Transmissive Materials for 1μm Optics

		BK7	Fused Silica	MS ZnS	ZnSe
Mechanical Properties	Density (g/cm^3)	2.51	2.203	4.09	5.27
	Poisson's Ratio	0.208	0.17	0.27	0.28
	Hardness (Knoop)	610	500	150-165	105-120
	Rupture Modulus (dyne/cm^2)	1.65E+08	5.00E+08	6.90E+08	5.50E+08
	Young's Modulus (dyne/cm^2)	8.2E+11	7.3E+11	7.45E+11	6.72E+11
Thermal Properties	Linear Expansion Coef (x10^-6/°C)	7.1	0.55	6.5	7.57
	Specific Heat (J/g/°C)	0.858	0.703	0.527	0.356
	Thermal Conductivity (W/cm/°C)	0.0111	0.0138	0.272	0.18
Optical Properties	Scatter Coefficient at 1.06 μm (/cm)	ND	ND	< 3%	< 0.5%
	Scatter Coefficient at 0.6328 μm (/cm)	ND	ND	< 10%	< 3%
	Index of Refraction @ 1.06 μm	1.5066	1.4496	2.287	2.483
	Temp. Change of Refractive Index(x10^-6/°C) @ 1.06 μm	1.2	11	42	70
	Bulk Absorption (/cm) @ 1.07 μm	~ 0.001	~ 0.0001	< 0.0005	< 0.001
	K-Values For Lenses, Plano/Convex Lens	0.07112	0.08994	0.02888	0.02849
	Positive Meniscus Lens	0.06573	0.07792	0.02051	0.01758
	Equi-Convex Lens	0.10290	0.11542	0.05494	0.05164

Zinc sulfide MultiSpectral (ZnS MS) is the only material for NIR and IR freeform optics.

Notes: 1) ND means not detectable.
2) K values are used to estimate focus spot size of lenses with spherical aberrations. Below are two equations used to estimate spot size. The equation on the left assumes a perfect lens such as an aspheric lens. The equation on the right assumes the lens has some spherical aberration.

Diffraction Limited Equation

$$d_d = \frac{4 \cdot \lambda \cdot M2 \cdot f}{\pi \cdot d_0}$$

Aberration Limited Equation

$$d_s = \frac{4 \cdot \lambda \cdot M2 \cdot f}{\pi \cdot d_0} + \frac{k \cdot d_0^3}{f^2}$$

Where:

d_d ≡ diffraction limited focused beam diameter
d_s ≡ aberration limited focused beam diameter
λ ≡ wavelength of light
M2 ≡ mode quality factor for the laser beam
d_0 ≡ beam diameter at the e^{-2} power points
f ≡ is the focal length of the lens
k ≡ is the aberration coefficient

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