Shalom EO
Crystals, optics and components

Infrared Optics

LWIR Lenses

MWIR Lenses

Infrared Domes

Infrared Windows

Infrared Lens Optics

About Us

Hangzhou Shalom Electro-optics Technology Co., Ltd. is an industrial-leading manufacturer and supplier of optics, crystals, and substrates. We have an engineering team and a sales group with decades of expertise and technical prowess. The state-of-the-art production line can support both a quick turnaround and sophisticated manufacturing. Besides custom services, thousands of standard modules in stock are also available for selection, with convenient online purchasing and fast dispatch. With a devoted attitude and unceasing efforts, we have established ourselves as a trusted partner among customers all over the globe.

A Wide Selection of Crystals, Optics, and Wafers for Versatile Applications

- Crystals, optics, optical filters, and components for lasers;
- IR lenses, windows, domes, and lens assemblies for thermal imaging cameras and applications;
- Scintillation crystals and detectors for nuclear detection;
- SAW crystals and wafers, Sapphire, other crystals substrates and wafers for semiconductor, HTSC, industrial, medical, scientific, and research applications

Online Ordering and Fast Delivery

Besides the customized products tailored to your request, thousands of standard products in our inventory are available for selection, you can order and shop online on our website. Our efficient sales group ensures a fast and convenient ordering process.

Expert Sales Group and Engineering Team

Our engineering team and sales group have profound engineering backgrounds and expert experience in the field of electro-optics sales group, competent to interpret your intentions well and arrange the best solution for you. Entrust your vision to our expert engineering team and proficient sales group, armed with a wealth of experience and technical prowess to interpret and exceed your expectations. The streamlined production workshop endows us with flexible efficiencies to accommodate both bulk orders and low-scale demands. Cutting-edge production techniques are utilized to achieve the pinnacles of excellence. We aim to maintain a desirable balance between price competitiveness and performance that maximizes your interest all the time.

ISO9001 QC System and Guarantee

Rest assured, in Hangzhou Shalom EO, we prioritize quality. All products are inspected in our clean room and supervised under our ISO9001-certified quality control system. Each shipped product will be sent with a report of the measured data to ensure the parameters of the product meet the published standards. Advanced equipment such as Zygo interferometers and atom force microscopes are utilized to realize stringent precision control. Furthermore, most of our products will have a 12-month guarantee, we will repair and replace the products for free within this guarantee period.

Keep pace with technical progress and collaborate with you on product upgrading and development

Innovative techniques and upgrading of your products will demand renewal and polishing up of the components integrated, which bring technique challenges. In a world of constant innovation, Hangzhou Shalom EO is your steadfast partner, committed to keeping pace with technical advancements and collaborating with you on product upgrades and developments. Together, let's propel your projects to new heights.

INFRARED OPTICS

Infrared optics are optical elements focused on the propagation, manipulation, and utilization of light within the infrared spectrum. Infrared wavelength band means wavelength range above 700nm to 1000μm. In general, it can be divided into four smaller spectra: near-infrared (NIR) at 700nm-900nm, short-wave infrared (SWIR) at 900nm-2300nm, mid-wave infrared (MWIR) at 3000nm-5000nm, and long-wave infrared (LWIR) at 8000nm-16000nm. Infrared or IR optics are often used in Forward-looking Infrared (FLIR), Fourier Transform Infrared (FTIR) spectroscope, SWIR imaging, MWIR, LWIR thermal imaging and detection, defense, aerospace, industrial processing, and excimer/CO2 lasers.

Hangzhou Shalom EO offers singlet IR optical lenses, IR optical windows, and domed windows, in addition to assembled lens modules designed for SWIR (0.9-1.7 micro), MWIR (3-5 micro), and LWIR (8-12 micro) thermal imaging cameras. Various specific infrared optical materials are available: Germanium, Zinc selenide (ZnSe), Zinc sulfide (ZnS), Chalcogenide glass, Silicon, Sapphire, and Fluorides (CaF2, BaF2, MgF2, and LiF). Our fabrication techniques include conventional polishing and diamond turning, and our optics types include flat surface, spherical, and aspherical surface optics.

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LWIR THERMAL IMAGING CAMERA LENSES

Long Wave Infrared (LWIR) thermal imaging camera lenses are integrated lens assemblies designed to match with uncooled infrared FPA detectors/sensors, operating at 8-12 micron spectral regions. Compared to MWIR thermal lenses, LWIR lenses have the distinctive features of independence from surrounding light/heat sources and are more affordable than the former. A set of LWIR lens modules, for the most part, is constituted of multiple (>2) single IR lenses with different surface profiles (e.g. diffractive lens, aspheric lens) made of various LWIR-transmitting materials (e.g Ge, ZnSe, Chalcogenide Glass, etc.) with complementary optical properties to compensate the spherical and chromatic aberrations and optimize for the image quality. With excellent detection, recognition, and identification (DRI) capabilities, the LWIR lens assemblies meet the specific requirements for a wide range of industrial, medical, commercial, defense, and homeland security applications.

Hangzhou Shalom EO offers off-the-shelf thermal camera lenses and custom lens modules, hundreds of stocked LWIR lenses. Shalom EO uses a wide assortment of materials including Germanium, Zinc Selenide, Chalcogenide Glass, ZnS, and Gallium Arsenide(GaAs), etc. as LWIR lens substrates, deposited with anti-reflection (AR) coatings or diamond-like carbon(DLC) coatings on the lens front. The LWIR thermal lenses are categorized into six classifications: Athermalized Lenses exhibit high resistance to temperature fluctuations thus shrinking the possibility of defocus at unstable temperatures, and Super Wide Angle and Fisheye Lenses provide broad fields of view, Single FOV Lenses have a certain designated focal length each, thus a fixed FOV, while Dual FOV Lenses have two switchable focal lengths each and hence a double FOV. The Zoom Lenses have continuous variable focal lengths, allowing flexible observation over a wide range

of distances and real-time detection. And Microscope IR Lenses are also available.

Shalom EO has established its trustful image as a manufacturer and a worldwide supplier of Infrared thermal imaging lenses over years of dedication. Our lens production line is of cutting-edge techniques under rigorous inspection, including CNC fabrication and single-point diamond turning (SPDT) polishing. The sealings of lens groups are IP67-rated waterproof, dust-tight . For focal length-variable lens modules, built-in manual and motorized focus mechanisms are incorporated, where compact mechanical architectures for lightweight concerns s could be customized upon request. Other specifications and structures such as pinhole lenses for temperature monitoring in furnaces could all be arranged.

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LWIR Athermalized Lenses for Thermal Imaging Camera

- Wide focal length range: 4.3mm to 100mm
- Broad working temperature range: -40℃ to 60℃
- Passive optical athermalization design
- Compact structure and IP67 sealing

Infrared optical materials exhibit substantial changes in their refractive indices along with temperature changes, this trait consequently leads to unstable focusing lengths of Infrared (IR) thermal imaging cameras, which are undesirable. Athermalization technique is often utilized in the design of IR thermal imaging to eliminate the defocus over an extended temperature range. There are three main techniques: Passive Optical Athermalization, Passive Mechanical Athermalization, and Active Electromechanical Athermalization. Passive Optical Athermalization eliminates the effect of defocus by combining different lens materials with complementary CTEs (Coefficients of Thermal Expansion) to compensate for thermal focus shift, the advantage is that the designed structure can be simplified and involves no spatial displacement of the lenses, thus standing out for compact and lightweight considerations.

Hangzhou Shalom EO offers off-the-shelf and custom LWIR thermal camera lenses of passive optical athermalization design, with a focus range of 4.3mm to 100mm and a temperature range of -40℃ to +60℃. With passive optical athermalization treatment, the lenses are compact with the absence of additional lenses to offset the thermal defocus and therefore are advantageous for weight-sensitive designs.

Products List of LWIR Athermalized Lenses:

Code	Focal length	Module	F#	Focusing Mechanism	Unit Price
301-001	4.3mm	L4.3F1.0	1.0	Athermalized	Inquire
301-002	7.1mm	L7.1F1.0	1.0	Athermalized	Inquire
301-003	8mm	L8F1.0	1.0	Athermalized	Inquire
301-004	9mm	L9F1.05	1.05	Athermalized	Inquire
301-005	10mm	L10F1.0	1.0	Athermalized	Inquire
301-006	12.3mm	L12.3F1.0	1.0	Athermalized	Inquire
301-007	12.8mm	L12.8F1.0	1.0	Athermalized	Inquire
301-008	13mm	L13F1.0	1.0	Athermalized	Inquire
301-009	13mm	L13F1.0	1.0	Athermalized	Inquire
301-010	13mm	L13F1.1	1.1	Athermalized	Inquire
301-011	15mm	L15F1.0	1.0	Athermalized	Inquire
301-012	17mm	L17F1.0	1.0	Athermalized	Inquire
301-013	19mm	L19F0.9	0.9	Athermalized	Inquire
301-014	19mm	L19F1.0	1.0	Athermalized	Inquire
301-015	19mm	L19F1.0	1.0	Athermalized	Inquire
301-016	19mm	L19F1.2	1.2	Athermalized	Inquire
301-017	20mm	L20F1.0	1.0	Athermalized	Inquire
301-018	25mm	L25F1.0	1.0	Athermalized	Inquire
301-019	27mm	L27F1.0	1.0	Athermalized	Inquire
301-020	32mm	L32F1.0	1.0	Athermalized	Inquire
301-021	35mm	L35F0.85	0.85	Athermalized	Inquire
301-022	35mm	L35F1.0	1.0	Athermalized	Inquire
301-023	35mm	L35F1.2	1.2	Athermalized	Inquire
301-024	38mm	L38F1.0	1.0	Athermalized	Inquire
301-025	40mm	L40F1.0	1.0	Athermalized	Inquire
301-026	40mm	L40F1.6	1.6	Athermalized	Inquire
301-027	50mm	L50F1.2	1.2	Athermalized	Inquire
301-028	50mm	L50F1.2	1.2	Athermalized	Inquire
301-029	60mm	L60F1.25	1.25	Athermalized	Inquire
301-030	75mm	L75F1.0	1.0	Athermalized	Inquire
301-031	75mm	L75F1.2	1.2	Athermalized	Inquire
301-032	75mm	L75F1.4	1.4	Athermalized	Inquire
301-033	95mm	L95F1.5	1.5	Athermalized	Inquire
301-034	100mm	L100F1.2	1.2	Athermalized	Inquire
301-035	100mm	L100F1.4	1.4	Athermalized	Inquire
301-036	100mm	L100F1.5	1.5	Athermalized	Inquire

Microscope Thermal Lenses and Other Special LWIR Lenses

- 1x to 23x off-the-shelf thermal microscope lenses
- LWIR microscope lenses deposited with AR coatings
- other custom LWIR thermal lens upon request

Microscope Thermal Lenses deliver outstanding thermal imaging capabilities at a microscopic scale, enabling users to delve into the temperature distribution of minute structures. With superior magnification and focusing capabilities, microscope thermal lens optics deliver clear and sharp images, facilitating in-depth analysis of fine object structures.

Our product range includes several modules of off-the-shelf microscope lenses, offering magnifications from 1x to 23x. These lenses are optimized for thermal cameras, ensuring seamless integration and enabling detailed inspection and analysis in thermal imaging applications. The advanced design and superior quality of our lenses guarantee exceptional performance, allowing for clear, detailed thermal imaging even in challenging scenarios.

In addition, this product series includes other specialized LWIR lenses suitable for a wide range of applications. These lenses can operate in extreme temperature conditions and also exhibit excellent optical clarity and high sensitivities, ensuring users obtain reliable imaging results in various environments.

Products:

Code	Types	Wavelength	Dimension	EFL	Coating	Unit Price
306-001	1X Magnification	8μm-12μm	Length:76.38, Diameter:Φ45	44.28mm	AR	Inquire
306-002	2X Magnification	8μm-12μm	Length: 84.39, Diameter:ϕ54	-	AR	Inquire
306-003	2X Magnification	8μm-12μm	Length:75.52,Diameter:Φ43	23.7mm	AR	Inquire
306-004	3X Magnification	8μm-12μm	Length:55.11, Diameter:Φ39	13.286mm	AR	Inquire
306-005	23X Magnification	8μm-12μm	-	-	AR	Inquire

LWIR Super Wide Angle Lenses, Fisheye Lenses for Thermal Imaging Camera

- Ultra wide angles of view and compact structure
- Modules available: Fisheye, Super Wide Angle, and Pinhole Lenses
- Available as off-the-shelf and custom versions
- Image distortion customizable
- IP67 sealing

Fisheye Lenses are a kind of novel, non-rectilinear wide-angle lenses with extraordinarily broad FOV, producing panoramic or hemispherical images with rather obvious image distortion, and the manner in which distortion occurs is determined by the mapping function of the lenses. Super Wide-Angle Lenses refer exclusively to the wide-angle lenses with ultra-short focal lengths and expanded FOV between 80°and 110°. There are more definite focal length boundaries that discriminate the two. In comparison, fisheye lenses tend to have broader FOV than wide-angle lenses and are designed to form a curvilinear perspective in the images, whilst wide-angle lenses are contrived to be rectilinear (i.e., linear perspective) and exhibit a little or no image distortion depending on the focal length (the shorter the focal length, the more difficult to maintain linear perspective). For thermal cameras, fisheye and super wide-angle lenses hold the advantages of tremendous FOV and deeper depth of field, which implies the capability of collecting IR radiations from the full scene in focus. This feature is quite beneficial for thermal imaging applied in security and surveillance, military, and other domains.

Hangzhou Shalom EO offers Off-the-shelf and Custom Super Wide-Angle Lenses and Fisheye Lenses for LWIR (8-12 micro) thermal imaging cameras. The lenses feature wide angles of view, compact architectures, compatibility with multiple detector sizes, and are available in either manual focusing or fixed focal length versions. Pinhole super wide angle and fisheye lens modules with miniature aperture are also available, which, utilizing the secondary imaging technique, are fit for tight, compact, and concealed designs (e.g. temperature monitoring of crystals-growing and metal-smelting furnaces, security). Full-frame (rectangular) fish eye lenses with 180°diagonal FOV are provided.

Product List of LWIR Super Wide Angle and Fisheye Lenses

Code	Focal length	Module	F#	Focusing Mechanism	Unit Price
302-001	3.3mm	L3.3F1.5	1.5	Manual	Inquire
302-002	3.6mm	L3.6F1.0	1.0	Manual	Inquire
302-003	3.0mm	L3.0F2.2(HGL803B)	2.2	Manual	Inquire
302-004	3.0mm	L3.0F2.2(HGL903B)	2.2	Manual	Inquire
302-005	4.0mm	L4.0F1.0	1.0	Manual	Inquire
302-006	4.8mm	L4.8F1.25	1.25	Manual	Inquire
302-007	5.0mm	L5.0F1.0	1.0	Manual	Inquire
302-008	6.8mm	L6.8F1.0	1.0	Manual	Inquire
302-009	6.0mm	L6.0F2.0	2.0	Manual	Inquire
302-010	7.0mm	L7.0F1.0	1.0	Manual	Inquire
302-011	7.5mm	L7.5F1.0	1.0	Manual	Inquire
302-012	8.0mm	L8.0F0.8	0.8	Fixed	Inquire
302-013	8.0mm	L8.0F1.0	1.0	Manual	Inquire

LWIR Single FOV Lenses for Thermal Imaging Camera

- Focal lengths up to 300mm
- Fixed, Manual or motorized focusing mechanism
- Working temperature range: -40℃ to 60℃
- Fit for a variety of detectors

For a thermal camera, Field of view (FOV) is defined as the maximum angle at which the device is sensitive to Infrared electromagnetic radiation. The focal length of the thermal lens modules and the dimension of the sensor/detector determine the FOV. For a given dimension of the detector, FOV is only dependent upon the focal length of the lenses. Unlike a set of double FOV lenses which has two switchable focal lengths, or a set of zoom lenses that has continuous variable focal lengths between a given range, a set of LWIR single FOV lenses features a fixed focal length, and therefore, a fixed FOV.

