II-VI INFRARED ... the world leader in CO_2 laser optics

CO_2 LASER CONSUMABLES

LENSES • MIRRORS • NOZZLES & ACCESSORIES • MORE

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II-VI

ABOUT II-VI INFRARED

II-VI Infrared is a business unit of II-VI Incorporated, a global leader in engineered materials and optoelectronic components.

Founded in 1971, II-VI Incorporated began by exclusively producing the highest-quality cadmium telluride (CdTe) material available for manufacturing high-power industrial CO_2 laser optics. Today, II-VI Incorporated has diversified into numerous business units including laser tools for materials processing (HIGHYAG); near-infrared optics, YAG components, and telecommunications components (VLOC); fiber optics, projection and display optics, DPSS laser, crystal materials, and other photonics products (Photop); defense and aerospace optics (Exotic Electro-Optics); tellurium and selenium products (PRM); thermoelectric cooling devices (Marlow Industries); silicon carbide (II-VI WBG); and advanced materials development (II-VI AMDC). Given this diversity of II-VI Incorporated's business units, to set the original IR materials and optics business unit apart from the corporate whole, it was christened II-VI Infrared.

As II-VI Incorporated continues to grow, II-VI Infrared focuses on the company's original, industry-leading products: infrared and CO_2 laser optics and materials. And thanks to decades of innovation in zinc selenide (ZnSe) and zinc sulfide (ZnS) materials processing, thin-film coating, precision diamond-turning, and finished optics fabrication, II-VI Infrared is the world leader in CO_2 laser optics, delivering an unbeatable combination of innovation, quality, and experience. II-VI Infrared also delivers the largest vertically integrated CO_2 laser optics manufacturing process – from raw materials to finished coated products – in the world.

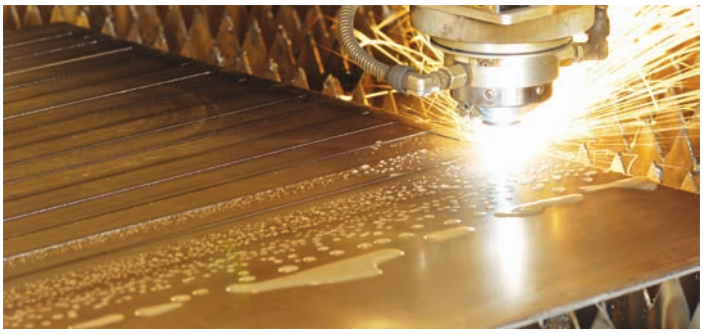
An optics foundry to CO_2 laser original equipment manufacturers (OEMs) the world over, consistently building optics to spec with consistent performance and quality, II-VI Infrared's products range from replacement CO2 laser optics and nozzles to lenses, partial reflectors, windows, beamsplitters, mirrors, beam expanders, reflective phase retarders, scanning-laser system optics, diamond-turned custom optics, and more. Our products and reputation make us the number-one supplier to OEMs of CO_2 laser systems worldwide, while our capabilities are without rival in the industry.

Our diamond-turning facility is among the largest and most advanced in the world, offering services such as flycutting and multiple-axis turning, as well as fast and slow tool servos for custom optics. Single-point diamond-turning is used in finishing transmissive optics and mirrors in a variety of metals and IR materials.

Major investments in computer design programs, thin film evaporation equipment, clean rooms, and QA testing facilities enable us to offer a broad range of IR thin-film coatings. II-VI Infrared is known for designing and producing consistently low-absorption coatings for high-power CO_2 laser optics. Additionally, our talented and experienced engineering team, using optical design software and CAD systems, designs and builds standard and custom optics as well as specialized mounts, components, and electro-optic assemblies.

Our quality assurance program includes comprehensive testing, documentation, and statistical analysis to ensure that each optic and component performs to customer requirements.

Contents



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OUR OPTICS MANUFACTURING FACILITIES

II-VI Infrared –– Global Headquarters
Saxonburg, PA USA

II-VI Singapore Pte., Ltd.
Singapore

II-VI Optics (Suzhou) Co., Ltd
Suzhou, P.R. China

PLANO-CONVEX LENSES

Specifications	Standards
Dimensional Tolerance	Diameter: +0.000"/-0.005" Thickness: ±0.010"
Edge Thickness Variation (ETV)	≤ 0.0005"
Clear Aperture (polished)	90% of diameter
Surface Figure at 0.63µm	Plano: 1 fringe Power ½ fringe Irregularity Radius: Power and irregularity vary depending upon radius
Scratch-Dig	20-10
AR Coating Reflectivity per Surface at 10.6µm	≤ 0.20%

Plano-convex lenses, the most economical transmissive focusing elements available, are ideally suited for laser heat treating, welding, cutting, and infrared radiation collection where spot size or image quality is not critical. They are also the economical choice in high f-number, diffraction limited systems where lens shape has virtually no effect on system performance.

For proper performance with a plano-convex lens, the curved surface should face toward the incoming collimated beam or the longer conjugate distance (the object and image distances together are referred to as the conjugate distance).

Besides the plano-convex, meniscus, and aspheric lens shapes offered in this catalog, II-VI routinely fabricates biconvex and negative focal length lenses upon request.

