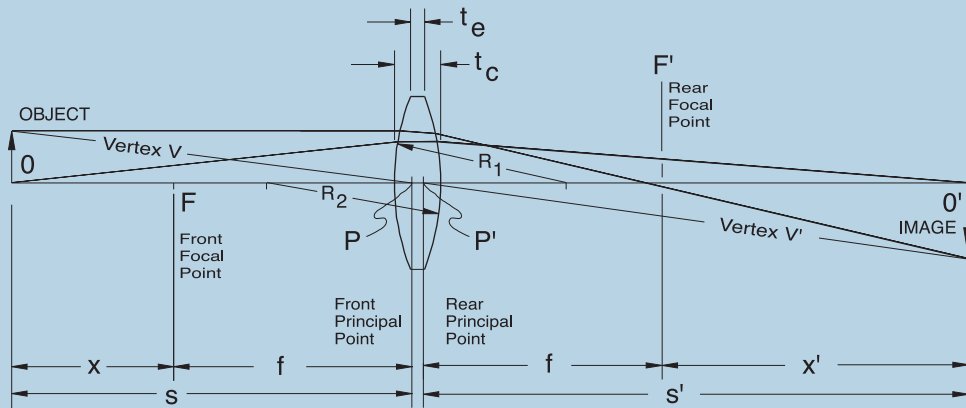


Spherical Lens Parameters



\varnothing = Lens Diameter

$M = \frac{S'}{S}$ Magnification or Conjugate Ratio

f = EFL (Effective Focal Length)

$$\frac{1}{f} = \frac{1}{S} + \frac{1}{S'}$$

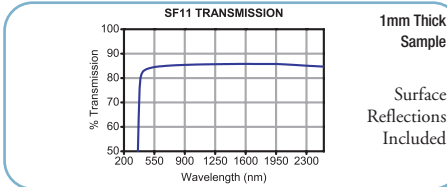
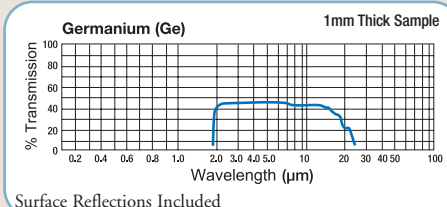
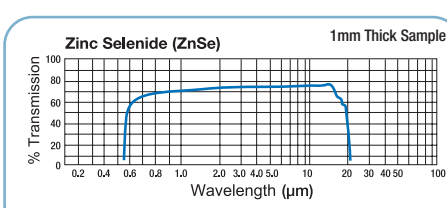
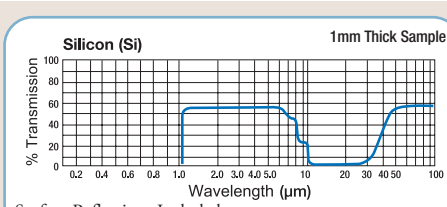
Paraxial Lens Formula (assumes $\sin \theta \approx \theta$)

S = Object Distance, positive for objects to the left of the front principal point P.

S' = Image Distance, positive for images to the right of the rear principal point P'

Transmission of Various Materials

GLASS	DESCRIPTION	TRANSMISSION	Graph	Notes
BK7	BK7 is a high-quality optical glass commonly used to make lenses intended for laboratory use. It has excellent mechanical and optical properties as well as good transmission in the visible and IR.	350nm to 2.0 μ m		1mm Thick Sample Surface Reflections Included
UV Fused Silica	UV fused silica is an excellent material for the transmission of UV light. It is durable and has good mechanical properties $T_{\text{external}} \geq 80\%/cm @ 185nm$ $T_{\text{internal}} \geq 88\%/cm @ 185nm$	185nm to 2.1 μ m		1mm Thick Sample Surface Reflections Included
CaF ₂	Calcium fluoride provides great transmission from the UV to the IR. Synthetic CaF ₂ is used to improve deep UV transmission and to increase the damage threshold.	180nm to 8.0 μ m		1mm Thick Sample Surface Reflections Included
MgF ₂	Magnesium fluoride, an extremely rugged and durable material, is transparent over an extensive range of wavelengths from the UV to the IR.	200nm to 6.0 μ m		1mm Thick Sample Surface Reflections Included

