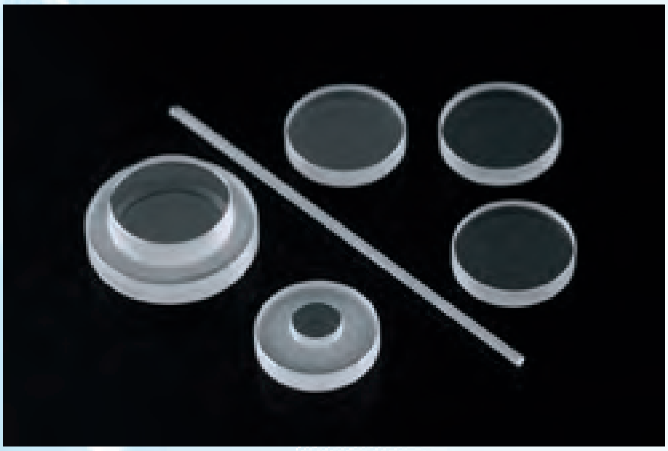
Sapphire Products



Sapphire
Al_2O_3 single crystal

Outstanding physical-chemical properties:

- Extraordinary mechanical resistance
- High hardness and shape stability up to 2 000 °C
- Excellent optical properties from UV to IR range
- High thermal conductivity
- High electrical resistivity
- Outstanding chemical resistance
- Perfect crystal lattice, no porosity

All of this makes sapphire a much sought - after material in industry and science

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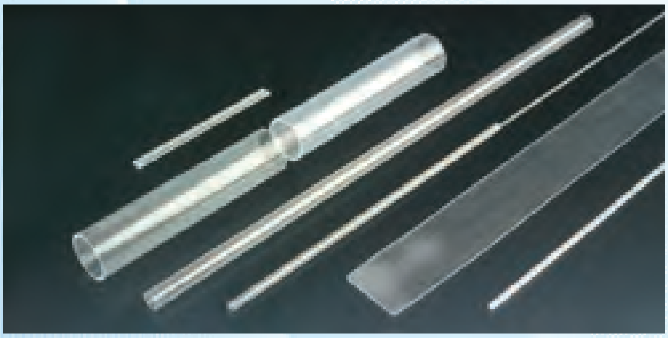
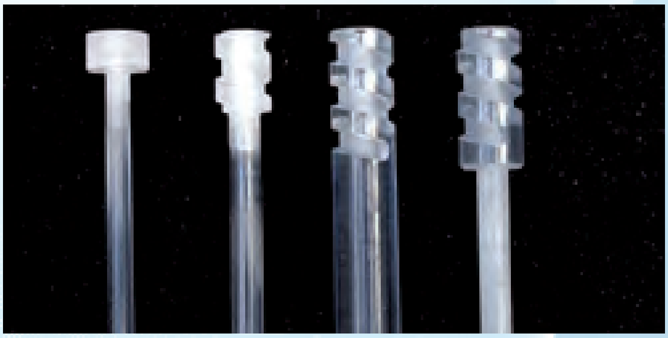
Sapphire Products

Sapphire - Al_2O_3 single crystal - has outstanding physical and chemical properties: extraordinary mechanical resistance, high hardness, excellent optical properties from UV to IR range, high melting point, high thermal conductivity, high electrical resistivity, extremely low dielectric constant, strength even in extreme temperature conditions, outstanding chemical resistance even to fluorination agents and a perfect crystal lattice. All of this makes sapphire a much sought-after material in industry and science.

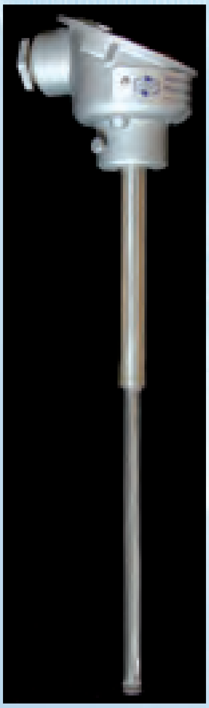
Sapphire Profiles Manufacturing

Sapphire profiles are produced in the desired shape by the EFG - „Edge-defined Film-fed Growth" (Stepanov's) method. They find utilization in different technical applications in industry, science and medicine. Standard production includes circular tubes with outside diameter range of 1.0 to 45 mm. The minimum inner diameter is 0.6 mm. Profiles such as rods, ribbons, rectangular or customer designed cross-sections are also available. The length of standard profiles can reach up to 2000 mm. Post-processing including grinding or machining of complex 3D parts is available upon request.