Part #	Description	Diameter		Focal Length	Working Distance	Edge Thickness	
		inches	(mm)	inches	inches	inches	(mm)
696289	ZnSe	1.1	27.94	2.5	-	0.085	2.16
561067	ZnSe	1.1	27.94	5.0	-	0.160	4.06
774048	ZnSe	1.1	27.94	7.5	-	0.106	2.69
941031	ZnSe	1.5	38.1	-	5.0	0.280	7.11
578662	ZnSe	1.5	38.1	5.0	-	0.300	7.62
227092	ZnSe	1.5	38.1	5.0	-	0.236	5.99
658108	ZnSe	1.5	38.1	5.0	-	0.310	7.87
464497	ZnSe	1.5	38.1	-	7.5	0.280	7.11
306068	ZnSe	1.5	38.1	7.5	-	0.300	7.62
618938	ZnSe	1.5	38.1	7.5	-	0.310	7.87
304725	ZnSe	2.0	50.8	5.0	-	0.310	7.87
741363	ZnSe	2.0	50.8	5.0	-	0.380	9.65
870676	ZnSe	2.0	50.8	-	5.0	0.380	9.65
892020	ZnSe	2.0	50.8	7.5	-	0.310	7.87
232771	ZnSe	2.0	50.8	7.5	-	0.380	9.65
781603	ZnSe	2.0	50.8	-	7.5	0.380	9.65
541344	ZnSe	2.0	50.8	8.75	-	0.310	7.87
628275	ZnSe	2.0	50.8	10.0	-	0.310	7.87
243827	ZnSe	2.5	63.5	8.75	-	0.310	7.87
236670	ZnSe	2.5	63.5	10.0	-	0.390	9.90

Note
Mounting services are available for plano-convex lenses. Contact a II-VI sales representative for more information.

Contact a II-VI sales representative for exact specifications.

MENISCUS LENSES

Specifications	Standards
Dimensional Tolerance	Diameter: +0.000"/-0.005" Thickness: ±0.010"
Edge Thickness Variation (ETV)	≤ 0.0005"
Clear Aperture (polished)	90% of diameter
Surface Figure (power/irregularity) at 0.63µm	Varies depending upon radius
Scratch-Dig	20-10
AR Coating Reflectivity per Surface at 10.6µm	≤ 0.20%

Meniscus lenses are designed to minimize spherical aberration, producing a minimum focal spot size for incoming collimated light.

In addition to the standard focal lengths listed below, II-VI maintains an extensive inventory of test plates and tooling, resulting in no additional tooling charges for focal length fabrication.

Part #	Description	Diameter inches	Diameter (mm)	Focal Length inches	Edge Thickness inches	Edge Thickness (mm)
566650	ZnSe	1.1	27.94	1.5	0.085	2.16
932739	ZnSe	1.1	27.94	2.5	0.085	2.16
801758	ZnSe	1.1	27.94	5.0	0.085	2.16
285767	ZnSe	1.5	38.1	2.5	0.085	2.16
831393	ZnSe	1.5	38.1	3.75	0.290	7.37
120216	ZnSe	1.5	38.1	5.0	0.354	8.99
698637	ZnSe	1.5	38.1	7.5	0.354	8.99
507790	ZnSe	1.5	38.1	5.0	0.236	5.99
406294	ZnSe	1.5	38.1	5.0	0.290	7.37
767963	ZnSe	1.5	38.1	5.0	0.354	8.99
452726	ZnSe	1.5	38.1	7.5	0.125	3.18
784964	ZnSe	1.5	38.1	7.5	0.236	5.99
702232	ZnSe	1.5	38.1	7.5	0.290	7.37
570721	ZnSe	1.5	38.1	7.5	0.354	8.99
206326	ZnSe	2.0	50.8	5.0	0.378	9.60
935669	ZnSe	2.0	50.8	5.0	0.100	2.54
695399	ZnSe	2.0	50.8	7.5	0.380	9.65
296875	ZnSe	2.0	50.8	10.0	0.100	2.54
490154	ZnSe	2.5	63.5	5.0	0.160	4.06
596352	ZnSe	2.5	63.5	7.5	0.160	4.06
286449	ZnSe	2.5	63.5	10.0	0.160	4.06

Note
Mounting services are available for meniscus lenses. Contact a II-VI sales representative for more information.

Contact a II-VI sales representative for exact specifications.

MP-5® ULTRA-LOW ABSORPTION LENS

THE BEST ... NOW EVEN BETTER. II-VI Infrared's MP-5 is an ultra-low absorbing lens that ships directly from the factory as a standard OEM CO_2 laser component. Its superior features include a patented coating design enabling lower thermal distortion, visible transmission for reduced set-up time, and easy detection of thermally induced stress. The MP-5 is backed by over a decade of proven performance, and this ultra-low absorbing lens is designed, produced, and supported by II-VI Infrared, the world leader in CO_2 laser optics.

A specially coated zinc selenide (ZnSe) focusing lens, the MP-5 is available in both 1.5" and 2.0" diameters, and ships in standard replacement lens configurations for most popular OEM laser models.