However, in real-life cases, although most single FOV thermal imaging lenses are devised with one definite focal length, manufacturers often incorporate some minute adjusting mechanism into the lenses, so that users can calibrate the scope and adjust the visual distance, whether the aiming objects are near or distant, users can bring the objects intended for observation into focus. Nominally, the focal length remains "fixed", and the FOV is the same, but the focal length is in fact variable to a quite subtle extent. There are two mechanisms for adjusting the focal length, manual focusing and motorized. Manual Focusing Lenses are lenses whose focal lengths can be changed using hands. While Motorized Lenses allow users to adjust the camera from remote distances without manual handling.

Hangzhou Shalom EO offers a series of IR single FOV lenses for LWIR (8-12 micro) thermal imaging cameras with focal lengths from 4.8mm to 300mm, fit for uncooled FPA detectors ranging from a low resolution of 160x120 pixels to a high resolution of 1024x768 pixels. Each of these thermal camera lenses from Shalom holds a designated focal length and provides a certain FOV. However, for the convenience of practical usage, for most off-the-shelf LWIR single FOV lens modules, the configured focal length is slightly adjustable, either using a manual focusing mechanism or a motorized mechanism, and lenses with absolutely invariable fixed focal lengths are also available. You might select our LWIR manual Focus Lenses, motorized Lenses, or fixed focal length lenses according to your requirements. Besides the off-the-shelf products, custom free-design IR thermal imaging lenses could also be tailored.

Product List of LWIR Single FOV Lenses

Code	Focal length	Module	F#	Focusing Mechanism	Unit Price
303-001	4.8mm	L4.8F1.0-man	1.0	Manual	$307.0
303-002	4.8mm	L4.8F1.0-mot	1.0	Motorized	Inquire
303-003	7.5mm	L7.5F1.0-man	1.0	Manual	Inquire
303-004	8.0mm	L8.0F0.8-man	0.8	Manual	$350.0
303-005	8.0mm	L8.0F0.8-mot	0.8	Motorized	Inquire
303-006	8.0mm	L8.0F0.8-fix	0.8	Fixed	Inquire
303-007	12.0mm	L12.0F1.0-man	1.0	Manual	Inquire
303-008	12.0mm	L12.0F1.0-mot	1.0	Motorized	Inquire
303-009	12.5mm	L12.5F1.0-man	1.0	Manual	Inquire
303-010	15.0mm	L15.0F1.0-man	1.0	Manual	Inquire
303-011	15.0mm	L15.0mmF1.0-mot	1.0	Motorized	Inquire
303-012	17.0mm	L17.0F1.0-man	1.0	Manual	Inquire
303-013	19.0mm	L19.0F1.0-man	1.0	Manual	Inquire
303-014	20.0mm	L20.0F1.0-man	1.0	Manual	Inquire
303-015	25.0mm	L25.0F0.8-man	0.8	Manual	Inquire
303-016	25.0mm	L25.0F1.0-man	1.0	Manual	Inquire
303-017	25.0mm	L25F1.0(325FB/1.0)-man	1.0	Manual	Inquire
303-018	25.0mm	L25F1.0-mot	1.0	Motorized	Inquire
303-019	35.0mm	L35.0F1.0-man	1.0	Manual	Inquire
303-020	35.0mm	L35.0F1.0-mot	1.0	Motorized	Inquire
303-021	35.0mm	L35.0F1.0(for XGA)-mot	1.0	Motorized	Inquire
303-022	40.0mm	L40F0.68-mot	0.68	Motorized	Inquire
303-023	40.0mm	L40F0.8-mot	0.8	Motorized	$520.0
303-024	40.0mm	L40.0F1.0-mot	1.0	Motorized	Inquire
303-025	50.0mm	L50F1.0-man	1.0	Manual	Inquire
303-026	50.0mm	L50.0F1.0(for XGA)-man	1.0	Manual	Inquire
303-027	50.0mm	L50F1.0-mot	1.0	Motorized	Inquire
303-028	55.0mm	L55.0F1.0-man	1.0	Manual	Inquire

Code	Focal length	Module	F#	Focusing Mechanism	Unit Price
303-035	75.0mm	L75.0F1.4-man	1.4	Manual	Inquire
303-036	100mm	L100F1.0-man	1.0	Manual	Inquire
303-037	100mm	L100F1.0-mot	1.0	Motorized	Inquire
303-038	100mm	L100F1.2-man	1.2	Manual	Inquire
303-039	100mm	L100F1.3-mot	1.3	Motorized	Inquire
303-040	100mm	L100F1.4-man	1.4	Manual	Inquire
303-041	100mm	L100F1.4-mot	1.4	Motorized	Inquire
303-042	100mm	L100F1.4-Light Weight	1.4	Fixed	Inquire
303-043	100mm	L100F2.0-man	2.0	Manual	Inquire
303-044	125mm	L125F1.0-mot	1.0	Motorized	Inquire
303-045	130mm	L130F1.2-mot	1.2	Motorized	Inquire
303-046	150mm	L150F1.2-mot	1.2	Motorized	Inquire
303-047	150mm	L150F1.2(for XGA)-mot	1.2	Motorized	Inquire
303-048	180mm	L180F2.0-mot	2.0	Motorized	Inquire
303-049	210mm	L210F1.3-mot	1.3	Motorized	Inquire
303-050	260mm	F260F1.3-mot	1.3	Motorized	Inquire
303-051	275mm	L275F2.0-man	2.0	Manual	Inquire
303-052	300mm	L300F1.3-mot	1.3	Motorized	Inquire

LWIR Zoom Lenses for Thermal Imaging Camera

- Maximum 13X Zoom Ratio
- Wide focal length range: wide angle focal lengths to a maximum telescope focal length: 400mm
- Motorized focusing or manual focusing
- DLC coating on front lenses

Zoom Lenses are lens assemblies providing a broad scope of variable focal lengths within certain designed boundaries, as the opposite of prime lenses with fixed focal lengths. A set of Continuous Zoom (CZ) lenses can support continuous shifting of focal lengths to generate focused images throughout a wide domain of distances from close up to remote positions without the bother of changing the working distance. This is a useful trait for LWIR thermal detectors as Long Wave Infrared imaging is prevalent for security and military applications, with the distinctive advantage of flexible FOVs, zoom lenses allow real-time surveillance without the danger of being spotted.

Hangzhou Shalom EO offers a series of Off-the-shelf Zoom Lenses for LWIR (wavelength 8-12 micros) thermal imaging with a maximum zoom ratio (i.e., the ratio between the longest focal length to the shortest focal length) of 13X. These assembled lens modules provide users with smooth, continuous zooming experiences and flexible alternation of views, with additional DLC coatings on the front lens and tight sealings contributing to reliable durability in various sorts of environments. The available focal lengths range from wide-angle focal lengths to a maximum telephoto focal length of 400mm, whilst zoom lenses for microscope IR imaging are also stored in our inventories. The zooming mechanisms of these lenses include manual zooming and motorized zooming. Besides the off-the-shelf zoom lenses, Shalom EO's engineering team is capable of designing and manufacturing custom LWIR zoom lenses tailored to your interests.

Product List of LWIR Zoom Lenses

Code	Focal length	Module	F#	Focusing Mechanism	Unit Price
305-001	/	L-Zoom-0.6X-3X-microscope	/	Manual	Inquire
305-002	7.5~75mm	L-Zoom-7.5/F1.2-75/F1.2continuous	1.2	Motorized	Inquire
305-003	15~100mm	L-Zoom-15/F1.4-100/F1.4continuous	1.4	Motorized	Inquire
305-004	15~150mm	L-Zoom-15/F1.4-150/F1.4continuous	1.4	/	Inquire
305-005	18~54mm	L-Zoom-18/F1.05-54/F1.05continuous	1.05	Manual	Inquire
305-006	25~75mm	L-Zoom-25/F1.0-75/F1.0continuous	1.0	Motorized	Inquire
305-007	25~75mm	L-Zoom-25/F1.2-75/F1.2continuous	1.2	Motorized	Inquire
305-008	25~100mm	L-Zoom-25/F1.2-100/F1.2continuous	1.2	Motorized	Inquire
305-009	25~105mm	L-Zoom-25/F1.6-105/F1.6continuous	1.6	/	Inquire
305-010	25~225mm	L-Zoom-25/F1.5-225/F1.5continuous	1.5	Motorized	Inquire
305-011	30~120mm	L-Zoom-30/F1.0-120/F1.0continuous	1.0	Motorized	Inquire
305-012	30~120mm	L-Zoom-30/F1.2-120/F1.2continuous	1.2	Motorized	Inquire
305-013	30~150mm	L-Zoom-30/F1.2-150/F1.2continuous	1.2	Motorized	Inquire
305-014	30~90mm	L-Zoom-30/F1.4-90/F1.4continuous	1.4	Motorized	Inquire
305-015	30~400mm	L-Zoom-30/F1.5-400/F1.5continuous	1.5	Motorized	Inquire

MWIR THERMAL IMAGING CAMERA LENSES

MWIR (Mid Wave Infrared) Thermal Imaging Camera Lenses are lenses oriented for operation in the 3-5 micro wavelength spectrum. Since the thermal contrast is stronger in the MWIR region than in the LWIR region, and the MWIR radiation is less susceptible to thermal diffraction, the MWIR lens modules, combined with sensitive cooled FPA detectors within an MWIR thermal camera, are more capable of producing images with high resolution, contributing to compelling overall image qualities. MWIR thermal camera lenses are also considered more suitable candidates for long-range detection than LWIR lenses. Shalom EO's MWIR lenses feature optimized Modulation Transfer Function (MTF) and exceptional Detection, Recognition, and Identification (DRI) functionalities. The lenses, with a broad portfolio of varied specifications, support detection under poor atmospheric/illumination conditions (e.g. in fog/complete darkness), and even allow invisible objects to be captured (e.g. gas leakage). Shalom EO's MWIR lenses are an excellent alternative for thermal imaging in various domains, including industrial, academic, surveillance, and homeland security.

Hangzhou Shalom EO offers off-the-shelf and custom Lenses for Thermal Imaging Cameras. For MWIR Lens Modules, a wide assortment of lenses is available, including MWIR Single FOV Lenses with a designated focal length and FOV each, MWIR Dual FOV Lenses with two selectable focal lengths, and MWIR Continuous Zoom Lens Assemblies which enable continuous shifting of focal lengths, permitting flexible observation over a wide range of distances and real-time detection. Materials with high MWIR transmission including Germanium, ZnSe, Chalcogenide Glass, Zinc Sulfide, GaAs, and Silicon are utilized as substrate materials, and anti-flection (AR) coatings, Diamond-Like Carbon (DLC) coating could be deposited according to your requirements.

Over the years, Shalom EO has built a solid reputation as a manufacturer and global supplier of infrared thermal imaging lenses. Our lens production line incorporates cutting-edge processes such as CNC fabrication and single-point diamond turning (SPDT) polishing, under stringent QC procedures. The sealings of lens groups are IP67-rated waterproof and dust-tight. Built-in manual and motorized focus mechanisms are integrated into focal-length-variable lens modules, and compact mechanical designs for lightweight concerns can be designed upon request. In addition, athermalized lens modules to compensate for temperature fluctuations are also accessible both in our stock list and as custom products.

MWIR Single FOV Lenses for Thermal Imaging Camera

- Focal length range: 13mm to 400mm
- Fixed, Manual, or motorized focusing mechanism
- Compatible with MWIR cooled detectors
- Maximum working temperature range: -40℃ ~ +60℃
- Off-the-shelf and custom modules available

Field of view (FOV) is defined as the maximum angle at which an optic is sensitive to electromagnetic radiations with the object distance being infinite. The focal length of the lens and the dimension of the sensor/detector determine the FOV. The dimension of the detector is fixed, therefore focal length alone decides the FOV. A set of MWIR single FOV lenses features a fixed focal length, and therefore, a certain FOV.

However, in real-life cases, for single FOV thermal camera lenses devised with one definite focal length, manufacturers often incorporate some focusing mechanism into the lenses, the adjustments are minute, but allow users could calibrate the scope and adjust the visual distance, whether the aiming objects are near or distant, users can bring the objects intended for observation into focus. Nominally, the focal length remains "fixed", and the FOV is the same, but is variable to a quite subtle extent. There are two mechanisms for adjusting the focal length, manual focusing and motorized. Manual Focusing Lenses are lenses whose focal lengths can be changed using hands. While Motorized Lenses allow users to adjust the camera from remote distances without manual handling.

Hangzhou Shalom EO offers a series of Single FOV Lenses for MWIR thermal imaging cameras. Each of the lens assemblies has a certain focal length which produces a definite FOV, and the selective focal lengths for the lens modules range from 13mm to 400mm. For the convenience of using, regarding most off-the-shelf MWIR single FOV lens modules, the configured focal length of each lens module is adjustable to a subtle degree, either using a manual focusing mechanism or a motorized mechanism. Nonetheless, MWIR lenses with absolutely invariable fixed focal lengths in addition to athermalized designs to improve thermal steadiness are also available if you prefer. Besides the off-the-shelf products, custom free-design IR thermal imaging lenses could also be tailored.

Product List of MWIR Single FOV Lenses

Code	Focal length	Module	F#	Focusing Mechanism	Unit Price
311-001	13mm	M13F2.0-ath	2.0	Athermalized	Inquire
311-002	27mm	M27F2.0-ath	2.0	Athermalized	Inquire
311-003	50mm	M50F2.0-ath	2.0	Athermalized	Inquire
311-004	100mm	M100F2.0-man	2.0	Manual	Inquire
311-011	100mm	M100F4.0-man	4.0	Manual	Inquire
311-005	150mm	M150F2.0-man	2.0	Manual	Inquire
311-006	200mm	M200F2.0-man	2.0	Manual	Inquire
311-007	200mm	M200F2.0-mot	2.0	Motorized	Inquire
311-008	250mm	M250F2.0-man	2.0	Manual	Inquire
311-009	300mm	M300F2.0-man	2.0	Manual	Inquire
311-010	400mm	M400F2.0-man	2.0	Manual	Inquire

MWIR Zoom Lenses for Thermal Imaging Camera

- Continuous Zoom (CZ) designs, maintained focus at full zoom range
- Maximum magnification x20
- Focal length up to 1100mm, detection range up to 35km
- High MWIR transmission and low image distortion
- Diffraction-limited MTF

Zoom Lenses are lens assemblies providing a broad scope of variable focal lengths within certain designed boundaries, as the opposite of prime lenses with fixed focal lengths. A set of Continuous Zoom (CZ) lenses can support continuous shifting of focal lengths to generate focused images throughout a wide domain of distances from close up to remote positions without the bother of changing the spatial location of the camera.