GLASS	DESCRIPTION	TRANSMISSION	
SF11	This glass provides excellent chemical resistance and has a high refractive index, which allows for the same amount of refraction with less curvature. It is useful for constructing optics that would be extremely difficult to make from BK7.	420nm to 2.3µm	 <p>1mm Thick Sample Surface Reflections Included</p>
Ge	The transmission characteristics of germanium in the IR region of the spectrum make it an ideal choice for imaging 2.0 - 16µm light. Ge plano-convex lenses are particularly well suited for more biomedical and military imaging applications.	2.0µm to 16µm	 <p>1mm Thick Sample Surface Reflections Included</p>
ZnSe	With a transmission range from 600nm - 600nm to 16µm, zinc selenide plano-convex lenses are ideal for IR applications. Due to the low absorption coefficient, these lenses are also particularly well suited for high-power CO ₂ laser applications. In contrast to Ge and Si, which also transmit in this spectral range, ZnSe transmits some visible light, thereby allowing for visual alignment of the optic.	600nm to 16µm	 <p>1mm Thick Sample Surface Reflections Included</p>
Si	Silicon plano-convex lenses are an ideal choice for applications from 1.2 - 8µm and are particularly well suited for imaging, biomedical, and military applications.	1200nm to 8.0 µm	 <p>1mm Thick Sample Surface Reflections Included</p>

- Optical Systems
- Free Space Isolators
- E-O Devices
- Spherical Singlets
- Multi-Element Lenses
- Cylindrical Lenses
- Aspheric Lenses
- Mirrors
- Diffusers & Lens Arrays
- Windows
- Prisms
- Gratings
- Polarization Optics
- Beamsplitters
- Filters & Attenuators
- Gas Cells

Spherical Singlet Anti-Reflection Coatings

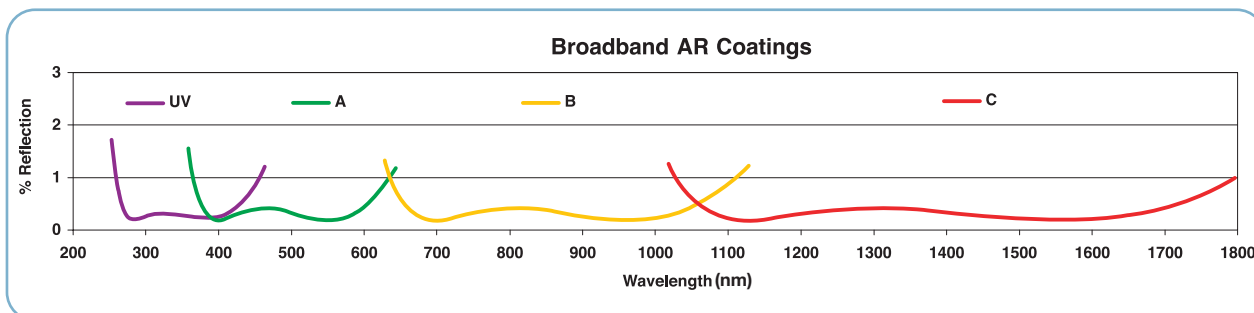
Most of our standard optics are available with high-performance, multilayer AR coatings, which minimize surface reflections within the specified wavelength ranges. These coatings are designed for angles of incidence between 0° and 30° (0.5 NA). For optics intended to be used at large

angles, consider using a custom coating optimized at a 45° of incidence; these coatings are effective from 25° to 52°. The plot shown below indicates the performance of the standard coatings in this family as a function of wavelength for a single surface. Broadband coatings have a typical absorption of 0.25% that is not shown in the reflectivity plots.