Specifications	Standards
Absorption	≤ 0.13% < 0.10% (typical)
Dimensional Tolerance	Diameter: +0.000"/-0.005" Thickness: ±0.010"
Edge Thickness Variation (ETV)	≤ 0.0005"
Clear Aperture (polished)	90% of lens diameter
Scratch-Dig	40-20

Note
Mounting services are available for MP-5 ® lenses. Contact a II-VI sales representative for more information.

Part #	Description	Diameter inches	Diameter (mm)	Focal Length inches	Edge Thickness inches	Edge Thickness (mm)
794914	ZnSe PO/CX*	1.5	38.1	5.2	0.280	7.11
204518	ZnSe PO/CX*	1.5	38.1	7.7	0.280	7.11
106106	ZnSe PO/CX*	1.5	38.1	5.0	0.300	7.62
383862	ZnSe PO/CX*	1.5	38.1	7.5	0.300	7.62
635061	ZnSe PO/CX*	2.0	50.8	7.5	0.310	7.88
392125	ZnSe PO/CX*	2.0	50.8	7.5	0.380	9.65
528717	ZnSe Meniscus	1.5	38.1	5.0	0.236	5.99
312503	ZnSe Meniscus	1.5	38.1	5.0	0.290	7.37
123397	ZnSe Meniscus	1.5	38.1	5.0	0.354	8.99
714512	ZnSe Meniscus	1.5	38.1	7.5	0.236	5.99
474644	ZnSe Meniscus	1.5	38.1	7.5	0.290	7.37
602033	ZnSe Meniscus	1.5	38.1	7.5	0.354	8.99

** PO/CX is plano convex.*
Contact a II-VI sales representative for exact specifications.

OUTPUT COUPLERS

Partial reflectors are commonly used as laser output couplers or beam attenuators.

For your convenience, II-VI maintains commonly used coatings and substrate radii of curvature in inventory. Specifications for these products are indicated on this page. For available special substrate sizes and coatings, please contact a II-VI sales representative for a quotation.

Laser output couplers often require a slightly wedged substrate to eliminate interference from multiple reflections inside the component. If you require a specific wedge value, please specify this when ordering.

Specifications		Standards
Dimensional Tolerances	Diameter Thickness (plano) Thickness (radiused)	+0.000"/-0.005" +0.005"/-0.010" ±0.010"
Parallelism	Plano Radiused, Diameter < 1" Radiused, Diameter ≥ 1"	≤ 3 arc minutes ≤ 10 arc minutes ≤ 5 arc minutes
Clear Aperture (polished)		90% of diameter
Surface Figure (power/irregularity) at 0.63µm	Plano Radiused	1 fringe/½ fringe (varies depending upon radius)
Surface-Dig		20-10
Side 1: Reflectivity Tolerance at 10.6µm		1% to 5%: ±0.5%R 6% to 85%: ±3% 86% to 95%: ±1.5% 96% to 98%: ±1% 99%: ±0.2% 99.5%: ±0.2%
Side 2: AR Coating Reflectivity at 10.6µm		≤ 0.20%

Note
Mounting services are available for output couplers. Contact a II-VI sales representative for more information.

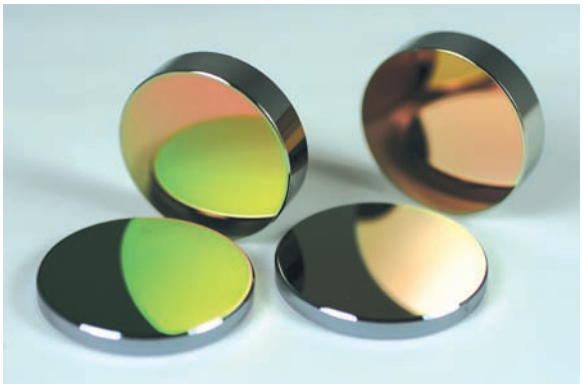
Part #	Description	Diameter inches	Diameter (mm)	Edge Thickness inches	Edge Thickness (mm)	Reflectivity	Radius** Side 1/Side 2
988175	ZnSe	1.0	25.4	0.236	5.99	65%	30MCC/30MCX
774314	ZnSe	1.0	25.4	0.236	5.99	50%	PO/PO
132098	ZnSe	1.1	27.94	0.220	5.59	50%	20MCC/15MCX
346822*	ZnSe	1.181	30.0	0.236	5.99	50%	30MCC/30MCX
554288	ZnSe	1.5	38.1	0.236	5.99	30%	10MCC/10MCX
187879	ZnSe	1.5	38.1	0.236	5.99	UC***	10MCC/15MCX
120765	ZnSe	1.5	38.1	0.236	5.99	30%	20MCC/PO
903007	ZnSe	2.0	50.8	0.300	7.62	48%	30MCC/20MCX

** MP-5 type coating.*
*** M is meter, CC is concave, PO is plano, CX is convex.*
**** UC is uncoated*
Contact a II-VI sales representative for exact specifications.

REAR MIRRORS

Rear mirrors, typically GaAs, Ge, or ZnSe, are partial reflectors with a very high reflection-to-transmission ratio (99.0 to 99.7%), and are key optical components in laser resonators or laser cavities. Rear mirrors, like output couplers, are a part of the lasing process. Thus, high reflectivity is desired. The slight transmission of rear mirrors is used in conjunction with power meters to test for laser resonator output power.