Sapphire Thermocouple Caps and Sets



A sapphire thermocouple set consists of an outer protective tube sealed on one side and of one or more inner capillaries used for the insulation of thermocouple branches.
Due to the single-crystal structure and perfect non-porosity, a sapphire protective sheath is significantly more resistant to extreme process conditions than other standard materials, especially ceramics. Thus equipped temperature probes can be employed to great advantage in places where fast chemical or mechanical damage to the probe otherwise occurs. The most successful applications are at temperatures above 1000 °C and at high pressures, in very corrosive environments, in moving flows of hard particles or melts, or in any combination of the said conditions. In some applications, sapphire life-time exceeds any ceramics by an order of magnitude.

EXAMPLES OF APPLICATION:

CHEMICAL ENGINEERING

Sapphire can be used in extreme temperature (up to 2000°C) and pressure chemical reactors in the presence of corrosive compounds such as hot mineral acids or melts, ammonia synthesis, sulphur, in petrochemistry, hydrogen production, etc.

POWER INDUSTRY

Desulphurization units, combustion product scrubbing, incinerators, fluidized-bed combustion furnaces, decontamination.

GLASS AND CERAMICS INDUSTRY

Substitute for Pt sheaths in glass melts, in corrosive coloured glass melts, in furnace crowns with corrosive compounds.

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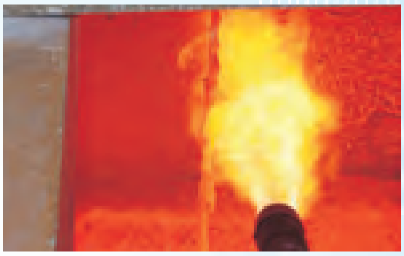
Sapphire Products

INSTRUMENT MANUFACTURING

High temperature specialised furnaces, microwave digestion, sample analysis, NMR tubes.

SEMICONDUCTOR MANUFACTURING

Due to high material purity of 99.995 % Al_2O_3 sapphire guarantees no process contamination.



Sapphire temperature probe in a glass furnace

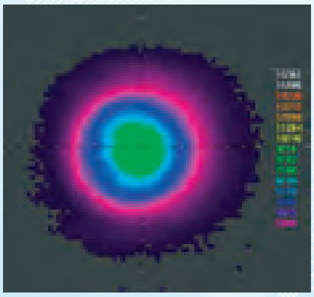
Sapphire for Optical Use

High optical transmittance of single crystal sapphire in range 0.18 - 6 µm together with its mechanical and temperature resistance predestine the use of this material in optical applications. Important advantage of sapphire is absence of -OH absorption peaks in transmission spectrum.

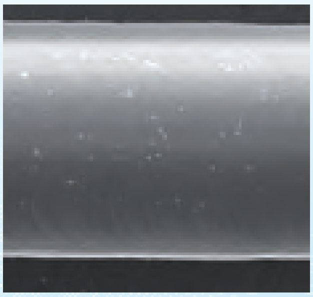
Optical windows and light guides are used in various devices such as photometers, spectrometers, furnaces and reactors. Sapphire tubes for optical applications, specifically developed for use in high quality discharge lamps, are also on offer.

Sapphire Optical Fiber

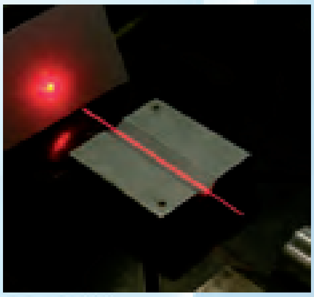
Bendable light guiding fibers for high throughput energy transfer are nontoxic and biocompatible. Sapphire fibers are produced in lengths of up to 1500 mm and in various diameters up to 1500 µm. Fibers with different coatings, plastic or armor are available.



Beam Spot



SEM Picture of Fiber Surface



Optical Bench

APPLICATION

Especially suitable as light guides for high energy lasers or optical temperature measurements.

Sapphire for Mechanical and Other Use

SAPPHIRE FOR MECHANICAL USE

Sapphire windows or profiles are scratch and wear resistant thanks to high hardness (Mohs 9). Sapphire pistons for laboratory pumps are resistant to strong acid, alkali and other chemicals.

SAPPHIRE FOR HIGH PRESSURE

Sapphire has high strength even at high temperatures. Sapphire tubes and capillaries for high pressure applications are used in NMR, EPR, XRS spectrometry and in special chemical reactors. For example tubes with OD/ID 8/5 mm can be used up to pressures of 60 MPa.

SAPPHIRE FOR LOW TEMPERATURES

Sapphire is a material well suited for cryogenic applications as its thermal conductivity is higher than that of other materials and reaches a maximum (>10^4 $W.m^{-1}.K^{-1}$) at temperature 30 K.

SAPPHIRE CRUCIBLES

A typical crucible consists of one single sapphire crystal grown into the required shape. In contrast, ceramics consist of vast quantities of sintered corundum grains. The boundaries between these grains present weak points where corrosion begins. As such, sapphire crucibles offer significant life-time advantage to corundum.

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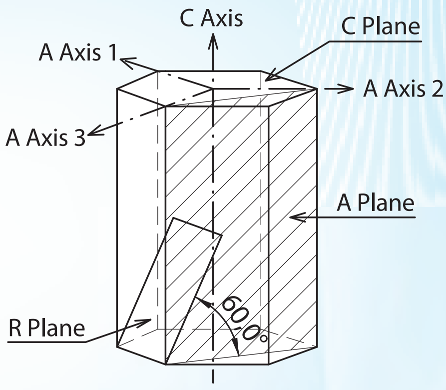
Sapphire Products

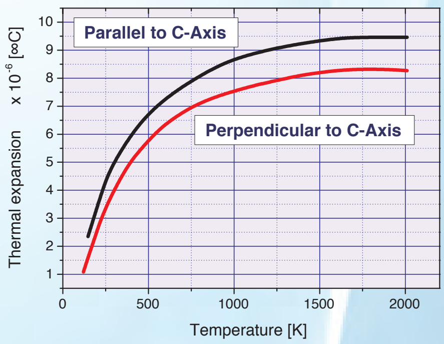
Material Properties

PHYSICAL	Crystallographic structure	Rhombohedral single crystals; R3c
	Density	$3.98 x 10^{3}$ kg.m^{-3} (20 °C)
	Hardness by Mohs	9
	Hardness by Knoop	1800 parallel to ‚c' axis (0001)
		2200 perpendicular to ‚c' axis
	Tensile strength	$2.1 x 10^{9}$ N.m^{-2} (25 °C)
	Compressive strength	$3.0 x 10^{9}$ N.m^{-2} (25 °C)
	Young's modulus of elasticity	$4.6 x 10^{11}$ N.m^{-2} (25 °C)
	Modulus of rupture	$0.7 x 10^{9}$ N.m^{-2} (25 °C)
	Coefficient of friction	0.15 - against steel
THERMAL	Melting point	2053 °C (3727 °F)
	Thermal expansion	$6.6 x 10^{-6}$ °C^{-1} (20-50 °C) parallel to ‚c' axis
		$5.0 x 10^{-6}$ °C^{-1} (20-50 °C) perpendicular to ‚c' axis
	Thermal conductivity	42 W.m^{-1}.K^{-1}
	Specific heat	$0.75 x 10^{3}$ J.kg^{-1}.K^{-1}
	Maximum operating temperature	2000 °C (3632 °F)
OPTICAL	Index of refraction	n_o = 1.768 (Sodium D-line)
		n_e = 1.760
	Optical transmition	0.18 - 6 μm (Total transmition up to 97%)
ELECTRICAL	Resistivity	$1 x 10^{18}$ Ω.m (25°C)
	Dielectric constant	11.5 parallel to ‚c' axis
		9.3 perpendicular to ‚c' axis (10^{3} - 10^{10} Hz)
	Dielectric loss tangent	$3 x 10^{-5}$ parallel to ‚c' axis
		$8.6 x 10^{-5}$ perpendicular to ‚c' axis
	Dielectric strength	$48 x 10^{6}$ V.m^{-1} (60 Hz)

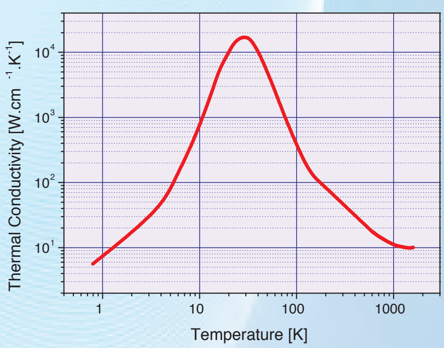


Sapphire crystallographic plains

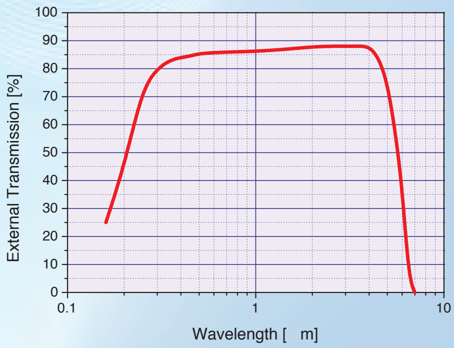
Thermal Expansion Coefficient



Thermal Conductivity



Transmission vs. Wavelength



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