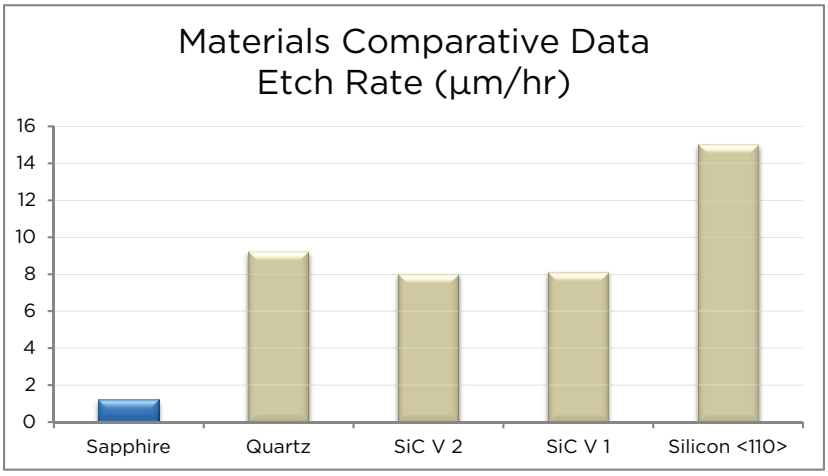
Benefits of Saint-Gobain Crystals Sapphire:

- No grain boundaries
- Extremely hard, rigid and scratch resistant
- Transmits UV, Visible and IR Wavelength
- Superior chemical properties
  (Halogens, HCl plasmas, Fluorine plasma NR_3,CF_4 ...)
- Minimal to no particle contamination
- Patented eutectic bonding enables complex shapes and structures

Advantages of Saint-Gobain Sapphire Products:

Extremely high fluorine plasma resistance AND lower particle generation, an excellent combination for:

- Increased productivity
- Increased throughput
- Less maintenance: reduced equipment downtime
- Reduced part inventory levels



Applications:

- HPD CVD
- PECVD
- Dry Etch
- Wet Etch

Products:

- Plasma containment tubes
- >330mm large components
- Viewports
- End effectors
- Lift pins
- Edge rings
- Showerheads
- E-chucks

CRYSTALS

SAINT-GOBAIN

Sapphire Properties

General Properties	
Chemical Formula	Al_2O_3 (aluminum oxide)
Names	Corundum, Sapphire, Alpha-alumina
Crystal System	Trigonal
Class	Hexagonal-scalenohedral
Thermal	
Melting Point	2053°C (3727°F)
Maximum Useful Temperature	=2000°C
Specific Heat	0.181 cal/gm°K (25°C) 0.300 cal/gm°K (1000°C)
Thermal Conductivity	0.4 watts/cm°K (25°C) 0.1 watts/cm°K (1000°C)
Thermal Expansion Coefficient	(25 – 1000°C) 8.8 x 10^{-6}; parallel to C-axis 7.9 x 10^{-6}; perpendicular to C-axis
Physical/Mechanical	
Density	3.97 gm/cm³ (0.143 lb/in³) (25°C)
Young's Modulus	435 GPa (63 x 10^6 psi) parallel to C-axis (25°C) 386 GPa (56 x 10^6 psi) parallel to C-axis (1000°C)
Modulus of Rigidity (Shear Modulus)	175 GPa (26 x 10^6 psi)
Poisson's Ratio	0.27 – 0.30 orientation dependent
Flexural Strength	1035 MPa (150 kpsi) parallel to C-axis (25°) 760 MPa (110 kpsi) perpendicular to C-axis (25°)
Compressive Strength	≈2 GPa (300 kpsi) 25°
Hardness 9 Moh's scale (between 20° and 25°C)	1900 Knoop Parallel to C-axis 2200 Knoop Perpendicular to C-axis
Chemical	
Weathering Resistance	Unaffected by atmospheric exposure
Sea Water Resistance	Unaffected by marine exposure
Biological Resistance	Unaffected by in-vivo exposure Non-thrombogenic Non-reactive with body fluids

Electrical	
Volume Resistivity (ohm-cm)	10^{16} (25°) 10^{11} (500°) 10^{6} (1000°)
Dielectric Strength	480,000 volts/cm (1,200 volts/mil)
Dielectric Constant	11.5 (10^3 – 10^9Hz, 25°C) parallel to C-axis 9.3 (10^3 – 10^9Hz, 25°C) perpendicular to C-axis
Loss Tangent	8.6 X 10^{-5} (@10^{10}Hz, 25°C) parallel to C-axis 3.0 X 10^{-5} (@10^{10}Hz, 25°C) perpendicular to C-axis
Magnetic Susceptibility	-0.21 X 10^{-6} parallel to C-axis -0.25 X 10^{-6} perpendicular to C-axis
Optical	
Transmission	UV through midwave IR (~200-5000nm)
Uniaxial Negative Refractive Index	Ordinary ray (C-axis) N_o = 1.768 Extraordinary ray N_e-1.760 Birefringence: 0.008
Temperature Coefficient of Refractive Index	13 X 10^{-6}/°C (visible range)
Spectral Emittance	0.1 (1600°C)
Spectral Absorption Coefficient	0.1 – 0.2cm^{-1} (0.66 µm, 1600°C)

SAINT-GOBAIN

Saint-Gobain Crystals

www.crystals.saint-gobain.com

Manufacturer reserves the right to alter specifications.

(12-18)