When laser resonator designs require rear mirrors to be total reflectors, Si, Cu, or Mo substrates are used, the latter being typically uncoated.



Specifications		Standards
Dimensional Tolerances	Diameter Thickness (plano) Thickness (radiused)	+0.000"/-0.005" +0.005"/-0.010" ±0.010"
Parallelism	Plano Radiused, Diameter < 1" Radiused, Diameter ≥ 1"	6-10 arc minutes 6-10 arc minutes 6-10 arc minutes
Clear Aperture (polished)		90% of diameter
Surface Figure (power/irregularity) at 0.63µm	Plano Radiused	1 fringe/½ fringe (varies depending upon radius)
Scratch-Dig		20-10
Side 1: Reflectivity Tolerance at 10.6µm		99%: ±0.2% 99.5%: +0.2/-0% 99.7%: ±0.1%
Side 2: AR Coating Reflectivity at 10.6µm		≤ 0.20%

Note
Mounting services are available for rear mirrors. Contact a II-VI sales representative for more information.

Part #	Description	Diameter inches	Diameter (mm)	Edge Thickness inches	Edge Thickness (mm)	Reflectivity	Radius* Side 1/Side 2
234709	Ge	1.0	25.4	0.236	5.99	99.5%	15MCC/PO
722287	Ge	1.1	27.94	0.220	5.59	99.5%	20MCC/PO
432529	Ge	1.181	29.99	0.236	5.99	99.6%	30MCC/PO
766409	Ge	2.0	50.8	0.375	9.53	99.5%	30MCC/PO
536364	GaAs	1.0	25.4	0.236	5.99	99.7%	30MCC/PO
230089	GaAs	1.1	37.94	0.120	3.05	99.7%	20MCC/PO
911209	ZnSe	1.5	38.1	0.236	5.99	99%	20MCC/PO

** M is meter, CC is concave, PO is plano. Contact a II-VI sales representative for exact specifications.*

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PLANO AND SPHERICAL MIRRORS

Specifications		Standards
Dimensional Tolerances	Diameter Thickness	+0.000"/-0.005" ±0.010"
Clear Aperature (polished)		90% of diameter
Surface Figure at 0.63µm	Plano and Radiused, r > 1 m	Power: 2 fringes Irregularity: 1 fringe
Scratch-Dig		10-5

Mirrors or total reflectors are used in laser cavities as rear reflectors and fold mirrors, and externally as beam benders in beam delivery systems.

Silicon is the most commonly used mirror substrate; its advantages are low cost, good durability, and thermal stability.

Copper is typically used in high-power applications for its high-thermal conductivity.

Molybdenum's extremely tough surface makes it ideal for the most demanding physical environments. Molybdenum is normally offered uncoated.

Part #	Description	Diameter inches	Diameter (mm)	Edge Thickness inches	Edge Thickness (mm)	Side 1 Coating
850800	Si	1.0	25.4	0.120	3.05	ES
690933	Si	1.5	38.1	0.375	9.53	MMR
221987	Si	1.75	44.45	0.375	9.53	EG
408825	Si	2.0	50.8	0.200	5.08	DEMMR
341534	Si	2.0	50.8	0.200	5.08	TRZ
674480	Si	2.0	50.8	0.400	10.16	TRZ
963043	Si	2.677	68.0	0.800	20.32	TRZ
614835	Si	3.0	76.2	0.250	6.35	TRZ
148570	Cu	1.1	37.94	0.236	5.99	EG
370229	Cu	1.969	50.01	0.200	5.08	TRZ
482518	Cu	1.969	50.01	0.354	8.99	EG
832216	Cu	1.969	50.01	0.394	10	TRZ
658306	Cu	2.362	59.99	0.236	5.99	TRZ
137530	Cu	4.0	101.6	0.75	19.05	PS
650010	Cu-WC*	4.25	107.95	1.5	38.1	ES
229095	Mo	4.0	101.6	0.350	8.89	UC

** WC is water-cooled copper.*
The parts listed are plano. For spherical parts, please contact a II-VI sales representative.
Contact a II-VI sales representative for exact specifications.

REFLECTIVE PHASE RETARDERS

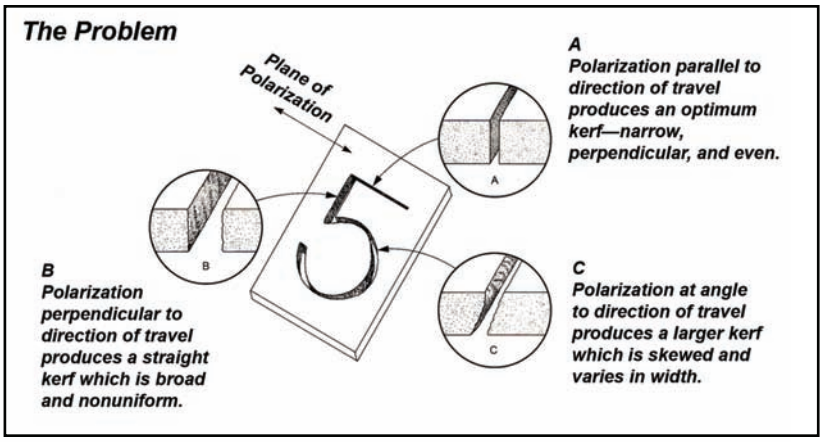


Figure 1

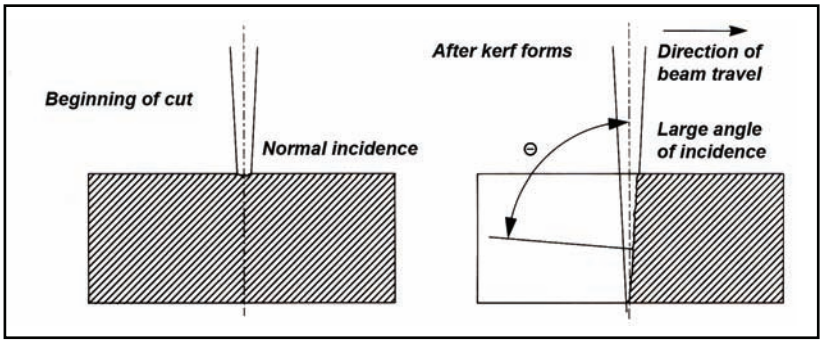


Figure 2

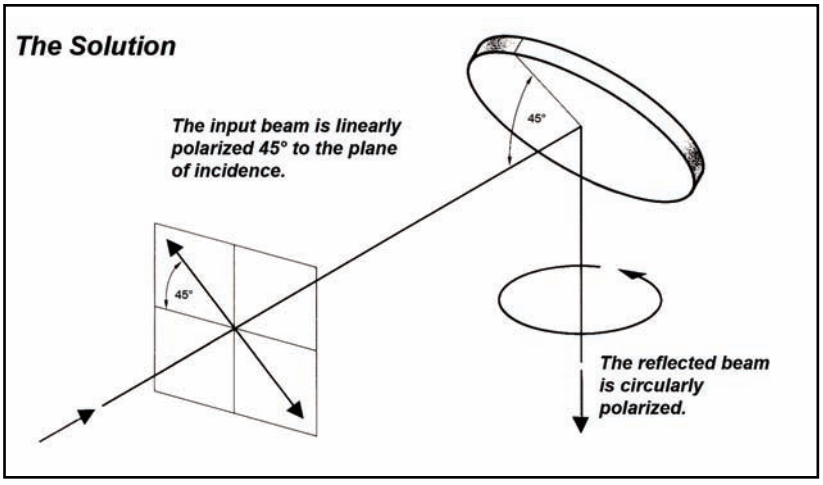


Figure 3

Metal cutting and other critical laser operations are sensitive to any variation in kerf width or cross-section. The kerf's quality depends on the polarization orientation relative to the cut direction. This is illustrated in Figure 1.

Current theory suggests that the assumption of a focused beam striking the work piece at normal incidence is only true at the cut's beginning. Once the kerf forms, the beam encounters metal at some large angle of incidence, Θ, as shown in Figure 2. Light which is s-polarized with reference to such a surface is reflected much more than light which is p-polarized, leading to the difference in cut quality.

Introducing a quarter-wave (90°) reflective phase retarder into the beam delivery path eliminates kerf variations by converting linear polarization to circular polarization. Circular polarization consists of equal amounts of s-polarization and p-polarization for any beam orientation, therefore all axes encounter the same composition of polarization, and material is removed uniformly regardless of cut direction. This is illustrated in Photo 1 on page 11.

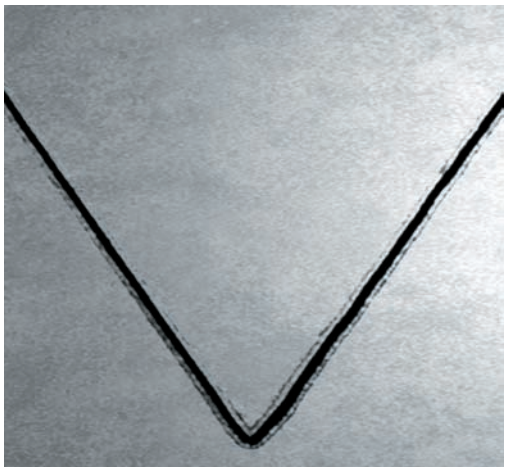
A linearly polarized beam is oriented so that the plane of polarization is 45° to the plane of incidence and strikes the RPR at 45° to the normal, as shown in Figure 3. The reflected beam is circularly polarized.

The substrate choice depends upon the power level at which the laser operates. Alternate substrates, including water-cooled copper, are available. Eighth-wave and sixteenth-wave RPR designs, and designs for peak wavelengths other than 10.6µm, are also available. Please contact a II-VI sales representative to obtain a quotation.

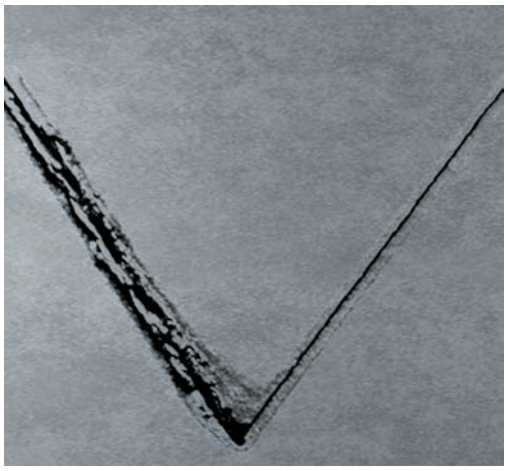
Specifications	Standards
Dimensional Tolerance	Diameter: +0.000"/-0.005" Thickness: ±0.010"
Parallelism	≤ 3 arc minutes
Clear Aperture (polished)	90% of diameter
Surface Figure (power/irregularity) at 0.63µm	≤ 2 fringe/½ fringe
Scratch-Dig	10-5
Reflectivity @ 10.6µm	≥ 98%
Phase Retardation for 10.6µm @ 45°	90°±3°
Ellipticity Ratio	0.90-1.11

Part #	Description	Diameter inches	Diameter (mm)	Edge Thickness inches	Edge Thickness (mm)	Phase Shift @ 10.6µm (degrees)
498237	Si	1.5	38.1	0.16	4.06	90+/-6
893833	Si	2.0	50.8	0.20	5.08	90+/-2
582132	Si	2.0	50.8	0.20	5.08	90+/-2
592353	Si	2.0	50.8	0.375	9.53	90+/-6
102719	Si	2.0	50.8	0.170	5	90+/-2
969917	Si	2.0	50.8	0.40	10.16	90+/-6
772930	Si	2.677	68	0.80	20.32	90+/-1
697768	Si	3.0	76.2	0.236	6	90+/-6
224094	Si	3.0	76.2	0.25	6.35	90+/-6
390686	Cu	1.5	38.1	0.25	6.35	90+/-6
666269	Cu	1.969	50	0.394	10	90+/-6
832944	Cu	2.25	57.15	0.394	10	90+/-2
488199	Cu-WC*	2.25	57.15	1.25	31.75	90+/-6
800102	Cu	2.362	60	0.394	10	90+/-2
634413	Cu	2.362	60	0.591	15	90+/-2
748680	Cu	3.0	76.2	0.50	12.7	90+/-6
744069	Cu	3.0	76.2	0.591	15	90+/-2

Photo 1



Clean cut produced by circularly polarized light.



Ragged cut produced by linearly polarized light.

** Cu-WC is water-cooled copper.*
Contact a II-VI sales representative for exact specifications.

ABSORBING THIN-FILM REFLECTORS (ATFR)

The Absorbing Thin-Film Reflector (ATFR) incorporates a polarization sensitive thin-film reflective coating on a Cu substrate. This coating was initially designed for use at 10.6µm and 45° angle of incidence. The coating will reflect s-polarization and absorb p-polarization; therefore, it must be placed in the beam delivery system where the incident beam is s-polarized.

In cutting applications where the workpiece is highly reflective, reflections from the workpiece can be transmitted back through the beam delivery system into the laser cavity. This is most likely to occur during the initial stages of the cut. These back reflections can cause laser cavity mode and power instabilities. It is also possible for the returned beam to be amplified in the laser cavity and then focused on one of the beam delivery optics, causing damage to that optic.

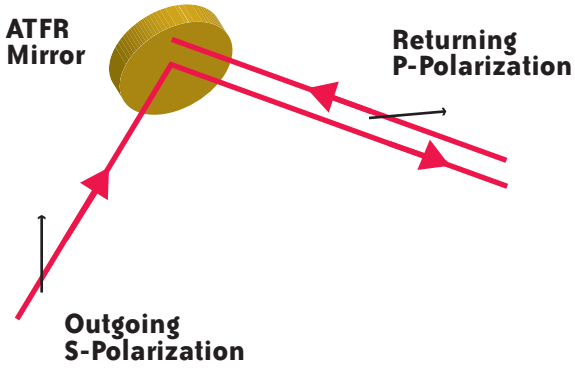
Use of the ATFR in cutting highly reflective metals, such as copper, brass, or aluminum, is especially important since these materials are highly reflective. The beam delivery systems used for cutting applications convert the linear polarization to circular polarization by means of reflective phase retarders (RPR). In this type of beam delivery system, reflected energy from the workpiece is converted back to linear polarization by the RPR. The plane of the reflected linear polarization is rotated 90° to the outgoing linear polarized laser beam. If one of the mirrors in the beam delivery system is oriented so that the outgoing laser beam is s-polarized, then the back reflected energy must be p-polarized at this mirror.

The property of the ATFR that makes it an ideal mirror for preventing unwanted reflections from reaching the laser cavity is its absorption of the reflected p-polarized laser beam.

Specifications	Standards
Reflectivity @ 10.6µm, 45° AOI	≥ 99.0% (S-pol) ≤ 1.5% (P-pol)
Reflectivity @ 0.6328µm, 45° AOI	≥ 80.0% (R-pol)
Angle of Incidence	S-pol: 45° P-pol: 45°

Spectral Performance for other wavelengths

Wavelength (µm)	Reflectivity @ 45° AOI	
	S-pol	P-pol
10.24	≥ 98.5%	≤ 3.0%
9.55	≥ 98.5%	≤ 3.0%
9.38	≥ 98.5%	≤ 3.0%
9.28	≥ 98.5%	≤ 3.0%
9.15	≥ 98.5%	≤ 3.0%



Part #	Description	Diameter inches	Diameter (mm)	Thickness inches	Thickness (mm)
682239	Cu	1.5	38.1	0.16	4.06
432326	Cu	1.969	50.0	0.394	10.0
160586	Cu	2.0	50.8	0.375	9.53
504774	Cu	2.25	57.15	1.25	31.75
728695	Cu	2.362	60.0	0.591	15.0
255328	Cu	3.0	76.2	0.50	12.7

Contact a II-VI sales representative for exact specifications.

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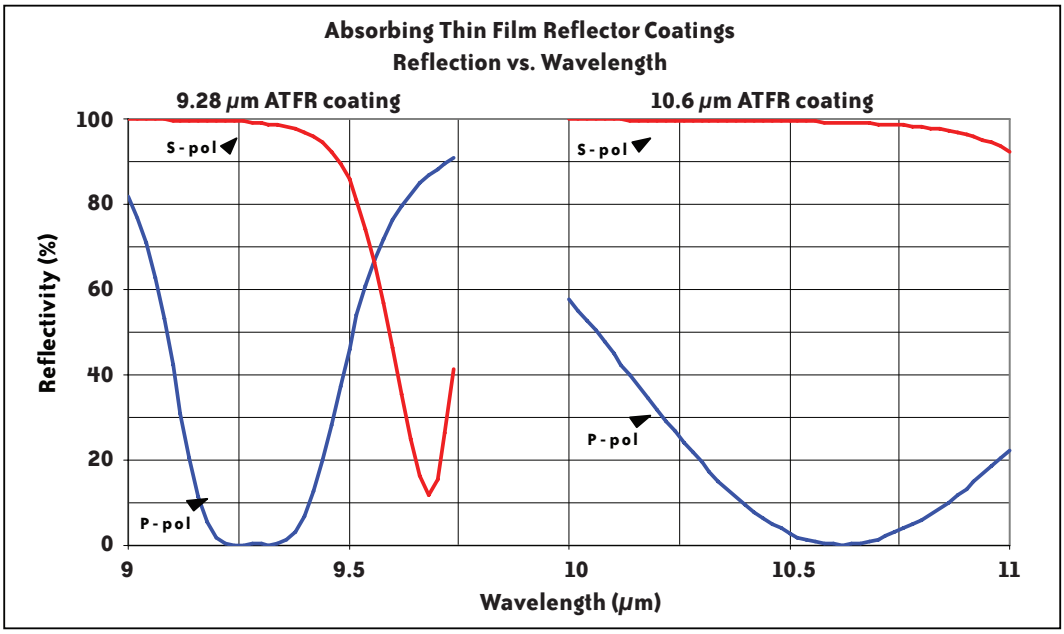
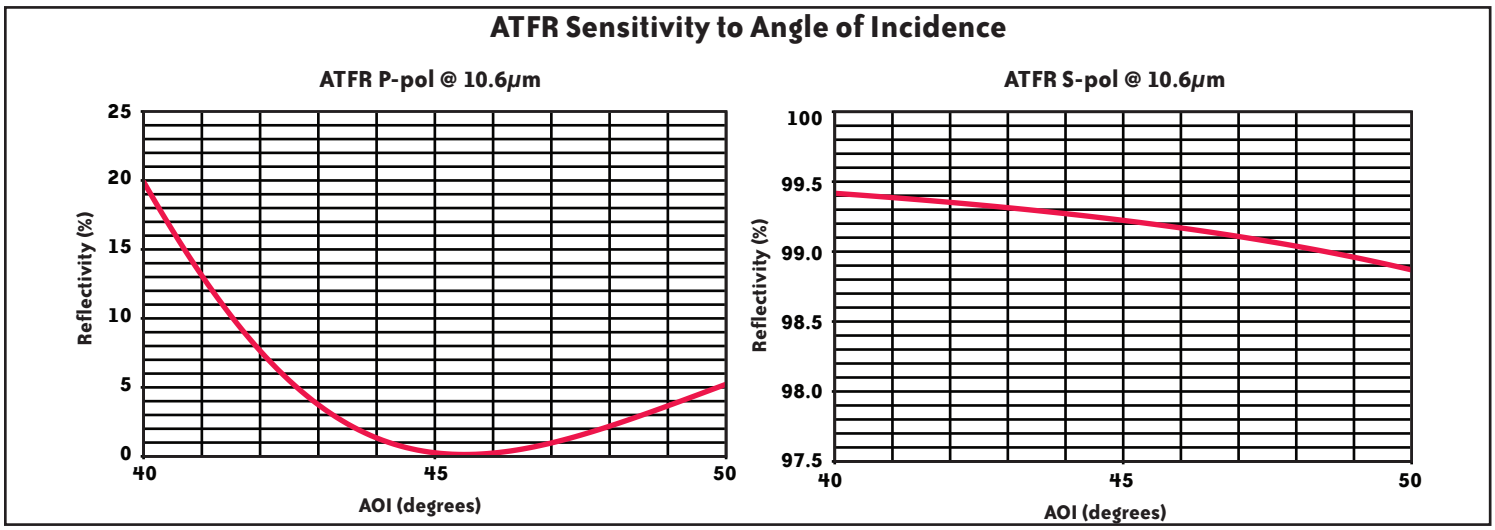