Hangzhou Shalom EO offers off-the-shelf and custom MWIR Zoom Lenses for Thermal Imaging Cameras operating in the 3-5 micro MWIR wavelength region. We have succeeded in developing a 90mm to 1100mm f/5.5 Continuous Zoom MWIR Thermal Camera Lens Module featuring a maximum detection range of 35km, lightweight, and large aperture, catering to diverse surveillance and monitoring missions requiring long detection ranges and high thermal contrast. All MWIR zoom lens modules boast flexible zooming, diffraction-limited MTF, and maintained focus at full zoom range. The lens assemblies are compatible with cooled detectors, supporting high resolutions and observation at a broad range of distances for various high-end applications.

Product List of MWIR Zoom Lenses

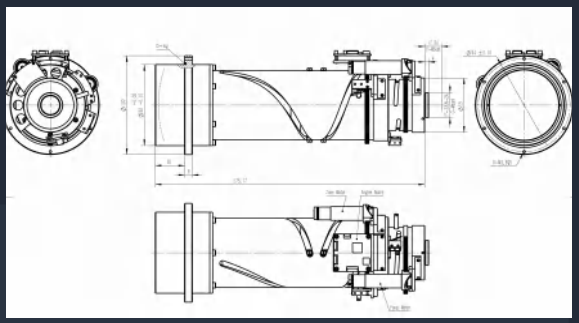
Code	Focal length	Module	F#	Focusing Mechanism	Weight	Unit Price
313-001	15~300mm	M-Zoom-15/F4.0-300/F4.0	4.0	Motorized	About 1000g	Inquire
313-005	15~300mm	M-Zoom-150/F4.0-1100/F4.0	4.0	Motorized	~420g	Inquire
313-002	15~300mm	M-Zoom-15/F5.5-300/F5.5	5.5	Motorized	650g	Inquire
313-006	18~275mm	M-Zoom-18/F5.5-275/F5.5	5.5	Motorized	~218g	Inquire
313-007	23~450mm	M-Zoom-23/F4.0-450/F4.0	4.0	Motorized	~1580g	Inquire
313-003	60~300mm	M-Zoom-60/F2.0-300/F2.0	2.0	Motorized	1600g	Inquire
313-008	41~825mm	M-Zoom-41/F4.0-825/F4.0	4.0	Motorized	~4.2kg	Inquire
313-004	90~1100mm	M-Zoom-90/F5.5-1100/F5.5	5.5	Motorized	4.2kg	Inquire

SWIR THERMAL IMAGING CAMERA LENSES

Short-wave infrared (SWIR) refers to the electromagnetic radiation spectral region of 900-1700nm, which is invisible to the human eye. SWIR thermal camera lenses are designed to capture and focus light within this specific wavelength range, unlocking a host of applications that were once constrained by the limitations of conventional optics.

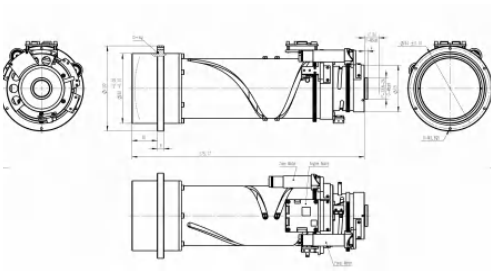
Compared with MWIR (mid-wave infrared) and LWIR (long-wave infrared), Short-wave infrared (SWIR) imaging shows more details and better contrast. This is because MWIR and LWIR radiations are emitted from the objects in the form of heat, leading to a lack of resolution and detail, while SWIR light interacts with objects in a similar manner to visible wavelengths in that the photons are reflected from the object. This reflective nature contributes to high-resolution imaging. Combined with compatible sensors such as InGaAs, SWIR lenses are advantageous as the lenses present comparable imaging details to visible images while SWIR radiation can reveal what the naked eye can not perceive, allowing objects to be more easily recognized and identified.

SWIR thermal camera lenses serve critical functions in fields such as agriculture, where SWIR thermal imaging lenses aid in monitoring crop health, such as the bruises on fruits, and in industrial settings, SWIR lenses facilitate non-destructive testing by revealing hidden details. Moreover, SWIR lenses are instrumental in defense and security applications, providing enhanced surveillance capabilities that extend beyond the capabilities of visible-light cameras.



Shalom EO offers various stocked and custom SWIR Thermal Camera Lenses, the lenses feature excellent performance-to-price ratios and are exceptional for electronic board inspection, material/food sorting, solar cell inspection, quality inspection, and security applications.

SWIR Zoom Lenses for Thermal Imaging Camera



- Continuous Zoom (CZ) designs
- Transmission Range 900-1700nm

Zoom Lenses are lens assemblies providing a broad scope of variable focal lengths within certain designed boundaries, as the opposite of prime lenses with fixed focal lengths. A set of Continuous Zoom (CZ) lenses can support continuous shifting of focal lengths to generate focused images throughout a wide domain of distances from close up to remote positions without the bother of changing the spatial location of the camera.

Hangzhou Shalom EO offers off-the-shelf and custom SWIR Zoom Lenses for Thermal Imaging Cameras operating in the 0.9-1.7 micros wavelength region with remarkable precision, revealing what the naked eye cannot perceive with high image resolution. A flexible zooming mechanism ensures smooth shifting and adjusting of sight, and focus is maintained at full zoom range.

Product List of SWIR Zoom Lenses

Code	Focal length	Module	F#	Weight	Unit Price	Delivery
321-001	30-300mm	M-Zoom-30/F2.8-300/ F4.3	2.8-4.3	~2kg	Inquire	Inquire

INFRARED OPTICAL WINDOWS

Infrared Optical Windows are transparent optical elements that allow infrared radiation to pass through with minimal attenuation and distortion, ensuring that the signal received by the optical system remains intact. These windows act as protective barriers, safeguarding delicate optical components from contaminants such as dust, moisture, and chemicals, which could degrade performance or cause damage. Many infrared optical windows are engineered to withstand a wide range of environmental conditions, including temperature extremes, humidity, and pressure variations, without compromising optical quality or mechanical strength. Infrared optical windows find applications across diverse fields where the manipulation and detection of infrared radiation are crucial, including thermal imaging, remote sensing, defense, and industrial processing.

Hangzhou Shalom EO offers off-the-shelf and custom infrared windows that operate at a wide wavelength range from 0.75μm to 20 μm, made of various substrate materials for selection: germanium (Ge), silicon (Si), zinc selenide (ZnSe), sapphire, calcium fluoride (CaF2), barium fluoride (BaF2), zinc sulfide (ZnS), etc. AR coating

options include broad band anti-reflection coating (BBAR), long-pass anti-reflection coating and hard diamond-like carbon (DLC) coating to withstand harsh environments can be deposited.

Germanium (Ge) Windows

- Stocked and custom Germanium (Ge) windows available
- Maximum diameter 300mm
- Broad wavelength range covering 2000-16000nm, excellent for IR applications
- Coating options: DLC coating, AR@3-5μm, AR@8-12μm, BBAR@3-12μm

Germanium (Ge) Windows are excellent for infrared spectrum applications because of their broad IR transmission range and opacity in the visible portion of the spectrum. Germanium offers broadband transmission across a wide range of infrared wavelengths from 2 μm to 14 μm, in particular in the mid-wave infrared (MWIR) and long-wave infrared (LWIR) regions, which in unite with low dispersion, making Ge well-suited for applications requiring distant and precise infrared thermal imaging and sensing. Ge windows are more rugged than other infrared (IR) materials, it is often used as protective windows for thermal cameras, or longpass filters for wavelengths above 2000nm. Germanium also has the virtues of high chemical inertness. But germanium would begin to become opaque in the IR spectrum when the temperature rises above 90℃, one should take caution when it is used in high-temperature applications.

Hangzhou Shalom EO offers both off-the-shelf and custom Germanium Windows, the maximum diameter is 300mm. Because Germanium has a considerably large refractive index, AR coatings are crucial to ensure high transmission. Coating options available include DLC (Diamond Like Carbon) coating, AR@3-5 micro, AR@8-12 micro, and BBAR@3-12 micro, Shalom EO is capable of fabricating the Germanium optical windows with high precision and coating sets according to your requests.

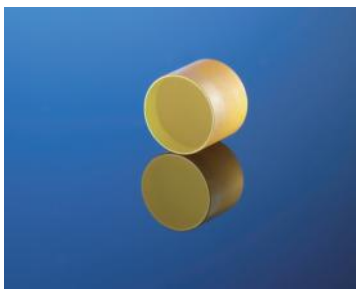
Specifications:

Material	Ge	Thickness	1-4mm
Coating	Uncoated, AR/DLC, AR/AR	Diameter	10-101.6mm
Wavelength range	2000-16000nm	Customization	available

Product List of Germanium Windows

Code	Material	Diameter	Thickness	Coating	Unit Price
320-001	Ge	10mm	2mm	AR/AR	$33.0
320-002	Ge	12mm	1mm	AR/DLC	$30.0
320-003	Ge	12mm	1mm	AR/AR	$29.0
320-005	Ge	18mm	1mm	AR/DLC	$38.0
320-006	Ge	20mm	1mm	AR/DLC	$40.0
320-007	Ge	25.4mm	1mm	Uncoated	$46.0
320-008	Ge	25.4mm	1mm	AR/DLC	$50.0
320-009	Ge	29mm	2mm	AR/DLC	$61.5
320-010	Ge	33mm	1mm	AR/DLC	$55.0
320-011	Ge	50.8mm	3mm	AR/DLC	$118.0
320-012	Ge	52mm	3mm	AR/DLC	$120.0
320-013	Ge	60mm	2mm	AR/DLC	$130.0
320-014	Ge	60mm	3mm	AR/DLC	$169.0
320-015	Ge	65mm	3mm	AR/DLC	$190.0
320-016	Ge	70mm	3mm	AR/DLC	$210.0
320-017	Ge	76mm	3mm	AR/DLC	$260.0
320-018	Ge	80mm	3mm	AR/DLC	$270.0
320-019	Ge	85mm	3mm	AR/DLC	$295.0
320-020	Ge	91.8mm	3mm	AR/DLC	$340.0
320-021	Ge	100mm	4mm	AR/DLC	$510.0
320-022	Ge	101.6mm	1mm	AR/DLC	$200
320-023	Ge	101.6mm	4mm	AR/DLC	$520.0

ZnSe windows



- Maximum diameter 200mm
- CVD ZnSe grown in the USA
- Broad transmission wavelength range from 600nm to 16000nm and low IR absorption
- Low chromatic dispersion, outstanding thermal properties
- Coating options: AR@3-5μm, AR@8-12μm, BBAR@3-12μm

Zinc Selenide (ZnSe) Windows are excellent for various IR applications due to their extensive transmission wavelength range from 0.6 to 1.6μm and are often optimized for the IR range of 3-16μm after AR coating. Its absorption coefficient is in particular low in the IR range, this trait, in combination with its low chromatic dispersion, minimizes signal loss and enables authentic transmission of infrared radiation. ZnSe windows boast outstanding thermal properties, therefore are recommended for thermally demanding condition. With high thermal shock resistance and low absorption, ZnSe windows are an exceptional option for high-power CO2 lasers and thermal imaging cameras. However, the material is relatively soft and chemically sensitive and thus extra caution needs to be taken during cleaning, handling, and mounting.

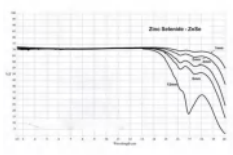
Hangzhou Shalom EO offers ZnSe Windows made of CVD (Chemical Vapor Deposition) ZnSe grown in the USA with high purity. Because ZnSe also has a high refractive index (around 2.4), which normally requires an anti-reflection coating to achieve high transmission, various coating options (AR/BBAR) are provided in Shalom EO. The maximum Diameter is 200mm, while the clear aperture is greater than 90%.

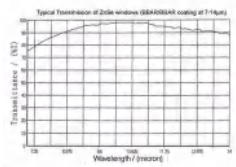
Specifications:

Materials	CVD ZnSe crystals	Diameter Range	~ 200mm
Aperture	>90%	Dimension Tolerance	+0.0/-0.2mm
Thickness Tolerance	+/-0.2mm	Surface Quality	60/40 S/D
Parallelism	1 arc minute	Chamfer	0.3-0.5mmx45degree
Coating	AR or BBAR		

Curves:

1. Transmission curve of the ZnSe windows with no coating
2. Transmission curve of ZnSe windows with BBAR/BBAR coating





Physical and Optical Properties:

Transmission Range	0.6 to 16μm	Refractive Index	2.4028 @ 10.6 μm
Reflection Loss	29.1% at 10.6 μm (2 surfaces)	Absorption Coefficient	0.0005 cm-1 at 10.6 μm
Reststrahlen Peak	45.7 μm	dn/dT	+61 x 10-6 /°C at 10.6 μm at 298K
dn/dμ = 0	5.5 μm	Density	5.27 g/cc
Melting Point	1525°C (see notes below)	Thermal Conductivity	18 W m-1 K-1 at 298K
Thermal Expansion	7.1 x 10-6 /°C at 273K	Hardness	Knoop 120 with 50g indenter
Specific Heat Capacity	339 J Kg-1 K-1	Dielectric Constant	n/a
Youngs Modulus (E)	67.2 GPa	Shear Modulus (G)	n/a
Bulk Modulus (K)	40 GPav	Elastic Coefficients	Not Available
Apparent Elastic Limit	55.1 MPa (8000 psi)	Poisson Ratio	0.28
Solubility	0.001g/100g water	Molecular Weight	144.33
Class/Structure	HIP polycrystalline cubic, ZnS, F43m		

Sapphire (Al2O3) Windows

- Exceptional mechanical strength and chemical resistance
- High thermal durabilities excellent for harsh environments
- Maximum diameter 300mm
- Various dimensions, shapes, orientations, and precision standards
- Broad wavelength range from 150-5500nm
- Blank substrates, AR-coated windows, and precision windows are available

Infrared Sapphire (Al2O3) Windows, featuring broad optical transmission from 150-5500nm spanning from UV to MWIR spectrum, and robust mechanical/thermal properties, high chemical resistance, are suitable for applications in harsh and variant environments or requiring a broad transparent wavelength range (e.g. infrared imaging, infrared spectroscopes, etc.).

Sapphire exhibits favorable transmission properties in the infrared region, in particular in the near-infrared (NIR) and mid-infrared (MWIR) wavelengths. Sapphire's most distinguishing attribute is its unequaled mechanical strength, which imparts excellent scratch resistance and durability to sapphire windows. Another remarkable virtue of sapphire windows is their chemical inertness which makes them resistant to corrosion. Sapphire windows can have a large length-to-thickness ratio without fracturing because of the tight internal covalent bonding of single-crystal sapphire while demonstrating good thermal stability due to its high thermal conduction.

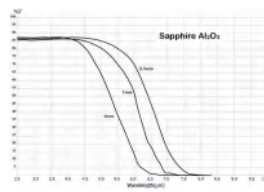
Shalom EO offers various forms of Infrared Optical Sapphire Windows including flat windows with parallel faces, circular/rectangular windows, wedge windows, and other custom specifications. Large aperture sapphire windows with diameters up to 300mm are available, and surface qualities of 60/40, 40/20, and 20/10 Scratch/Dig are optional according to the precision requirements of your interest. Our blank sapphire substrates feature high transmission in the wavelength range between 2.5-4.5μm with an average transmission rate above 85%. Single-layer MgF2 coatings and other AR coatings could be deposited to increase transmission. Precision sapphire windows competent for lasers are available.