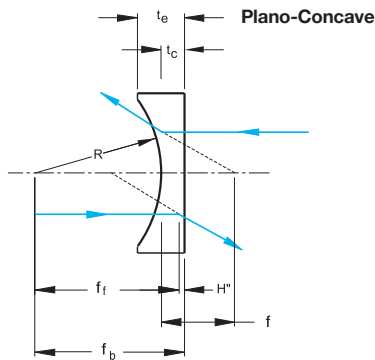
- R < 0.5% Average Over Band at 0° Incidence
- Less Angular Sensitivity within Angular Range
- Frequently Run Coatings are Listed Below

Normal Incidence Broadband Multilayer Anti-Reflective Coating

COATING CODE	WAVELENGTH RANGE	DESIGN ANGLE OF INCIDENCE	USEFUL ANGLE OF INCIDENCE
-UV	290-370nm	0°	0 to 30°
-A	350-650nm	0°	0 to 30°
-B	650-1050nm	0°	0 to 30°
-C	1050-1620nm	0°	0 to 30°



UV Fused Silica: Plano-Concave & Bi-Concave Lenses



Plano-Concave lenses have a negative focal length and are typically used to diverge collimated beams of light in instruments like Galilean type beam expanders or Telescopes. The spherical aberration introduced into the electromagnetic wavefront by a plano-concave lens is negative and, as a result, it can be used to balance the positive spherical aberrations introduced by other lenses.

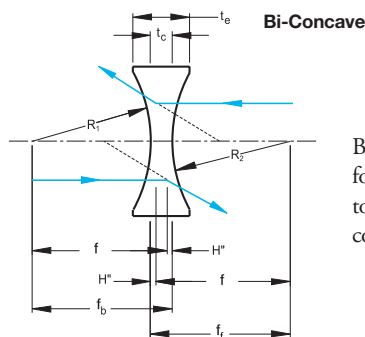
Specifications

- **Material:** UV Grade Fused Silica
- **Wavelength Range:** 185nm-2.1µm Uncoated
- **Design Wavelength:** 588nm, n = 1.460
- **Diameter Tolerance:** +0.00/-0.10mm
- **Focal Length Tolerance:** ±1%
- **Scratch-Dig:** 40-20
- **Centration:** ≤3arcmin
- **Clear Aperture:** >90% of Dia.
- **Transmission:** T_{internal} ≥ 88%/cm @ 185nm

Plano-Concave Lenses: UV Grade Fused Silica

ITEM #	DIA (mm)	f (mm)	PRICE				R (mm)	t _c (mm)	t _e ¹ (mm)	f _b (mm)	SUGGESTED MOUNT ²
			\$	£	€	RMB					
LC4573	6.0	-10.0	\$ 68.90	£ 43.40	€ 64.10	¥ 658.00	-4.6	2.0	3.1	-11.4	LMRA8 & LMR05
LC4291	8.0	-12.0	\$ 70.30	£ 44.30	€ 65.40	¥ 671.40	-5.5	2.0	3.7	-13.4	
LC4924	12.7	-20.0	\$ 72.40	£ 45.60	€ 67.30	¥ 691.40	-9.2	2.0	4.5	-21.4	
LC4210	12.7	-25.0	\$ 69.60	£ 43.80	€ 64.70	¥ 664.70	-11.5	3.0	4.9	-27.1	
LC4796	12.7	-30.0	\$ 69.50	£ 43.80	€ 64.60	¥ 663.70	-13.8	3.0	4.5	-32.1	
LC4357	12.7	-50.0	\$ 69.30	£ 43.70	€ 64.40	¥ 661.80	-23.0	3.5	4.4	-52.4	LMR05
LC4413	12.7	-75.0	\$ 68.90	£ 43.40	€ 64.10	¥ 658.00	-34.5	3.5	4.1	-77.4	
LC4232	12.7	-100.0	\$ 68.90	£ 43.40	€ 64.10	¥ 658.00	-46.0	3.5	3.9	-102.4	
LC4918	12.7	-200.0	\$ 68.90	£ 43.40	€ 64.10	¥ 658.00	-92.0	4.0	4.2	-202.7	
LC4252	25.4	-30.0	\$ 77.30	£ 48.70	€ 71.90	¥ 738.20	-13.8	3.0	11.4	-32.1	LH1
LC4513	25.4	-75.0	\$ 76.00	£ 47.90	€ 70.70	¥ 725.80	-34.5	3.5	5.9	-77.4	LMR1
LC4888	25.4	-100.0	\$ 76.00	£ 47.90	€ 70.70	¥ 725.80	-46.0	3.5	5.3	-102.4	
LC4425	50.8	-75.0	\$ 259.10	£ 163.20	€ 241.00	¥ 2,474.40	-34.5	3.5	14.6	-77.4	LH1
LC4743	50.8	-100.0	\$ 244.80	£ 154.20	€ 227.70	¥ 2,337.80	-46.0	4.0	11.6	-102.7	LMR2
LC4869	50.8	-150.0	\$ 234.60	£ 147.80	€ 218.20	¥ 2,240.40	-69.0	4.0	8.8	-152.7	

