Properties of Single Crystal Sapphire

Chemical Properties

Extremely high chemical stability in many acid environments even at high temperatures.

Chemical formula: 99,997 Al_2O_3

Physical Properties

Anisotropy, properties largely dependent on crystallographic orientation. High mechanical strength for high-pressure and shock-loading applications. Excellent rain erosion resistance and low frictional coefficient.

Crystal structure: rhombohedral type single crystal, a= 4,758 Å; c=12,991 Å
Density: 3,98g/cm^3 ; 20 °C
Hardness: Mohs 9 (Knoop 2200, Flat// to C-axis; 1900 Flat ⊥ to C-axis)
Tensile strength: 0,4 GPa at 25 °C; 0,35 GPa at 1000 °C
Compressive strength: 2,1 GPa at 25 °C
Flexural strength: 0,6 GPa at 25 °C
Young's modulus: 350 GPa at 25 °C
Compressive modulus: 380 GPa at 25 °C
Flexural modulus: 360 GPa at 25 °C
Rigidity modulus: 150 GPa at 25 °C
Bulk modulus: 240 GPa at 25 °C
Poisson's ratio: 0,29
Frictional coefficient: Sapphire – Steel: 0,15; Sapphire - Sapphire: 0,1

Thermal Properties

High thermal conductivity, particularly at cryogenic temperatures, thermal shock resistance.

Melting point: 2053 °C

Application temperature: 2000 °C

Thermal expansion: 6,2 • 10^{-6},°C $^{-1}$ (20- 50 °C), // to C-axis; 5,4 • 10^{-6} C^{-1}(50°C), ⊥ to C

Heat capacity: 18,6 cal/(Mol • °C), (25°C); 30 cal/(Mol • °C), (1000°C)

Thermal conductivity: 40 W/m°K (25°C); 12 W/m°K (400 °C); 4 W/m°K (1200 °C)
(phenomenal 10 000 W/m°K at –200°C)

Specific heat: 0,1 cal g $^{-1}$ °C^{-1} (25 °C)

Optical Properties

High transparency from the ultraviolet (~0,2µm) through the visible, near infrared (6.5 µm) and again from about 50 microns out through the microwave spectrum.

Fraction: 1,8 (@ 0,3µ), 1,6 (@5µ)
Optical transmission: 0,17- 6µm
Reflection loss: 12% (1µ, by 2 surfaces)

Electrical Properties

High electrical resistivity, dielectric constant and strength.

Electrical resistivity: 10^{16} Ohm • cm (20°C); 10^{11} Ohm • cm (500°C)
Dielectric constant: 11,6 // to C-axis; 9,4 ⊥ to C-axis, at 25°C, (10^3- 10^{10} Hz)
Dielectric strength: 480 kV cm^{-1} (60 Hz)
Dielectric dissipation: 0,00006 // to C-axis; 0,00003 ⊥ to C-axis (10 GHz)

GWI • Nordring 15 • D-91207 Lauf • Fax: +49 9123 981905 • SALES@SAPPRO.DE