Sapphire (Al2O3)

Specialist Data Sheet

Product Name	Sapphire (Al2O3)
Transmission Range	0.17 ~ 5.5 µm
Refractive Index	No 1.75449; Ne 1.74663 @ 1.06 µm
Reflection Loss	14% @ 1.06 µm
Absorption Coefficient	0.3 x 10^{-3} cm^{-1} @ 2.4 µm
Reststrahlen Peak	13.5 µm
dN/dT	13.7 x 10^{-6} @ 5.4 µm
dN/du	1.5 µm
Density	3.97 g/cc
Melting Point	2040 ℃
Thermal Conductivity	27.21 W m^{-1} K^{-1} @ 300K
Thermal Expansion	5.6 (para) & 5.0 (perp) x 10^{-6} /K *
Hardness	Knoop 2000 with 2000g indenter
Specific Heat Capacity	419 J Kg^{-1} K^{-1}
Dialectric Constant	11.5 (para) 9.4 (perp) @ 1 MHz
Youngs Modulus (E)	335 GPa
Shear Modulus (G)	148.1 GPa
Bulk Modulus (K)	240 GPa
Elastic Coefficients	C11= 496 ; C12=164 ; C13=115 ; C33=498 ; C44=148
Apparent Elastic Limit	300 Mpa (45,000psi)
Poisson Ratio	0.25
Solubility	98 x 10^{-6} g/100g water
Molecular Weight	101.96
Class/Structure	Trigonal (hex), R3c

Notes:

Sapphire is grown by a variety of methods. Verneuil and Czochralski methods are usual for standard grade material. Higher quality material, particularly for electronic substrates is manufactured by Kyropulos growth and this can be very pure with excellent UV transmission. Large thin sheets can be made by ribbon growth. Sapphire is slightly birefringent, general purpose IR windows are usually cut in a random way from crystal but for specific applications where the birefringence is an issue, an orientation is elected. Usually this is with the optic axis at 90 degrees to the surface plane and is known as "zero degree" aterial. Synthetic optical sapphire has no colouration.

* Note that all manufacturers seem to disagree on the actual figures for thermal expansion!

Application:

For extreme toughness and strength, sapphire is a very useful optical window material for use in the UV, visible, and near infra-red.

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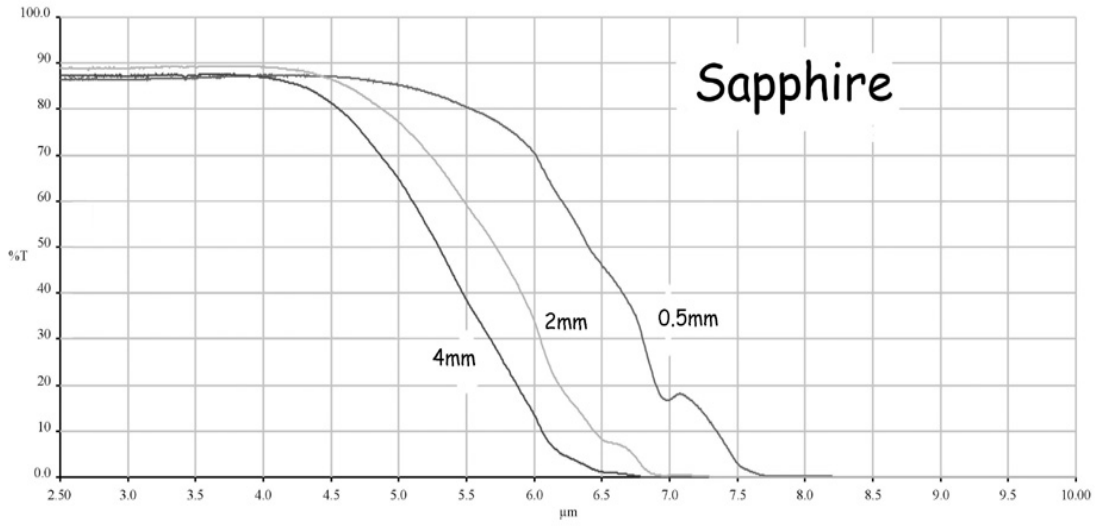
µm	No	Ne	µm	No	Ne	µm	No	Ne
0.193	1.9288	1.9174	0.458	1.7784	1.7702	1.550	1.7462	1.7384
0.213	1.8890	1.8784	0.488	1.7753	1.7671	2.010	1.7375	1.7297
0.222	1.8754	1.8650	0.515	1.7730	1.7649	2.249	1.7323	1.7243
0.226	1.8702	1.8599	0.532	1.7717	1.7636	2.703	1.719	1.711
0.244	1.8506	1.8407	0.590	1.7680	1.7600	2.941	1.712	1.711
0.248	1.8470	1.8372	0.633	1.7659	1.7579	3.333	1.701	1.693
0.257	1.8393	1.8297	0.670	1.7643	1.7563	3.704	1.687	1.679
0.266	1.8330	1.8236	0.694	1.7634	1.7554	4.000	1.674	1.666
0.280	1.8244	1.8151	0.755	1.7614	1.7535	4.348	1.658	1.658
0.308	1.8110	1.8020	0.780	1.7607	1.7527	4.762	1.636	1.628
0.325	1.8047	1.7958	0.800	1.1601	1.7522	5.000	1.623	1.615
0.337	1.8001	1.7921	0.820	1.7596	1.7517	5.263	1.607	1.599
0.351	1.7969	1.7882	0.980	1.7561	1.7482			
0.355	1.7960	1.7883	1.064	1.7545	1.7466			
0.442	1.7804	1.7721	1.320	1.7501	1.7423			

Transmission Range Graph:



Comment: 2mm

1100 nm

Data Points

nm	%T	nm	%T	nm	%T	nm	%T
500.0	86.65	400.0	86.18	300.0	84.96	200.0	22.53

Sample: UV Sapphire
Run Date: 11:59:52, 01/03/2006
Operator: Crystran Test Room
Comment: 2mm

Data Points

nm	%T	nm	%T	nm	%T	nm	%T
500.0	86.06	400.0	85.21	300.0	83.98	200.0	70.75

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Transmission Range Graph: