Silicon (Si)

APPLICATIONS: Silicon is used as an optical window primarily in the 3 to 5 micron band and as a substrate for production of optical filters. Large blocks of Silicon with polished faces are also employed as neutron targets in Physics experiments

Transmission Range	1.2 to 15µm (1)
Refractive Index	3.4223 @ 5µm (1) (2)
Reflection Loss	46.2% at 5µm (2 surfaces)
Absorption Coefficient	0.01 cm^{-1} at 3µm
Reststrahlen Peak	n/a
dn/dT	160 x 10^{-6} /°C (3)
dn/dµ = 0	10.4µm
Density	2.33 g/cc
Melting Point	1420 °C
Thermal Conductivity	163.3 W m^{-1} K^{-1} at 273 K
Thermal Expansion	2.6 x 10^{-6} / K at 20°C
Hardness	Knoop 1150
Specific Heat Capacity	703 J Kg^{-1} K^{-1}
Dielectric Constant	13 at 10 GHz
Youngs Modulus (E)	131 GPa (4)
Shear Modulus (G)	79.9 GPa (4)
Bulk Modulus (K)	102 GPa
Elastic Coefficients	C_{11}=167; C_{12}=65; C_{44}=80 (4)
Apparent Elastic Limit	124.1MPa (18000 psi)
Poisson Ratio	0.266 (4)
Solubility	Insoluble in Water
Molecular Weight	28.09
Class/Structure	Cubic diamond, Fd3m

Silicon is grown by Czochralski pulling techniques (CZ) and contains some oxygen which causes an absorption band at 9µm. To avoid this, Silicon can be prepared by a Float-Zone (FZ) process. Optical Silicon is generally lightly doped (5 to 40 ohm cm) for best transmission above 10µm. Silicon has a further pass band 30 to 100µm which is effective only in very high resistivity uncompensated material. Doping is usually Boron (p-type) and Phosphorus (n-type).

REFERENCES:

(1) Handbook Optical Constants, ed Palik, V1, ISBN 0-12-544420-6
(2) Li, Refractive Index of Germanium etc, J.Phys Chem, V9, p561, 1980
(3) Icenogle et al, Appl. Opt. V15, 2348 (1976)
(4) Wortman & Evans, V36, (1), P153 (1965)

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µm	No	µm	No	µm	No
1.357	3.4975	1.367	3.4962	1.395	3.4929
1.5295	3.4795	1.660	3.4696	1.709	3.4664
1.813	3.4608	1.970	3.4537	2.153	3.4476
2.325	3.4430	2.714	3.4358	3.000	3.4320
3.303	3.430	3.500	3.4284	4.000	3.4257
4.258	3.4245	4.500	3.4236	5.000	3.4223
5.500	3.4213	6.000	3.4202	6.500	3.4195
7.000	3.4189	7.500	3.4186	8.000	3.4184
8.500	3.4182	10.00	3.4179	10.50	3.4178
11.04	3.4176