Specifications:

Materials	Sapphire crystals	Diameter Range	Max. 300mm
Aperture	>90%	Dimension Tolerance	+0.0/-0.2mm
Thickness Tolerance	+/-0.1mm	Surface Quality	Optional: 60/40, 40/20 or 20/10 S/D
Parallelism	30 arc sec	Chamfer	0.3-0.5mmx45°
Coating	No coating, or single layer MgF2 and other custom coating options		

Curves:

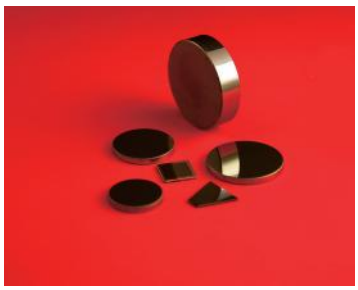
Transmission curve of the Sapphire windows (no coating)



Basic Properties:

Transmission Range	0.17 to 5.5 μm	Refractive Index	No 1.75449; Ne 1.74663 at 1.06 μm
Reflection Loss	14% at 1.06 μm	Absorption Coefficient	0.3 x 10-3 cm-1 at 2.4 μm
Reststrahlen Peak	13.5 μm	dn/dT	13.1 x 10-6 at 0.546 μm
dn/dμ = 0	1.5 μm	Density	3.97 g/cc
Melting Point	2040°C	Thermal Conductivity	27.21 W m-1 K-1 at 300K
Hardness	Knoop 2000 with 2000g indenter	Specific Heat Capacity	763 J Kg-1 K-1 at 293K (4)
Dielectric Constant	11.5 (para) 9.4 (perp)at 1MHz	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 (45,000 psi)
Poisson Ratio	0.25	Solubility	98 x 10-6 g/100g water
Molecular Weight	101.96	Class/Structure	Trigonal (hex), R3c

Silicon (Si) Windows



- Maximum diameter 300mm
- Window made of Czochralski or Float Zone Silicon
- Transmission range 1.2-15μm
- CZ silicon for MWIR (3-5μm) and FZ silicon for LWIR (8-12μm) applications
- Coating options: DLC coating, AR coating
- Low density for lightweight design, mechanical ruggedness, and Low cost

Hangzhou Shalom EO offers Silicon (Si) Windows made from optical grade silicon (Czochralski or Float Zone Silicon) for IR applications. Silicon windows exhibit good transmission properties in the IR spectrum, in particular in the MWIR and LWIR spectral regions. Due to their high thermal conductivity, Si windows perform great for lasers. In addition, with its low density (2.329 g/cm3, half that of Ge or ZnSe), silicon is conducive to realizing weight-sensitive designs. Silicon features chemical/abrasion resistance, making silicon windows durable and suitable for use in challenging environments (in fact, it is the hardest material that is transparent to 1000-1600nm light).

The silicon crystal grown using the Czochralski method is excellent for applications in the MWIR (3-5μm) spectrum. After depositing AR coating optimized for the wavelength range, the reflection of CZ silicon windows could be miniature. However, CZ silicon has a strong absorption band at 9μm. Whilst during the production process, Float Zone silicon is doped with Nitrogen and purified to reduce its carbon and oxygen composition, attenuating the absorption at 9μm, therefore FZ silicon windows could be used in the LWIR (8-12μm) range.

Shalom EO offers custom Silicon Windows. The Si windows are available in various custom dimensions, with a maximum diameter of 300mm. Coating options include DLC/AR coating and AR/AR coating.

Specifications:

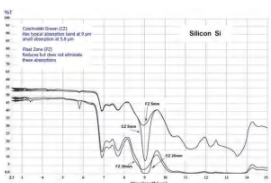
Materials	Silicon crystals	Diameter Range	~ 300mm
Aperture	>90%	Dimension Tolerance	+0.0/-0.2mm
Thickness Tolerance	+/-0.1mm	Surface Quality	60/40 S/D
Parallelism	1 arc minute	Chamfer	0.3-0.5mmx45degree
Coating	AR/AR or DLC/AR		

Material Properties:

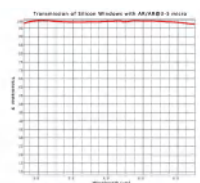
Transmission Range	1.2 to 15 μm	Refractive Index	3.4223 @ 5 μm (1) (2)
Reflection Loss	46.2% at 5 μm (2 surfaces)	Absorption Coefficient	0.01 cm-1 at 3 μm
Reststrahlen Peak	n/a	dn/dT	160 x 10-6 /°C (3)
dn/dμ = 0	10.4 μm	Density	2.33 g/cc
Melting Point	1420 °C	Thermal Conductivity	163.3 W m-1 K-1 at 273 K
Thermal Expansion	2.6 x 10-6 / 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	C11=167; C12=65; C44=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		

Curves:

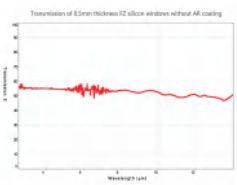
1. Transmission curve of the Silicon windows (no coating)



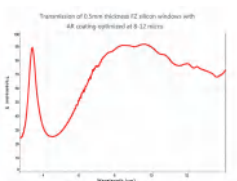
2. Transmission curve of the Silicon windows with AR/AR coating at 3-5 μm



3. Transmission of 0.5mm thickness FZ silicon windows without AR coating



4. Transmission of 0.5mm thickness FZ silicon windows with AR coating optimized at 8-12 micro



Calcium Fluoride (CaF2) Windows

- Maximum diameter 200mm
- Transmission range 0.18μm to 8.0μm, low absorption in the UV, VIS , and IR region
- High damage threshold and low chromatic dispersion
- Applications: Spectroscope, thermal imaging, fluorescence imaging, excimer laser, etc.

Calcium Fluoride (CaF2) Windows, featuring high average transmission spanning from deep UV to near IR spectra (180nm-8 μm), and low absorption coefficients, are excellent for applications in the UV, Visual, and IR regions, resulting in miniature signal loss and high optical efficiencies. CaF2 window has a low chromatic dispersion relative to other IR materials, meaning it spreads out or distorts light to a minimum extent as it passes through the window. Calcium Fluoride also has the advantages of high damage thresholds and chemical resistance. Its Group Velocity Dispersion (GVD) is the lowest among the IR transmitters, therefore CaF2 is also recommendable for Femtosecond IR lasers.

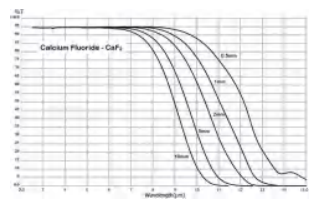
Hangzhou Shalom EO offers Calcium Fluoride Windows with protective coatings and assembled windows with metal holders. Our CaF2 windows serve as capable components for spectroscopes or fluorescence imaging/ thermal imaging, the uncoated window substrates are excellent for excimer laser.

Specifications:

Materials	IR Grade Calcium Fluoride Crystals	Aperture	>90%
Dimension Tolerance	+0.0/-0.2mm	Thickness Tolerance	+/-0.1mm
Surface Quality	60/40 S/D	Parallelism	1 arc minute
Chamfer	0.3-0.5mmx45degree	Coating	Optional protective coating

Curves:

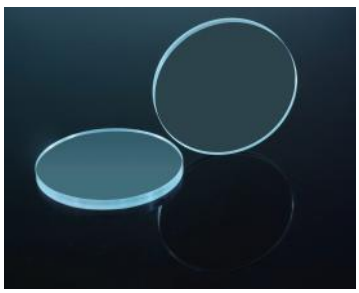
Transmission curve of the CaF2 windows of different thickenss



Physical and Optical Properties:

Transmission Range	0.13 to 10 μm	Refractive Index	1.39908 at 5 μm (1) (2)
Reflection Loss	5.4% at 5 μm	Absorption Coefficient	7.8 x 10-4 cm-1 @ 2.7 μm
Reststrahlen Peak	35 μm	dn/dT	-10.6 x 10-6 /°C (3)
dn/dμ = 0	1.7 μm	Density	3.18 g/cc
Melting Point	1360°C	Thermal Conductivity	9.71 W m-1 K-1 (4)
Thermal Expansion	18.85 x 10-6 /°C (5)(6)	Hardness	Knoop 158.3 (100) with 500g indenter
Specific Heat Capacity	854 J Kg-1 K-1	Dielectric Constant	6.76 at 1MHz (7)
Youngs Modulus (E)	75.8 GPa (7)	Shear Modulus (G)	33.77 GPa (7)
Bulk Modulus (K)	82.71 GPa (7)	Elastic Coefficients	C11 = 164 C12 = 53 C44 = 33.7 (7)
Apparent Elastic Limit	36.54 MPa	Poisson Ratio	0.26
Solubility	0.0017g/100g water at 20°C	Molecular Weight	78.08
Class/Structure	Cubic (111) cleavage		

Barium Fluoride (BaF2) Windows



- Maximum diameter 200mm
- Extensive transmission range 0.2-11.0μm, high transmission rate
- Excellent as viewport windows and for IR spectroscope
- Coating Options: Protective Coating

Barium Fluoride Windows, with their extensive transmission range from the deep UV to LWIR spectrum (0.2-11.0 μm), is prevalent for Infrared applications requiring additional transmission in the Ultraviolet region. Barium Fluoride windows are excellent when being used for IR spectroscopes and as viewport windows for thermal imaging inspection in electric power facilities and petroleum industries. A low refractive index of 1.48 implies that BaF2 windows have high transmission rates without anti-reflection coating.

BaF2 has similar properties to CaF2, the main difference is that barium fluoride is more resistant to high-energy radiation, and with an equivalent thickness, the transmission range of BaF2 stretches about 1 micron further into the LWIR spectrum. However, exposure to moisture will increase its sensitivity to temperature and reduce its transmission rate to UV lights. The transmission of BaF2 substrate begins to drop at 500 °C under the attacks of water, but when kept dry, it endures temperatures up to 800 °C.

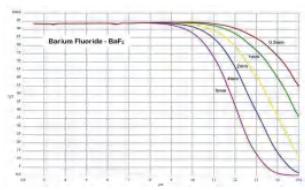
Hangzhou Shalom EO offers BaF2 Windows with protective coatings and assembled windows with metal holders. It is worth noting that BaF2 is a toxic material, so please wear gloves during the handling process. You might also contact us to obtain detailed instructions.

Specifications:

Materials	IR Grade Barium fluoride Crystals	Diameter Range	~ 200mm
Aperture	>90%	Dimension Tolerance	+0.0/-0.1mm
Thickness Tolerance	+/-0.2mm	Surface Quality	60/40 S/D
Parallelism	1 arc minute	Chamfer	0.3-0.5mmx45degree
Coating	Optional protective coating		

Curves:

Transmission curve of the BaF2 windows of different thickness



Physical and Optical Properties:

Transmission Range	0.15 to 12 μm	Refractive Index	1.45 at 5 μm (1)
Reflection Loss	6.5% at 5 μm (2 surfaces)	Absorption Coefficient	3.2 x 10-4cm-1 @ 6 μm
Reststrahlen Peak	47 μm	dn/dT	-15.2 x 10-6 °C (2)
dn/dμ = 0	1.95 μm	Density	4.89 g/cc
Melting Point	1386°C	Thermal Conductivity	11.72 W m-1 K-1 @ 286 K
Thermal Expansion	18.1 x 10-6 /°C @ 273 K	Hardness	Knoop 82 with 500g indenter (4)
Specific Heat Capacity	410 J Kg-1 K-1 (3)	Dielectric Constant	7.33 at 1 MHz
Youngs Modulus (E)	53.07 GPa (3)	Shear Modulus (G)	25.4 GPa (3)
Bulk Modulus (K)	56.4 GPa	Elastic Coefficients	C11 = 89.2 C12 = 40.0 C44 = 25.4 (2)
Apparent Elastic Limit	26.9 MPa (300psi) (4)	Poisson Ratio	0.343
Solubility	0.17g/100g water at 23°C	Molecular Weight	175.36
Class/Structure	Cubic CaF2, Fm3m, (111) , cleavage		

Zinc Sulfide (ZnS) Windows

- Maximum diameter 250mm
- CVD Grown Zinc Sulfide (transmission 8-12μm) and Multispectral Zinc Sulfide (Cleartran) (transmission 0.4-14.0μm)
- Excellent mechanical strength and chemical inertness for harsh environments (harder than ZnSe Windows)
- Coating Options: AR/AR coating

Zinc Sulfide (ZnS) Crystal can be divided into two categories: CVD ZnS grown using chemical vapor deposition, which is a polycrystalline material often used in the LWIR (7 to 14 micro) region of thermal imaging, renowned for their resistance to fracture, superior hardness, chemical resistance, and low cost. There is also Multispectral ZnS (or Cleartran, water-clear ZnS), which goes under a further post-deposition hot isostatic press process after the CVD fabrication, which eliminates the microscopic voids or defects of ZnS, expanding the transmission range from Visible to IR spectra (0.4-14.0μm).

Hangzhou Shalom EO offers Windows made of CVD ZnS and Multispectral Zinc Sulfide (Cleartran). The windows are excellent for FLIR (Forward Looking Infrared). Various custom shapes and anti-flection coatings on two surfaces are available. In comparison, CVD ZnS is harder, although both CVD and Multispectral (Cleartran) Zinc Sulfide much higher fracture strength than ZnSe and could adapt to applications under extreme conditions (e.g. exterior IR windows on aircraft frames). The multispectral ZnS windows are exceptional for applications throughout VIS and IR regions (e.g., visible cameras, mid and long-wave detectors, and laser rangefinders).

Specifications:

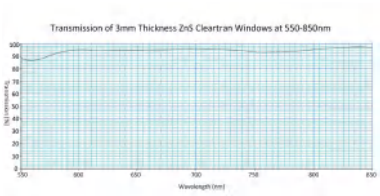
Materials	CVD ZnS or Multispectral ZnS (Cleartran)	Diameter Range	~ 250mm
Aperture	>90%	Dimension Tolerance	+0.0/-0.2mm
Thickness Tolerance	+/-0.1mm	Surface Quality	60/40 S/D
Parallelism	1 arc minute	Chamfer	0.3-0.5mmx45degree
Coating	AR/AR coating@7-14μm		

Physical and Optical Properties:

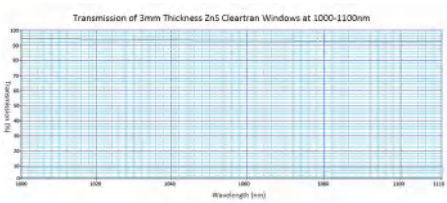
Transmission Range	0.37 to 13.5 μm	Refractive Index	2.20084 at 10 μm
Reflection Loss	24.7% at 10 μm (2 surfaces)	Absorption Coefficient	0.0006 cm-1 at 3.8 μm
Reststrahlen Peak	30.5 μm	dn/dT	+38.7 x 10-6 /°C at 3.39 μm
dn/dμ = 0	n/a	Density	4.09 g/cc
Melting Point	1827°C (See notes below)	Thermal Conductivity	27.2 W m-1 K-1 at 298K
Thermal Expansion	6.5 x 10-6 /°C at 273K	Hardness	Knoop 160 with 50g indenter
Specific Heat Capacity	515 J Kg-1 K-1	Dielectric Constant	88
Youngs Modulus (E)	74.5 GPa	Shear Modulus (G)	n/a
Bulk Modulus (K)	n/a	Elastic Coefficients	Not Avalailable
Apparent Elastic Limit	68.9 MPa (10,000 psi)	Poisson Ratio	0.28
Solubility	65 x 10-6 g/100g water	Molecular Weight	97.43
Class/Structure	HIP poly-crystalline cubic, ZnS, F42m		

Curves:

1. Transmission of 3mm Thickness ZnS Cleartran Windows at 550-850nm



2. Transmission of 3mm Thickness ZnS Cleartran Windows at 1000-1100nm



3. Transmission of 3mm Thickness ZnS Windows at 8-12 micro

Packaging Windows for FPA Windows

- Germanium and Silicon substrates
- High precision surface polishing
- High quality metallic coating on edges
- Coating options: BBAR, Longpass/bandpass filtering coating

Packaging windows are critical components for the FPA detectors in thermal imaging cameras, the central apertures of these packaging windows serve as infrared filters and transmit the IR radiation in selection. The metallic coatings around the edges of windows allow welding and packaging, Germanium (Ge) and Silicon (Si) are often used as the substrate materials. High-quality metallic coatings are wrapped on the edge of the windows, and several kinds of filtering coatings are available: broadband AR coating, longpass filtering coating, and bandpass filtering. Custom windows are available upon your request.

Specifications:

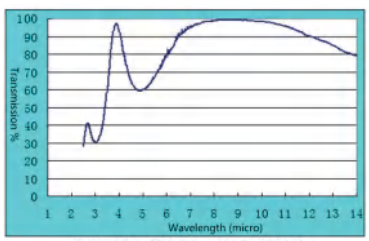
Substrate Materials	Germanium, Silicon	Dimensions	Customized
Thickness/Diameter Tolerance	+/-0.05mm	Surface Quality	80/50 S/D
Parallelism	< 1 arc minute	Clear Aperture	>90%
Chamfer	<0.2x45degree	Coating	custom IR coating
Metallization Materials	Au, Ag or Cu (upon customer's request)		

Hangzhou Shalom EO provide following types of the packaging windows:

Filtering Specifications of Packaging Windows	
AR coating on Ge substrate	T>94%@7-12μm
AR coating on Si substrate	T>88%@8-12μm
Long pass filtering coating on Ge substrate	T<1%@<7μm, Tavg>92%@8-12.5μm
Bandpass filtering coating on Ge substrate	T<1%@<7.5μm, Tavg >90%@8-12μm T<1%@12.5μm
Broadband AR coating on Ge substrate	Tavg>92%@2-14μm

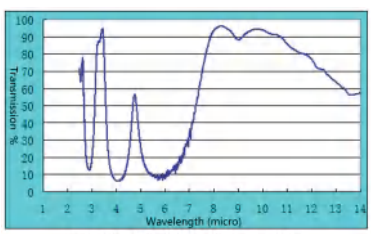
Curves:

1. Transmission of Ge Windows with AR@7-14 Micro



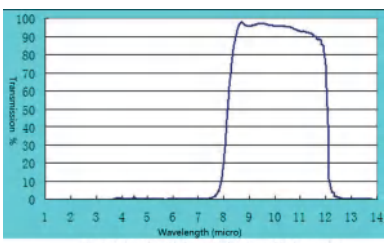
Transmission of Ge windows with AR@7-14 micro

2. Transmission of Si Windows with AR@8-12 Micro



Transmission of Si windows with AR@8-12 micro

3.Transmission of Ge Windows with Band-pass Filtering Coating



Transmission of Ge windows with band-pass filtering coating

Infrared Window Assemblies for Thermal Imaging Camera

- Anodized Aluminium holder
- Dust-tight design, IP67 waterproof
- Window materials: Germanium, CaF2 and BaF2
- Easy installation, no screw needed

Thermal imaging is one of the most effective measures for high-power and high-voltage electric installations to avoid possible accidents. Infrared window assemblies are needed to be installed on the housing of the electric and industrial equipment as the viewport windows for the thermal image camera which gives the cameras a direct line of sight into energized electrical equipment without having to open cabinet doors or panels, protecting users from arc flash incidents, and reducing inspection time. IR window assemblies cater to versatile applications, such as high-voltage switchgear viewing panes, and windows for thermal cameras oriented for monitoring high-temperature metallurgic ovens.

Hangzhou Shalom EO offers standard and custom infrared inspection window assemblies with a dust-tight, IP67-rated waterproof design, made of CaF2, BaF2, and Germanium with broad transmission in the NIR, SWIR, MWIR, and LWIR region, allowing effective utilization of the IR radiations for thermal imaging camera inspection. Anodized aluminum metal housings are incorporated. The window assemblies are easy to install, no screw is needed.

Specifications (Materials Used):

Flange	Metal	Housing or Cover	Metal Materials
Optics	CaF2, BaF2, Germanium	Cover Fixing	Fixed by Magnet nub
Water and Dust Ingress	IP67 of NF EN60529		

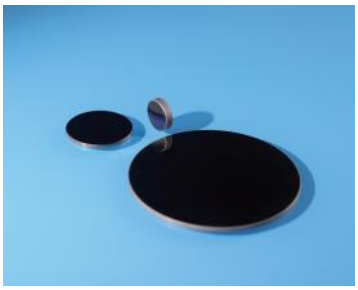
Typical Dimensions:

Models	Body Diameter	Crystals Diameter	Viewing Diameter	Assembly Thickness
SHIRW-60	84 mm	60mm	55mm	22mm
SHIRW-75	99 mm	75mm	70mm	22mm
SHIRW-100	124 mm	100mm	95mm	22mm

Specifications of Common Materials used in the Infrared Optics:

Material	Chemical Symbol	Transmission Wavelength (μm)	Reflection (Two Surfaces)	Knoop Hardness
Calcium Fluoride	CaF2	0.13-10	5%	158
Barium Fluoride	BaF2	0.15-12.5	7%	82
Germanium	Ge	1.8-23	53%	780
Zinc Selenide	ZnSe	0.5-22	29%	120
Sapphire	Al2O3	0.15-5.5	14%	2000
Silicon	Si	0.14-6	29%	850
IR Polymer	N/A	0.15-22	21%	N/A

Infrared Neutral Density Filters



- Reflection type IR ND filters
- Germanium (Ge) substrates and metal alloy coating
- Wide operation wavelength range: optimized at 2.2μm, maximum 15μm
- Custom Optical Density (OD)
- Custom Diameters available

An Infrared Neutral Density Filter is a neutral density filter with even attenuation to the IR spectrum, consisting of a metal alloy coating deposited on a substrate chosen according to the wavelength region of interest. Unlike a complete dielectric or absorption filter, the metallic ND filter utilizes a combination of absorption and reflection to reduce the intensities of light, and the optical densities of the metallic-coated neutral density infrared filters are determined by metal alloy coatings.

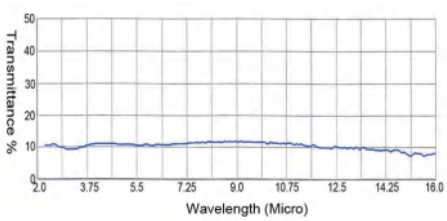
Shalom EO offers Custom Infrared Neutral Density Filters comprising metallic coatings deposited upon germanium substrates designed to attenuate radiation over a stunningly wide range in the IR region, the ND coatings are optimized at 2.2 microns and are capable of covering extensive wavelengths up to15 microns.

Specifications:

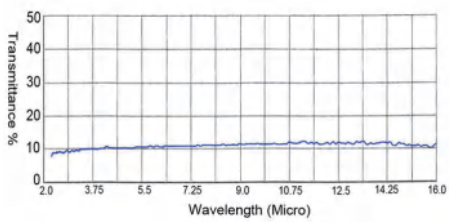
Substrates	Germanium	Diameter Range	Custom
Transmission	10%, 20% or custom	Aperture BBAR Coating on back surface S2	Optional
Dimension Tolerance	±0.2mm	Clear Aperture	+/-0.2mm, 90% of the outside dimension
Surface Quality	80/50 S/D	Flatness	2-4 waves per 25mm
Parallelism	3-5 arc minutes	Mechanical	Unmounted

Curves:

1. Transmission of IR ND filters (Germanium, T=10%, BBAR coating on back surface S2)



2. Transmission of IR ND filters (Germanium, T=10%, No BBAR coating on back surface S2)



IR LENS COMPONENTS

An IR Lens is a lens component optimized to focus, collimate, or manipulate infrared radiation within the infrared spectrum (that is, the spectral portion between the wavelength range of 700nm and 1000μm), including Near-Infrared (NIR), Shortwave Infrared (SWIR), Midwave Infrared(MWIR), and Longwave Infrared (LWIR).

Hangzhou Shalom is an adept global supplier of IR Lens Components, our broad infrared lens production portfolios include Plano-convex IR Lenses, Plano-concave IR Lenses, Meniscus IR Lenses, Aspheric IR Lenses, Ball/Half-Ball Lens, etc. to achieve diversified functions as to focus, collimate, collect, and diverge lights. Besides the lenses, aluminum reflective mirrors designed for LWIR and MWIR long-focal-length thermal cameras are also accessible. We offer IR lens components made of various substrate materials , including Germanium (Ge), Silicon (Si), Zinc Selenide (ZnSe), Chalcogenide Glass, Sapphire, Calcium Fluoride (CaF2), Barium Fluoride (BaF2), Zinc Sulfide(ZnS), with their working wavelength range encompassing multiple Infrared wavebands. Coating options include broadband anti-reflection (BBAR) coating, long-pass anti-reflection coating, DLC coating, etc. Cutting-edge technologies like CNC and Single Point Diamond Turning (SPDT) techniques are utilized to enhance effectiveness and high precision. Before dispatch, strict QC inspections are carried out to secure the performance and durability of lenses. Exploiting the meticulous engineering of a complex of lens forms, material properties, and coatings, Shalom EO's IR lens components cater to versatile applications including thermal imaging cameras for surveillance, security, industrial inspection, and medical diagnostics; infrared spectroscopes; lasers like CO2 lasers, fiber lasers, and semiconductor lasers; remote sensing and various other applications where infrared light needs to be controlled or directed.

For material comparison, Germanium Lens features a broad transmission range from 3-14 micro and a large refractive index, hence is prevalent for MWIR and LWIR thermal camera lens assemblies. ZnSe lens exhibits a low absorption in the mid-IR region and is excellent for CO2 laser output and MWIR pulsed lasers. Chalcogenide glass lens has eminent thermal properties and is ideal for designing cost-effective athermalized lens modules. Sapphire lens features unrivaled hardness, and scratch/chemical resistance. CaF2 Lens demonstrates extensive transmission bands from UV to IR. BaF2 has similar properties to CaF2, the main difference is that barium fluoride is more resistant to high-energy radiation and sensitive to thermal shock/moisture. Silicon offers good transmission in the MWIR (CZ silicon) and LWIR (FZ silicon) with the additional advantages of ruggedness and lightweight.

Germanium (Ge) Lenses

- Maximum diameter 300mm
- Broad working wavelength range 3μm to 14μm
- Various Custom Lens Shapes: Plano-concave, Plano-convex, Double-convex, Double-concave, Meniscus, and Aspheric Lenses
- Aspheric lenses manufactured using SPDT technique
- Coating options: DLC coating, AR@3-5μm, AR@8-12μm, BBAR@3-12μm and custom
- Ideal for Thermal Imaging, FLIR, FTIR applications, etc.

Germanium lenses (Ge lenses) are often incorporated into IR imaging systems operating from 2μm to 16 μm, covering the LWIR (8-12μm) and MWIR (3-5μm) spectral range with their broad transmission to the IR radiations and opacity to the UV and VIS wavelengths. Ge lens has the highest refractive index of common IR transmitters, which implies great light collection and bending strength. Ge lens exhibits slight chromatic aberration due to low optical dispersion, meaning minimal distortion and spreading of light, ensuring authentic transmission of the optical signals. Germanium has a Knoop Hardness of 780, this trait contributes to the rugged nature of Germanium Lenses. Germanium can be Diamond or DLC coated to be utilized as the front optics in the lens group with surpassing toughness to withstand demanding environments. Caution should be taken for high-temperature conditions where the Ge will become opaque to IR wavelengths as the temperature rises. In addition, its relatively high density should be considered where weight is an issue.

The optical transmission rate of Germanium is over 45% between 2-14μm at temperatures up to 45^{0}C, with optimal transmission spectrum residing between 2-12 μm, and after the anti-reflection coating process, average transmission could be leveraged to above 95%. However, the transmission of Ge lenses starts to degrade at 100^{0}C, then plummets above 200^{0}C. Exposure to higher temperatures can lead to catastrophic failure in the material so Germanium is unsuitable for use in high-temperature conditions.

Hangzhou Shalom EO suppliers a series of custom Germanium Lenses including plano-convex, Plano-concave, double convex, double concave, and meniscus Ge lenses, with spherical and aspherical lens surfaces. Due to the large refractive index of Ge, AR coatings are needed to enhance its transmission. Coating Options encompass Anti-reflection (AR), Broad Band AR (BBAR), and Diamond (DLC) coatings. The shapes, dimensions (diameters, up to 300mm), and coatings could all be tailored upon request. Besides the conventional spherical surface lenses, Hangzhou Shalom EO also provides aspherical surface lenses made by the SPDT (Single Point Diamond Turning) technique.

