

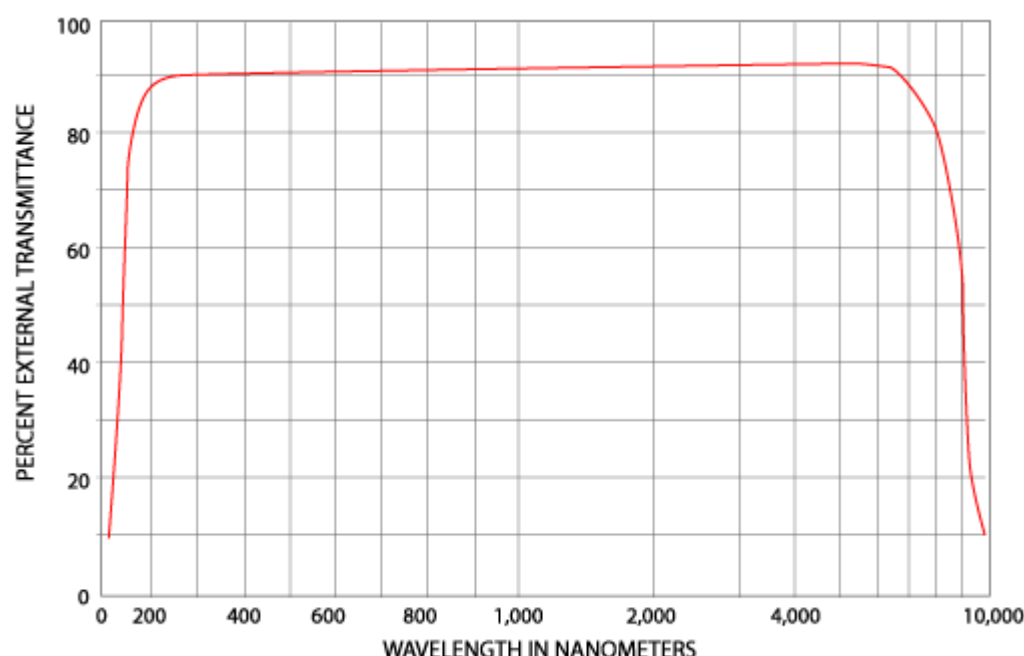
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Material Properties

Calcium Fluoride

Calcium fluoride (CaF_2), a cubic single-crystal material, has widespread applications in the ultraviolet and infrared spectra. CaF_2 is an ideal material for use with excimer lasers. It can be manufactured into windows, lenses, prisms, and mirror substrates.

CaF_2 transmits over the spectral range of about 130 nm to 10 μm as shown in the figure below. Traditionally, it has been used primarily in the infrared, rather than in the ultraviolet. CaF_2 occurs naturally and can be mined. It is also produced synthetically using the Stockbarger method, which is a time- and energy-consuming process. Unfortunately, achieving acceptable deep ultraviolet transmission and damage resistance in CaF_2 requires much greater material purity than in the infrared, and it completely eliminates the possibility of using mined material.



External transmittance for calcium fluoride

To meet the need for improved component lifetime and transmission at 193 nm and below, manufacturers have introduced a variety of inspection and processing methods to identify and remove various impurities at all stages of the production process, from incoming materials through crystallization. The needs for improved material homogeneity and stress birefringence have also caused producers to make alterations to the traditional Stockbarger approach. These changes allow tighter temperature control during crystal growth, as well as better regulation of vacuum and annealing process parameters.

Excimer-grade CaF_2 provides the combination of deep ultraviolet transmission (for 193 nm and even 157 nm), high damage threshold, resistance to color center formation, low fluorescence, high homogeneity, and low stress birefringence characteristics required for the most demanding deep ultraviolet applications.

Calcium Fluoride Constants

Density: 3.18 gm cm^{-3} @ 25°C

Poisson Ratio: 0.26

dN/dT: $-10.6 \times 10^{-6}/^\circ\text{C}$

Young's Modulus: 1.75×10^7 psi

Coefficient of Linear Expansion: $18.9 \times 10^{-6}/^\circ\text{C}$ (from 20°C to 60°C)

Melting Point: 1360°C

Refractive Index of Calcium Fluoride

Wavelength (μm)	Refractive Index <i>n</i>
0.193	1.501
0.248	1.468
0.257	1.465
0.266	1.462
0.308	1.453
0.355	1.446
0.486	1.437
0.587	1.433
0.65	1.432
0.7	1.431
1.0	1.428
1.5	1.426
2.0	1.423
2.5	1.421
3.0	1.417
4.0	1.409
5.0	1.398
6.0	1.385
7.0	1.369
8.0	1.349

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