1 Edge Thickness given before 0.2mm @ 45° typ. Chamfer.
2) See the Lens Mount Section, Starting on Page 153.



Bi-Concave lenses have a negative focal length and are commonly used to increase the divergence of converging light.

Related Products

See page 882



Lens Tissues/Forceps

ITEM#	\$	£	€	RMB	DESCRIPTION
MC-5	\$ 8.70	£ 5.50	€ 8.10	¥ 83.10	Lens Tissues, 5 Booklets
FCP	\$ 18.30	£ 11.50	€ 17.00	¥ 174.80	Forceps, Solid Stainless Steel

Bi-Concave Lenses: UV Grade Fused Silica

ITEM #	DIA (mm)	f (mm)	PRICE				R (mm)	t _c (mm)	t _e ¹ (mm)	f _b (mm)	SUGGESTED MOUNT ²
			\$	£	€	RMB					
LD4797	6.0	-6.0	\$ 83.60	£ 52.70	€ 77.70	¥ 798.40	-5.9	2.5	4.1	-6.8	LMRA6 & LMR05
LD4148	6.0	-12.0	\$ 68.10	£ 42.90	€ 63.30	¥ 650.40	-11.5	3.0	3.8	-13.0	
LD4271	9.0	-9.0	\$ 85.70	£ 54.00	€ 79.70	¥ 818.40	-8.7	2.5	5.0	-9.8	LMRA9 & LMR05
LD4014	9.0	-18.0	\$ 68.90	£ 43.40	€ 64.10	¥ 658.00	-17.0	3.0	4.2	-19.0	
LD4771	12.7	-15.0	\$ 84.70	£ 53.40	€ 78.80	¥ 808.90	-14.3	3.0	6.0	-16.0	LMR05
LD4650	12.7	-25.0	\$ 81.10	£ 51.10	€ 75.40	¥ 774.50	-23.5	3.0	4.8	-26.0	
LD4269	12.7	-30.0	\$ 80.60	£ 50.80	€ 75.00	¥ 769.70	-28.1	3.0	4.5	-31.0	
LD4511	12.7	-50.0	\$ 74.70	£ 47.10	€ 69.50	¥ 713.40	-46.5	3.0	3.9	-51.0	
LD4931	25.4	-25.0	\$ 104.00	£ 65.50	€ 96.70	¥ 993.20	-23.5	3.0	10.5	-26.0	LMR1
LD4293	25.4	-50.0	\$ 100.00	£ 63.00	€ 93.00	¥ 955.00	-46.6	3.5	7.0	-51.2	
LD4735	25.4	-75.0	\$ 85.20	£ 53.70	€ 79.20	¥ 813.70	-69.6	3.5	5.8	-76.2	
LD4103	25.4	-100.0	\$ 84.60	£ 53.30	€ 78.70	¥ 807.90	-92.6	3.5	5.3	-101.2	

1 Edge Thickness given before 0.2mm @ 45° typ. Chamfer.
2) See the Lens Mount Section, Starting on Page 153.