Specifications:

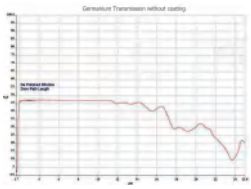
Materials	Optical grade germanium single crystals	Diameter Range	~300mm
Diameter Tolerance	-0.01/-0.03mm	Thickness Tolerance	+/-0.03mm
Surface Quality	60/40 S/D	Fringes (N)	3
Irregularity (delta N)	1	Centration	3'
Chamfer	0.1-0.3mmx45 degree	Coatings	AR/AR@7-14micro DLC/AR@7-14micro BBAR/ BBAR@3-12 micro See coating curves below

Physical and Optical Properties:

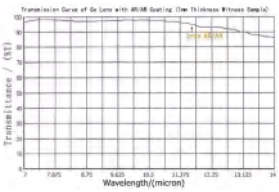
Transmission Range	1.8 to 23 μm	Refractive Index	4.0026 at 11 μm (1)(2)
Reflection Loss	53% at 11 μm (2 surfaces)	Absorption Coefficient	<0.027 cm-1@ 10.6 μm
Reststrahlen Peak	n/a	dn/dT	396 x 10-6 /°C (2)(6)
dn/dμ = 0	Almost constant	Density	5.33 g/cc
Melting Point	936 °C (3)	Thermal Conductivity	58.61 W m-1 K-1 at 293K (6)
Thermal Expansion	6.1 x 10-6/°C at 298K (3)(4)(6)	Hardness	Knoop 780
Specific Heat Capacity	310 J Kg-1 K-1 (3)	Dielectric Constant	16.6 at 9.37 GHz at 300K
Youngs Modulus (E)	102.7 GPa (4) (5)	Shear Modulus (G)	67 GPa (4) (5)
Bulk Modulus (K)	77.2 GPa (4)	Elastic Coefficients	C11=129; C12=48.3; C44=67.1 (5)
Apparent Elastic Limit	89.6 MPa (13000 psi)	Poisson Ratio	0.28 (4) (5)
Solubility	Insoluble in water	Molecular Weight	72.59
Class/Structure	Cubic Diamond, Fd3m		

Curves:

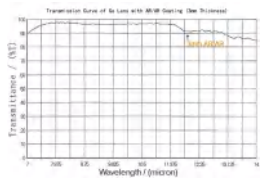
1. Transmission curve of Ge windows with no coating



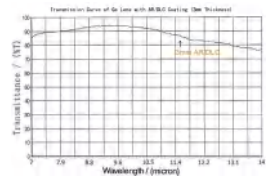
2. Transmission Curve of Ge Lens with AR/AR Coating (1mm Thickness Witness Sample)



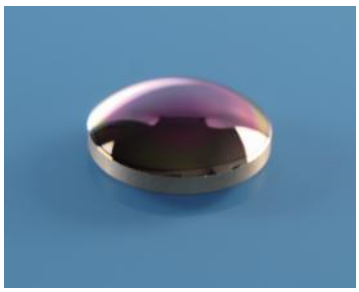
3. Transmission Curve of Ge Lens with AR/AR Coating (3mm Thickness)



4. Transmission Curve of Ge Lens with AR/DLC Coating (3mm Thickness)



Chalcogenide Glass Lenses and Balls



- Low cost
- Small temperature coefficients of refractive index, excellent for producing athermalized lens assemblies
- Wide wavelength range covering MWIR (3-5μm) and LWIR (8-12μm)
- Various lens forms (spherical or aspheric) customizable
- 7 kinds of Chalcogenide glass codes from China

Chalcogenide glass lenses are lenses made of chalcogenide glass, which are glass materials composed of chalcogen elements (S, Se, Te) combined with other elements such as As, Sb, or Ge. Chalcogenide glass features a broad IR transmission wavelength range in the MWIR/LWIR region (3-5 micro,8-12 micro) with a superior transmission rate within the range. The thermal properties of Chalcogenide glass lenses are also remarkable, with low temperature coefficients of refractive index, Chalcogenide glass lenses are attractive candidates for producing passive optical athermalized IR lens assemblies of compact and lightweight design. Furthermore, Chalcogenide glass has a lower softening point and mechanical hardness than common crystal materials, therefore could be processed into various optical components with higher efficiencies. The production cost of chalcogenide glass is lower than most IR crystal materials (1/4 of that of Germanium). It is also feasible, using high precision molding, to realize bulk production of aspheric Chalcogenide glass lenses. With China's export controls on Ge, Chalcogenide glass lens has emerged as a potential alternative to Ge lens.

Hangzhou Shalom EO offers Custom Chalcogenide Glass Lenses and Chalcogenide Glass Ball Lens with a maximum diameter of 100mm and anti-reflection coatings at LWIR and MWIR regions. The lens forms (ball lens, aspheric lens, convex lens, concave lens, etc.), dimensions, and other parameters could all be tailored for you. Various Chalcogenide Glass Materials could be selected upon your request, the majority being the Chinese IRG series from NHG, the glass codes including IRG201, IRG202, IRG203, IRG204, IRG205, IRG206, and IRG207, while other similar glass codes from other companies could also be procured.

Specifications:

Materials	Chalcogenide glass	Diameter Range	~100mm
Diameter Tolerance	+0.0/-0.2mm	Thickness Tolerance	+/-0.05mm
Surface Quality	60/40 S/D	Fringes (N)	3
Irregularity (delta N)	1	Centration	3'
Chamfer	0.1-0.3mmx45 degree	Coatings	AR/AR@3-5μmAR/AR@8-12μm

Glass Codes:

Listed below is a Glass Code Reference Chart of Chalcogenide Glass from the elite manufacturers, identical glass codes are written in the same row. Shalom EO in general would use the IRG20X series chalcogenide materials from Chinese supplier NHG （New Huaguang).

NHG	VITRON	PIKE	UMICORE	SCHOTT
IRG201	IG2	AMTIR-1		IRG22
IRG202			GASIR-1	
IRG203			GASIR-2	
IRG204	IG2	AMTIR-1		IRG22
IRG205	IG5	AMTIR-3		IRG25
IRG206	IG6	AMTIR-2	GASIR-5	IRG26
IRG207	IG4			IRG24

Zinc Selenide (ZnSe) Lenses

- Low dispersion and low absorption coefficient
- Maximum diameter 200mm
- Superior thermal properties, broad transmission wavelength range 0.6μm to 16μm
- Coating options: AR@3-5μm, AR@8-12μm, BBAR@3-12μm or custom
- ZnSe Lenses for CO2 Laser also available

Zinc Selenide (ZnSe) Lenses, with their broad transmission wavelength range (0.6 μm to 16 μm), are often oriented for manipulating and focusing light in MWIR and LWIR spectra. The low absorption, miniature chromatic dispersion, and high thermal shock resistance made ZnSe lenses prevalent for various infrared applications requiring high thermal robustness and minimal signal transmission loss/distortion like CO2 high-power lasers, thermal imaging, military, and medical equipment, etc. Zinc selenide (ZnSe) has a large refractive index, contributing to the capable focusing of IR radiation. Zinc selenide is soft with a low scratch resistance and is chemically sensitive thus extra caution is required during cleaning, handling, and mounting.

Shalom EO provides custom zinc selenide lenses made of CVD (Chemical Vapor Deposition) ZnSe grown in the USA with high purity. Tailored to meet specific needs, Shalom EO lenses offer diverse coating options, including AR coatings at 3-5μm and 8-12μm, BBAR coating across 3-12μm, or customizable coatings to suit individual requirements.

Specifications:

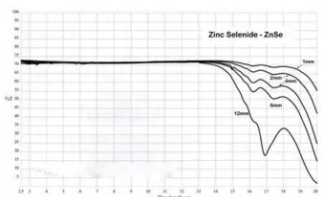
Materials	CVD ZnSe crystals	Diameter Range	~200mm
Diameter Tolerance	+0.0/-0.2mm	Thickness Tolerance	+/-0.2mm
Surface Quality	60/40 S/D	Fringes (N)	3
Irregularity (delta N)	1	Centration	3'
Chamfer	0.1-0.3mmx45 degree	Coatings	AR/AR@7-14micro BBAR/BBAR@3-12 micro

Physical and Optical Properties:

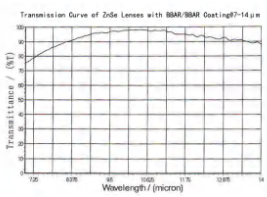
Transmission Range	0.6 to 21.0μm	Refractive Index	2.4028 at 10.6μm
Reflection Loss	29.1% at 10.6μm (2 surfaces)	Absorption Coefficient	0.0005 cm-1 at 10.6μm
Reststrahlen Peak	45.7μm	dn/dT	+61 x 10-6 /°C at 10.6μm at 298K
dn/dμ = 0	5.5μm	Density	5.27 g/cc
Melting Point	1525°C (see notes below)	Thermal Conductivity	18 W m-1 K-1 at 98K
Thermal Expansion	7.1 x 10-6 /°C at 273K	Hardness	Knoop 120 with 50g indenter
Specific Heat Capacity	339 J Kg-1 K-1	Dielectric Constant	n/a
Youngs Modulus (E)	67.2 GPa	Shear Modulus (G)	n/a
Bulk Modulus (K)	40 GPa	Elastic Coefficients	Not Available
Apparent Elastic Limit	55.1 MPa (8000 psi)	Poisson Ratio	0.28
Solubility	0.001g/100g water	Molecular Weight	144.33
Class/Structure	HIP polycrystalline cubic,ZnS, F43m		

Curves:

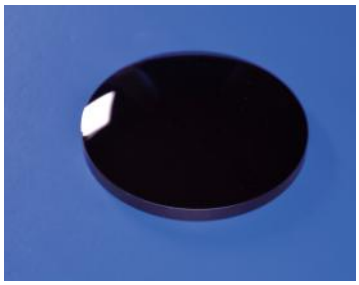
Transmission Curve of ZnSe with No Coating



2. Transmission Curve of ZnSe Lenses with BBAR/BBAR Coating@7-14μm



Silicon (Si) Lenses



- Low density and lightweight
- Maximum diameter 300mm
- Czochralski Si for MWIR, Float Zone Si for LWIR
- Coating options: DLC coating, AR coating
- Low cost, mechanical ruggedness, chemical resistance

Silicon (Si) lenses manufactured using optical grade silicon are competent for light collimation, direction, and manipulation in the IR spectrum. There are two kinds of silicon, Czochralski Si, used for the 3-5μm MWIR range, and Float Zone Si, used for the 8-12μm LWIR range. It has a low density of half the magnitude of Ge or ZnSe, thus Si lens is ideal for weight-sensitive applications. Silicon is also harder and less brittle than germanium, with the additional virtue of chemical resistance and low cost.

Specifications:

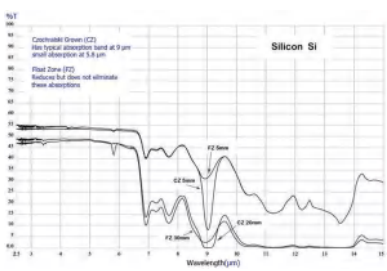
Materials	Silicon crystals	Diameter Range	~300mm
Diameter Tolerance	-0.01/-0.03mm	Thickness Tolerance	+/-0.03mm
Surface Quality	60/40 S/D	Fringes (N)	3
Irregularity (delta N)	1	Centration	3'
Chamfer	0.1-0.3mmx45 degree	Coatings	AR/AR@3-5micro DLC/AR@3-5micro

Physical and Optical Properties:

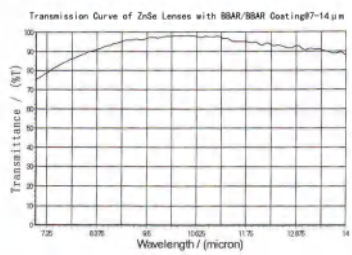
Transmission Range	0.12μm to 15 μm and and 30μm to >100 μm (1)	Refractive Index	3.4223 @ 5 μm (1) (2)
Reflection Loss	46.2% at 5 μm (2 surfaces)	Absorption Coefficient	0.01 cm-1 at 3 μm
Reststrahlen Peak	n/a	dn/dT	160 x 10-6 /°C (3)
dn/dμ = 0	10.4 μm	Density	2.33 g/cc
Melting Point	1420 °C	Thermal Conductivity	163.3 W m-1 K-1 at 273 K
Thermal Expansion	2.6 x 10-6 / 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	C11=167; C12=65; C44=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		

Curves:

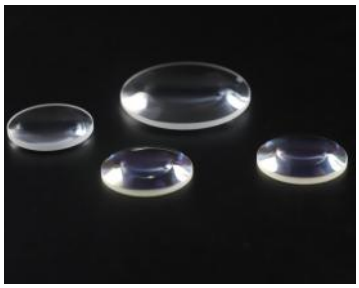
Transmission Curve of Silicon with No Coating



2.Transmission Curve of Silicon Lens with AR/AR Coating at 3-5μm



Calcium Fluoride (CaF2) Lenses



- Maximum diameter 200mm
- High average transmission and damage threshold
- Fit for MWIR (3-5μm) thermal image applications, excimer lasers
- Chemical inertness and low dispersion

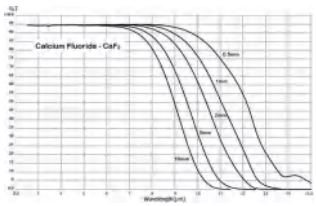
Due to its high average transmission between 0.25μm and 7μm and low chromatic dispersion relative to other IR materials, calcium fluoride (or CaF2) is an excellent choice for windows and lenses for spectroscope in the deep UV to mid IR wavelength range. For its good transmission properties at the MWIR range, CaF2 lenses are often selected as the lens for MWIR (3-5 micro) thermal imaging applications. Its Group Velocity Dispersion (GVD) is the lowest among the IR transmitters, therefore CaF2 is also recommendable for Femtosecond IR lasers. Other attributes of CaF2 lenses include high damage thresholds and low absorption, which make them popular for excimer lasers. In addition, CaF2 lenses also boast chemical inertness and excellent mechanical strength.

Specifications:

Materials	CaF2 crystals	Diameter Range	~200mm
Diameter Tolerance	+0.0/-0.2mm	Thickness Tolerance	+/-0.1mm
Surface Quality	60/40 S/D	Fringes (N)	3
Irregularity (delta N)	1	Centration	3'
Chamfer	0.1-0.3mmx45 degree	Coatings	AR/AR@3-5micro

Curves:

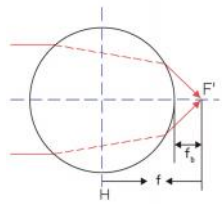
Transmission curves of CaF2 substrates of different thicknesses

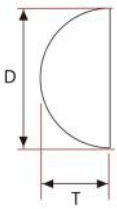


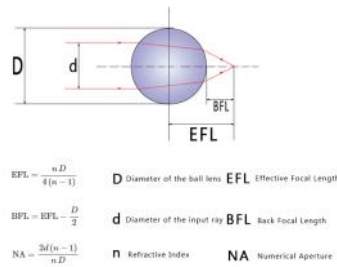
Physical and Optical Properties:

Transmission Range	0.13 to 10 μm	Refractive Index	1.39908 at 5 μm (1) (2)
Reflection Loss	5.4% at 5 μm	Absorption Coefficient	7.8 x 10-4 cm-1 @ 2.7 μm
Reststrahlen Peak	35 μm	dn/dT	-10.6 x 10-6/°C (3)
dn/dμ = 0	1.7 μm	Density	3.18 g/cc
Melting Point	1360°C	Thermal Conductivity	18.85 x 10-6/°C (5)(6)
Hardness	Knoop 158.3 (100) with 500g indenter	Specific Heat Capacity	854 J Kg-1 K-1
Dielectric Constant	6.76 at 1MHz (7)	Youngs Modulus (E)	75.8 GPa (7)
Shear Modulus (G)	33.77 GPa (7)	Bulk Modulus (K)	82.71 GPa (7)
Elastic Coefficients	C11 = 164 C12 = 53 C44 = 33.7 (7)	Apparent Elastic Limit	36.54 MPa
Poisson Ratio	0.26	Solubility	0.0017g/100g water at 20°C
Molecular Weight	78.08	Class/Structure	Cubic (111) cleavage

Sapphire Ball Lenses and Half-ball Lenses







- Unrivaled mechanical strength, extreme surface hardness and chemical resistance
- Transmission Range: 0.15 to 5.5μm
- Suitable for application from UV to MWIR
- AR coating available
- Both Stocked and Custom Sapphire Ball lenses and Half-Ball lenses Available

Ball lenses belong to a special form of biconvex lenses which have the geometry of a ball (sphere). Ball lenses are manufactured from a single optical material with good transmittance in the wavelength region of interest. The conventional applications of ball lenses include focusing light in the field of fibers (e.g. laser to fiber coupling, fiber to fiber coupling), emitters, and detectors, in major to collimate light depending on the geometries of the input light source. Also, ball lenses could be ball pre-forms of aspheric lenses where ball lenses are deformed on purpose to prevent spherical aberrations.

Half-Ball lenses are variants of ball lenses, obtained through cutting the ball lenses in half. Due to the ease of mounting derived from the one flat surface, half-ball lenses are more convenient for applications where space limitations exist and more compact designs are required, such as fiber communication, endoscopes, microscopes, optical pick-up devices, and laser measurement facilities.

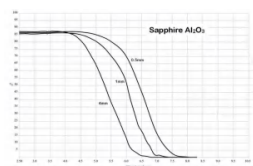
Sapphire Ball lenses and Half Ball lenses are ideal for demanding applications in the IR spectrum because of wide transmission range of 0.15-5.5μm, superior surface hardness (9 on the Mohs scale, the third hardest mineral, after diamond at 10 and moissanite at 9.5, which means high resistance to scratch and abrasion), high thermal conductivities, outstanding dielectric properties and resistance to common chemical acids and alkalis. In addition, sapphire features a high refractive index, which is advantageous for light collection. Shalom EO offers off-the-shelf and custom Sapphire Ball Lenses and Half Ball Lenses with a maximum diameter of 300mm, AR coatings are available.

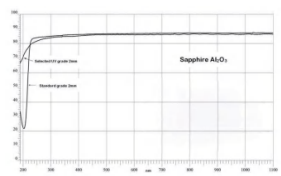
Specifications:

Materials	Optical grade sapphire crystals	Diameter Range	~300mm
Diameter Tolerance	+0.0/-0.2mm	Thickness Tolerance	+/-0.2mm
Surface Quality	60/40 S/D	Fringes (N)	3
Irregularity (delta N)	1	Centration	3'
Chamfer	0.1-0.3mmx45 degree		

Curves:

1. Transmission of Sapphire at Infrared wavelength range (no coating)
2. Transmission of Sapphire at UV wavelength range (no coating)





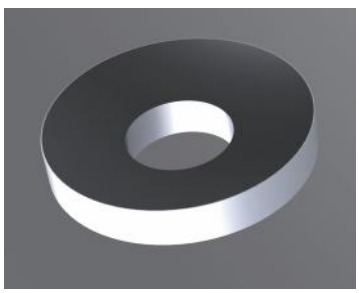
Physical and Optical Properties:

Transmission Range	0.17 to 5.5 µm	Refractive Index	No 1.75449; Ne 1.74663 at 1.06 µm (1)
Reflection Loss	14% at 1.06 µm	Absorption Coefficient	0.3 x 10-3 cm-1 at 2.4 µm(2)
Reststrahlen Peak	13.5 µm	dn/dT	13.1 x 10-6 at 0.546 µm(3)
dn/dµ = 0	1.5 µm	Density	3.97 g/cc
Melting Point	2040°C	Thermal Conductivity	27.21 W m-1 K-1 at 300K
Thermal Expansion	5.6 (para) & 5.0 (perp)x 10-6/K*	Hardness	Knoop 2000 with 2000gindenter
Specific Heat Capacity	763 J Kg-1 K-1 at 293K(4)	Dielectric Constant	11.5 (para) 9.4 (perp) ☒at 1MHz
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 (45,000 psi)	Poisson Ratio	0.25
Solubility	98 x 10-6 g/100g water	Molecular Weight	101.96
Class/Structure	Trigonal (hex), R3c		

Product List of Sapphire Ball Lenses and Half-ball Lenses

Code	Types	Material	Diameter	EFL	Coating	Unit Price
1105-003	Ball	Sapphire	1.0mm	0.57mm	None	$10.0
1106-003	Half-Ball	Sapphire	1.0mm	-	None	Inquiry
1105-006	Ball	Sapphire	2.0mm	1.15mm	None	$10.0
1106-006	Half-Ball	Sapphire	2.0mm	-	None	$10.0
1105-009	Ball	Sapphire	3.0mm	1.72mm	None	$10.0
1106-009	Half-Ball	Sapphire	3.0mm	-	None	Inquiry
1105-012	Ball	Sapphire	4.0mm	2.30mm	None	$12.0
1106-012	Half-Ball	Sapphire	4.0mm	-	None	$12.0
1105-015	Ball	Sapphire	5.0mm	2.87mm	None	$12.0
1106-015	Half-Ball	Sapphire	5.0mm	-	None	$12.0
1105-018	Ball	Sapphire	6.0mm	3.45mm	None	$15.0
1106-018	Half-Ball	Sapphire	6.0mm	-	None	Inquiry
1105-021	Ball	Sapphire	7.0mm	4.02mm	None	Inquiry
1106-021	Half-Ball	Sapphire	7.0mm	-	None	Inquiry
1105-024	Ball	Sapphire	8.0mm	4.60mm	None	$18.5
1106-024	Half-Ball	Sapphire	8.0mm	-	None	Inquiry
1105-027	Ball	Sapphire	9.0mm	5.17mm	None	$20.0
1106-027	Half-Ball	Sapphire	9.0mm	-	None	$21.0
1105-030	Ball	Sapphire	10.0mm	5.75mm	None	$23.0
1106-030	Half-Ball	Sapphire	10.0mm	-	None	$23.0

Aluminum (Al) Mirrors



- constructed of monolithic aluminum blocks without reflection coatings
- Ideal for MWIR (3-5 micro) and LWIR (8-12 micro) thermal imaging with long focal lengths
- Diameter range up to 300mm
- Both spherical and aspherical optical surfaces optional

The Aluminum (Al) mirrors in this catalog are a special kind of Al mirrors constructed of monolithic aluminum blocks without the further deposition of reflection coatings, the reflective nature of these aluminum mirrors derives from the concave shapes and the polishing procedure. Shalom EO's aluminum mirrors find prominence in thermal imaging systems with long focal lengths, such as continuous zoom lenses and double FOV lenses. The operation wavelength range of our Al mirrors covers the MWIR (3-5 micro) and LWIR (8-12 micro) wavelength ranges.

Specifications:

Materials	Aluminum(Al)	Diameter Range	~300mm
Diameter Tolerance	-0.01/-0.03mm	Surface Quality	60/40 S/D
Fringes (N)	3	Irregularity (delta N)	1
Centration	3'		

Barium Fluoride (BaF2) Lenses

- Maximum diameter 200mm
- Transmission range 0.15μm to 11μm
- Exceptional tolerance to high-energy radiation
- Ideal for MWIR cooled thermal imaging cameras

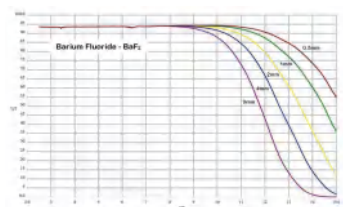
Barium Fluoride Lenses or BaF2 Lenses are excellent for light direction and manipulation in the ultraviolet, visible, and infrared spectral regions with a high transmission rate above 90% between 0.25 and 9.5μm. Barium Fluoride Shares similar properties with CaF2, with the advantage that BaF2 is more resistant to high-energy radiation. Nonetheless, BaF2 is half as hard as CaF2, and its transmission is more susceptible to temperature change (this is in particular true in humid environments because BaF2 is not stable under exposure to water). Barium Fluoride lenses are often used in thermal cameras integrated with a cryogenic cooler, Hangzhou Shalom EO offers the BaF2 lenses used in MWIR (3-5 micro) thermal imaging applications.

Specifications:

Materials	BaF2 crystals	Diameter Range	~200mm
Diameter Tolerance	+0.0/-0.2mm	Thickness Tolerance	+/-0.1mm
Surface Quality	60/40 S/D	Fringes (N)	3
Irregularity (delta N)	1	Centration	3'
Chamfer	0.1-0.3mmx45 degree	Coatings	AR/AR@3-5micro

Curves:

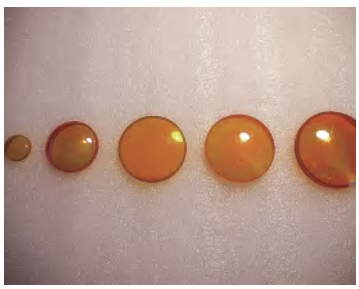
Transmission Curves of BaF2 Substrates of Different Thicknesses



Physical and Optical Properties:

Transmission Range	0.15 to 12 μm	Refractive Index	1.45 at 5 μm (1)
Reflection Loss	6.5% at 5 μm (2 surfaces)	Absorption Coefficient	3.2 x 10-4 cm-1 @ 6 μm
Reststrahlen Peak	47 μm	dn/dT	-15.2 x 10-6 /°C (2)
dn/dμ = 0	1.95 μm	Density	4.89 g/cc
Melting Point	1386°C	Thermal Conductivity	11.72 W m-1 K-1 @ 286 K
Thermal Expansion	18.1 x 10-6 /°C @ 273 K	Hardness	Knoop 82 with 500g indenter (4)
Specific Heat Capacity	410 J Kg-1 K-1 (3)	Dielectric Constant	7.33 at 1 MHz
Youngs Modulus (E)	53.07 GPa (3)	Shear Modulus (G)	25.4 GPa (3)
Bulk Modulus (K)	56.4 GPa	Elastic Coefficients	C11 = 89.2 C12 = 40.0 C44 = 25.4 (2)
Apparent Elastic Limit	26.9 MPa (300psi) (4)	Poisson Ratio	0.343
Solubility	0.17g/100g water at 23°C	Molecular Weight	175.36
Class/Structure	Cubic CaF2, Fm3m, (111) cleavage		

Zinc Sulfide (ZnS) Lenses



- Maximum diameter 200mm
- Both CVD Zinc Sulfide and Multispectral Zinc Sulfide (Cleartran) available
- Transmission 7-14μm (CVD ZnS); transmission 0.4-14.0μm (Cleartran)
- Superior fracture strength and mechanical hardness

Hangzhou Shalom EO provides ZnS Lenses made of Chemical Vapor Deposition (CVD) Zinc Sulfide or Multispectral Zinc Sulfide (also called Cleartran or water-clear ZnS). Both the two kinds of ZnS have become favorable in extreme conditions due to their high fracture strength which far exceeds that of ZnSe and mechanical robustness. In comparison, CVD ZnS is harder than Cleartran and is used for LWIR spectrum from 7 to 14 micro; whilst the multispectral ZnS, which is a special form of CVD ZnS with the zinc hydrides removed using a hot isostatic process, exhibits a broader transmission range spanning from the VIS to IR region (0.4-14μm), and the additional advantages of chemical inertness and low scattering.

Specifications:

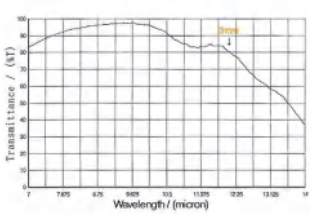
Materials	CVD ZnS or Multispectral ZnS (Cleartran)	Diameter Range	~200mm
Diameter Tolerance	+0.0/-0.2mm	Thickness Tolerance	+/-0.2mm
Surface Quality	60/40 S/D	Fringes (N)	3
Irregularity (delta N)	1	Centration	3'
Chamfer	0.1-0.3mmx45 degree	Coatings	AR/AR@7-14micro

Physical and Optical Properties:

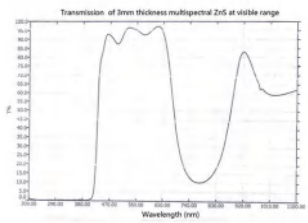
Transmission Range	0.37 to 13.5 μm	Refractive Index	2.20084 at 10 μm
Reflection Loss	24.7% at 10 μm (2 surfaces)	Absorption Coefficient	0.0006 cm-1 at 3.8 μm
Reststrahlen Peak	30.5 μm	dn/dT	+38.7 x 10-6/°C at 3.39 μm
dn/dμ = 0	n/a	Density	4.09 g/cc
Melting Point	1827°C (See notes below)	Thermal Conductivity	27.2 W m-1 K-1 at 298K
Thermal Expansion	6.5 x 10-6 /°C at 273K	Hardness	Knoop 160 with 50g indenter
Specific Heat Capacity	515 J Kg-1 K-1	Dielectric Constant	88
Youngs Modulus (E)	74.5 GPa	Shear Modulus (G)	n/a
Bulk Modulus (K)	n/a	Elastic Coefficients	Not Avalailable
Apparent Elastic Limit	68.9 MPa (10,000 psi)	Poisson Ratio	0.28
Solubility	65 x 10-6 g/100g water	Molecular Weight	97.43
Class/Structure	HIP polycrystalline cubic, ZnS, F42m		

Curves:

1.Transmission Curve of 3mm Thickness AR Coated CVD ZnS Substrates at 7-14 microWavelength Range



2.Transmission Curve of 3mm Thickness Multispectral ZnS at the Visible Wavelength Range



INFRARED DOMES

An optical dome is a special optical window consisting of two parallel and curved planes. Optical domes act as protective covers in optical systems to shield sensitive components, such as lenses or sensors, from environmental factors like dust, moisture, and physical damage while allowing light to pass through with minimum distortion. In comparison to conventional flat windows, the strong curvature of IR domes impart them with a wider reception range of angles of entering light, and the potential to minimize side effects such as optical aberrations and parasitic reflections. The dome shape might also be more advantageous in terms of Aerodynamic concerns. IR domes transmit the IR radiations and are often used in applications that encounter extreme environments such as aviation, and missiles for navigation, targeting, and surveillance purposes, Infrared domes serve as critical components to protect IR sensors and cameras while allowing them to capture images or data in low-light or nighttime conditions. The design of infrared domes needs to consider factors such as material selection, shape optimization to minimize distortion, and coatings for durability or specific optical properties. Infrared domes must also be able to withstand environmental conditions without affecting their IR transmission characteristics.

Shalom EO offers infrared domes made of various substrate materials: sapphire, hot-pressed MgF2, CVD ZnS and Multispectral ZnS, ZnSe, and Germanium. While sapphire domes offer unrivaled hardness and good transmission in the MWIR region, hot-pressed MgF2 domes are

excellent for the MWIR band with the additional benefit of thermal stability and decent mechanical hardness, and ZnSe domes and Germanium domes are good choices for 3µm to 12µm covering the MWIR and LWIR region. CVD ZnS and Multispectral ZnS domes provide superior thermo-mechanical properties and fracture strength, contributing to high endurance in hostile environments. The dimensions of the domes also come in a rich selection. The domes could be furnished with anti-reflection coatings or DLC (Diamond Like Carbon) coatings.

Hot-pressed MgF2 Domes

- Large Flexural strength: > 20,000 psi
- Large Knoop hardness: >1350 kg mm-2
- High transmission within the range of 2μm to 7.5μm
- Excellent for MWIR thermal imaging
- Applications: defense, security, and aerospace, etc.

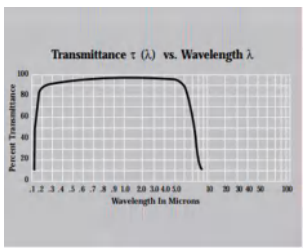
Hangzhou Shalom EO offers Hot-pressed magnesium fluoride or MgF2 domes optimized for missiles and launch tubes. Hot-pressed Magnesium Fluoride (MgF2) is a favorable option as the IR material to manufacture MWIR domes, with its dominating prevalence attributing to high infrared transmittance at the range of 2-7.5μm, small thermal expansion coefficient, good mechanical properties, and low fabrication cost.

Specifications:

Materials	Hot-pressed MgF2	Diameter Range	~ 280mm
Thickness Tolerance	+/-0.2mm (Optional:+/-0.1mm and +/-0.05mm)	Surface Quality	60/40 S/D
Fringes (N):	customized	Irregularity (delta N)	customized
Chamfer	0.1~0.3mmx45degree	Coating	Uncoated(Note: coating is unnecessary for its high transmission)

Curves:

Transmission of Hot-pressed MgF2 Materials



Physical and Optical Properties:

Transmission Range	0.7 to 9μm	Knoop Hardness	>539kg/mm2
Fracture Strength	96MPa	Compression Strength	>300MPa
Bending Strength	>90MPa	Density	>3.17g/cm3
Thermal Expansion	<1.3x10-5 K-1(25-300℃)	Refractive Index	1.3812+/-0.005 (at 0.5893μm)
Transmittance	>85%(2-7.5μm)		

Sapphire (Al2O3) Domes

- Diameter range from 10mm to 380mm
- Excellent transmission from UV to MWIR
- Exceptional mechanical properties and chemical resistance
- Ideal for defense and aerospace application

Sapphire Domes are protective covers or enclosures made from sapphire (Al2O3) crystal. Sapphire is a hard and scratch-resistant material that offers excellent optical properties with its fine transmission over a wide range extending from UV to MWIR spectral region, making it suitable for various applications where robustness and transmission are essential. The wide transmission wavelength range of sapphire domes caters to multi-spectral operation and their incomparable mechanical strength excels in high-speed context.

Hangzhou Shalom EO offers custom sapphire domes. Our sapphire domes are optimized for utilization in aircraft, Industrial, missile, and scientific experiment applications to be incorporated into sensors, IR cameras, high-pressure chambers, etc. providing protection against high-speed impacts, extreme temperatures, and abrasive particles encountered while maintaining a transparent and robust barrier.

Specifications:

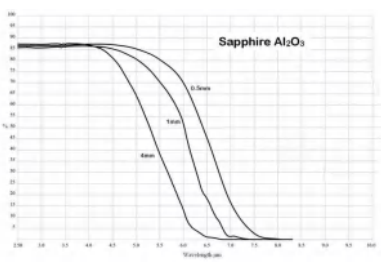
Materials	Optical grade sapphire crystals (Al2O3)	Diameter Range	10~ 380mm
Thickness Tolerance	+/-0.2mm (Optional:+/-0.1mm and +/-0.05mm)	Surface Quality	60/40 to 40/20 S/D
Fringes (N)	customized	Irregularity (delta N)	customized
Chamfer	0.1~0.3mmx45degree		

Physical and Optical Properties:

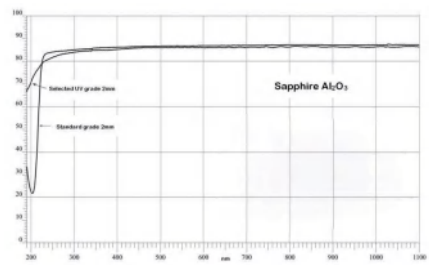
Transmission Range	0.17 to 5.5μm	Refractive Index	No 1.75449; Ne 1.74663 at 1.06μm (1)
Reflection Loss	14% at 1.06μm	Absorption Coefficient	0.3 x 10-3 cm-1 at 2.4μm (2)
Reststrahlen Peak	13.5μm	dn/dT	13.1 x 10-6 at 0.546μm (3)
dn/dμ = 0	1.5μm	Density	3.97 g/cc
Melting Point	2040°C	Thermal Conductivity	27.21 W m-1 K-1 at 300K
Thermal Expansion	5.6 (para) & 5.0 (perp) x 10-6 /K *	Hardness	Knoop 2000 with 2000gindenter
Specific Heat Capacity	763 J Kg-1 K-1 at 293K (4)	Dielectric Constant	11.5 (para) 9.4 (perp) at 1MHz
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 (45,000 psi)	Poisson Ratio	0.25
Solubility	98 x 10-6 g/100g water	Molecular Weight	101.96
Class/Structure	Trigonal (hex), R3c		

Curves:

1. Transmission of Sapphire at Infrared Wavelength Range (no coating)



2. Transmission of Sapphire at UV Wavelength Range (no coating)



CVD and Multispectral ZnS Domes

- Both CVD ZnS and Cleartran available
- Maximum diameter: 280mm
- Excellent thermo-mechanical properties and mechanical strength, endurance to hostile environments
- Wide transmission range: 8-12μm (CVD ZnS) or 0.4-12μm (Cleartran), high transmission in the LWIR region
- deal for infrared imaging, missile guidance, scientific instruments, etc.

CVD (Chemical Vapor Deposition) Zinc Sulfide excels or exhibits identical characteristics to hot-pressed zinc sulfide in terms of optical properties (in particular the significant enhancement in transmission in the range of 10.5~12μm), mechanical properties, and thermal properties. CVD ZnS, with a transmission spectrum of 8-12μm and twice the fracture strength of ZnSe and exceptional hardness, has found extensive use in uses in LWIR applications that demand mechanical resilience in hostile environments. Multispectral Zinc Sulfide, also called Cleartran, is a modified version of CVD ZnS that undergoes a further post-deposition hot isostatic procedure to expand the transmission range into 0.4-12μm. In comparison, besides the difference in transparent range, CVD ZnS is harder, although both of them are far more rugged than ZnSe.

Shalom EO is a professional manufacturer of CVD ZnS Domes and Multispectral ZnS Domes. Our CVD and Multispectral ZnS domes find widespread utilities in applications like Infrared imaging, missile guidance, scientific instruments, etc. Our ZnS domes boast outstanding optical transmission and minimal absorption/low scatters in the IR band, mechanical strength, and durability which is crucial in harsh environments, such as aerospace and defense. The controllable nature of the CVD process ensures the uniform deposition of zinc sulfide, resulting in homogeneous optical and mechanical properties across the entire dome.

Specifications:

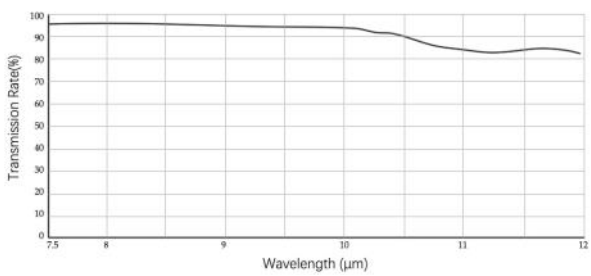
Materials	CVD ZnS and Multispectral ZnS (Cleartran)	Diameter Range	~ 280mm
Thickness Tolerance	+/-0.2mm (Optional:+/-0.1mm and +/-0.05mm)	Surface Quality	60/40 S/D
Fringes (N)	customized	Irregularity (delta N)	customized
Chamfer	0.1~0.3mmx45degree	Coating	AR Coating

Physical and Optical Properties:

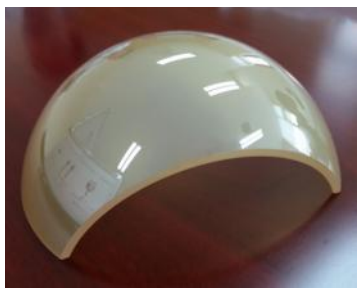
Transmission Range	8-12μm (CVD ZnS) 0.4-12μm (Multispectral ZnS)	Knoop Hardness	210
Melting Point	1830°C	Youngs Modulus	80GPa
Bending Strength	>100MPa	Density	4.08g/cm3
Thermal Expansion	<9x10-6K-1(~600℃)	Refractive Index	2.2004
Transmittance	>70%(8-12μm)	Poisson Ratio	0.25-0.36
Specific Heat	0.468J/(g*K)	Thermal Conductivity	19W/(m*K)

Curves:

The measured transmission curve of CVD zinc sulfide dome after coating is shown in the figure below:



Zinc Selenide (ZnSe) Domes



- Optimized for IR wavelength range of 3-16μm, covering MWIR and LWIR regions
- made of CVD ZnSe grown in the USA
- Superior thermal properties, low absorption
- Low chromatic dispersion
- Ideal for thermally demanding environments, CO2 lasers, military

Zinc Selenide (ZnSe) Domes are excellent for various IR applications due to their extensive transmission wavelength range from 0.6 to 1.6μm , often optimized for the IR range of 3-16μm after AR coating. Its absorption coefficient is in particular low in the IR range, this trait, in combination with its low chromatic dispersion, minimizes signal loss and enables authentic transmission of infrared radiation. ZnSe domes boast outstanding thermal properties and therefore are recommended for thermally demanding conditions. With high thermal shock resistance and low absorption, ZnSe domes an exceptional option for high-power CO2 lasers and thermal imaging cameras. However, ZnSe is relatively soft and chemically sensitive and thus extra caution needs to be taken during cleaning, handling, and mounting.
Hangzhou Shalom EO offers ZnSe Domes made of CVD (Chemical Vapor Deposition) ZnSe grown in the USA with high purity.

Specifications:

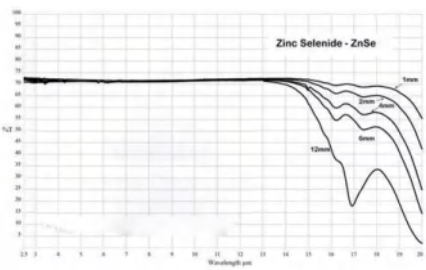
Materials	CVD ZnSe	Diameter Range	~ 280mm
Thickness Tolerance	+/-0.2mm (Optional:+/-0.1mm and +/-0.05mm)	Surface Quality	60/40 S/D
Fringes (N)	customized	Irregularity (delta N)	customized
Chamfer	0.1~0.3mmx45degree	Coating	AR/AR@7-12μm

Physical and Optical Properties:

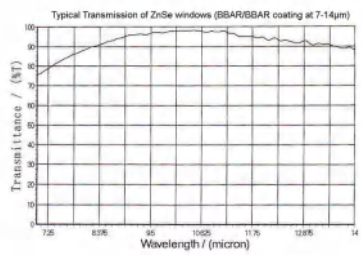
Transmission Range	0.6 to 21.0μm	Refractive Index	2.4028 at 10.6μm
Reflection Loss	29.1% at 10.6μm (2 surfaces)	Absorption Coefficient	0.0005 cm-1 at 10.6μm
Reststrahlen Peak	45.7μm	dn/dT	+61 x 10-6 /°C at 10.6μm at 298K
dn/dμ = 0	5.5μm	Density	5.27 g/cc
Melting Point	1525°C (see notes below)	Thermal Conductivity	7.1 x 10-6 /°C at 273K
Hardness	Knoop 120 with 50g indenter	Specific Heat Capacity	339 J Kg-1 K-1
Dielectric Constant	n/a	Youngs Modulus (E)	67.2 GPa
Shear Modulus (G)	n/a	Bulk Modulus (K)	40 GPa
Elastic Coefficients	Not Available	Apparent Elastic Limit	55.1 MPa (8000 psi)
Poisson Ratio	0.28	Solubility	0.001g/100g water
Molecular Weight	144.33	Class/Structure	HIP polycrystalline cubic, ZnS, F43m
Class/Structure	Trigonal (hex), R3c		

Curves:

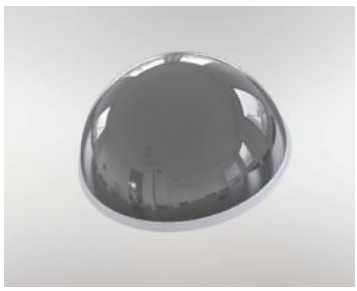
1. Transmission Curve of ZnSe Windows with No Coating



2. Transmission Curve of ZnSe Windows with BBAR/BBAR Coating at 7-14μm



Germanium (Ge) Domes



- Maximum Diameter: 280mm
- Wide operation wavelength range of 2-14μm
- Mechanical ruggedness, low chromatic dispersion
- Excellent for defense, security, and aerospace applications, MWIR and LWIR thermal imaging cameras

Germanium domes are a special kind of window made of germanium crystal with a curved profile, Ge domes are excellent for IR applications due to their broad transmission range of 2-14μm, rejection to the visible spectrum and low chromatic dispersion, functioning as a protective barrier to shield sensitive components from hostile environments while let the portion of IR radiations of interest pass unhindered. Germanium domes are often used in IR thermal imaging cameras operating in the 2μm to 14μm spectral range, covering the LWIR (8-12μm) and MWIR (3-5μm) region. The rugged nature of Ge makes it competent at handling extreme environments (such as aerospace and defense). Germanium domes can be AR coated with Diamond (DLC coating or Hard carbon coating), producing a front optic with striking toughness.

Specifications:

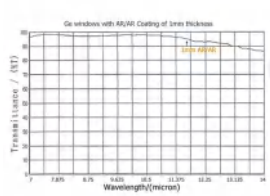
Materials	Optical grade germanium single crystals	Diameter Range	~280mm
Thickness Tolerance	±0.2mm (Optional: ±0.1mm or ±0.05mm)	Surface Quality	60/40 S/D
Fringes: (N)	customized	Irregularity (delta N)	customized
Chamfer	0.1~0.3mmx45degree	Coating(optional)	AR/AR@7-14μm DLC/AR@7-14μm BBAR/BBAR@3-12μm See the curves below

Physical and Optical Properties:

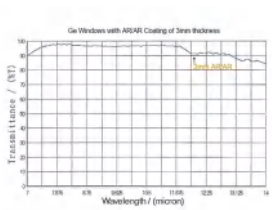
Transmission Range	1.8 to 23μm (1)	Refractive Index	4.0026 at 11μm (1)(2)
Reflection Loss	53% at 11μm (2 surfaces)	Absorption Coefficient	<0.027 cm-1 @ 10.6μm
Reststrahlen Peak	n/a	dn/dT	396 x 10-6 /°C (2)(6)
dn/dμ = 0	Almost constant	Density	5.33 g/cc
Melting Point	936 °C (3)	Thermal Conductivity	58.61 W m-1 K-1 at 293K (6)
Thermal Expansion	6.1 x 10-6 /°C at 298K (3)(4)(6)	Hardness	Knoop 780
Specific Heat Capacity	310 J Kg-1 K-1 (3)	Dielectric Constant	16.6 at 9.37 GHz at 300K
Youngs Modulus (E)	102.7 GPa (4) (5)	Shear Modulus (G)	67 GPa (4) (5)
Bulk Modulus (K)	77.2 GPa (4)	Elastic Coefficients	C11=129; C12=48.3; C44=67.1 (5)
Apparent Elastic Limit	89.6 MPa (13000 psi)	Poisson Ratio	0.28 (4) (5)
Solubility	Insoluble in water	Molecular Weight	72.59
Class/Structure	Cubic Diamond, Fd3m		

Curves:

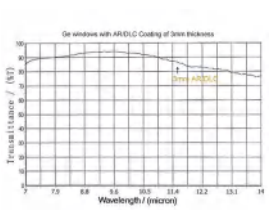
1. Transmission curve for Ge windows with coating AR/AR of 1mm thickness



2.Transmission curve for Ge windows with coating AR/AR of 3mm thickness



3.Transmission curve for Ge windows with coating AR/DLC of 3mm thickness



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