Absorbing Thin Film Reflector Coatings
Reflection vs. Wavelength
9.28 μm ATFR coating
10.6 μm ATFR coating
S-pol
P-pol
S-pol
P-pol
Reflectivity (%)
100
80
60
40
20
0
9
9.5
10
10.5
11
Wavelength (μm)


ATFR Sensitivity to Angle of Incidence
ATFR P-pol @ 10.6μm
Reflectivity (%)
25
20
15
10
5
0
40
45
50
AOI (degrees)
ATFR S-pol @ 10.6μm
Reflectivity (%)
100
99.5
99.0
98.5
98.0
97.5
40
45
50
AOI (degrees)

IR OPTICS HANDLING & CLEANING

Great care should be taken when handling infrared optics. Please note the following precautions:

1. Always wear powder-free finger cots or rubber/latex gloves when handling optics. Dirt and oil from the skin can severely contaminate optics, causing a major degradation in performance.

2. Do not use any tools to manipulate optics —— this includes tweezers or picks.

3. Always place optics on supplied lens tissue for protection.

4. Never place optics on a hard or rough surface. Infrared optics can be easily scratched.

5. Bare gold or bare copper should never be cleaned or touched.

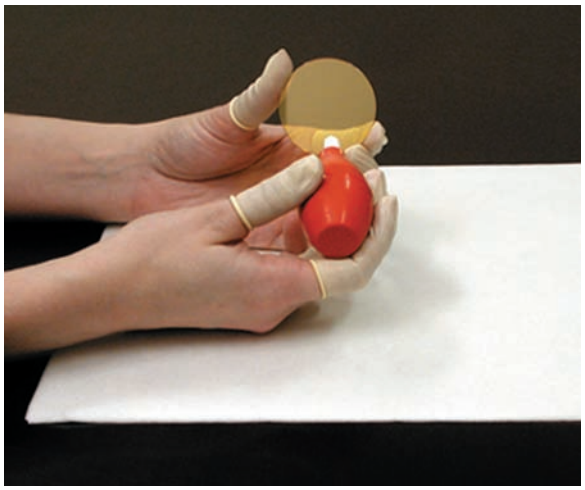
6. All materials used for infrared optics are fragile, whether single crystal or polycrystalline, large or fine grained. They are not as strong as glass and will not withstand procedures normally used on glass optics.

Due to the problems encountered when cleaning mounted optics, it is recommended that the cleaning procedures described here be performed only on unmounted optics. If cleaning must be performed on a mounted optic, refer to the instructions printed in italics and in brackets [ ]. These are additional steps that must be performed when cleaning mounted optics.

Note

Except for Step 1 and Step 2, the cleaning procedures described here should not be used for new optics. New optics are cleaned and packaged prior to leaving II-VI to ensure their high quality condition upon receipt. If you suspect a problem with contamination, or other cosmetic defects with a new optic, please contact II-VI Infrared immediately.

Step 1 - Mild Cleaning for Light Contamination (dust, lint particles)



Use an air bulb to blow off any loose contaminants from the optic surface before proceeding to the cleaning steps. If this step does not remove the contamination, continue to Step 2.

Note:
Avoid using shop air lines because they usually contain significant amounts of oil and water. These contaminants can form detrimental absorbing films on optical surfaces.

[*No additional steps necessary for mounted optics.*]

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Step 2 - Mild Cleaning for Light Contamination (smudges, fingerprints)

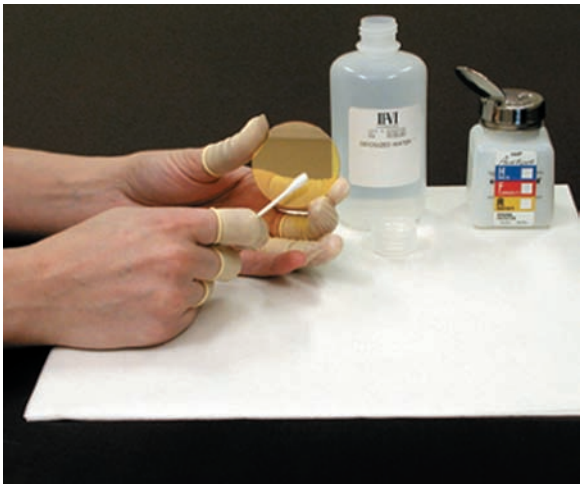
Dampen an unused cotton swab or a cotton ball with acetone or isopropyl alcohol. Gently wipe the surface with the damp cotton. Do not rub hard. Drag the cotton across the surface just fast enough so that the liquid evaporates right behind the cotton. This should leave no streaks. If this step does not remove the contamination, continue to Step 3.

Note:
Use only paper-bodied 100% cotton swabs and high-quality surgical cotton balls.

HPLC (low water content) or reagent grade acetone and isopropyl alcohol are recommended.

[*No additional steps necessary for mounted optics.*]

Step 3 - Moderate Cleaning for Moderate Contamination (spittle, oils)



Dampen an unused cotton swab or cotton ball with white distilled vinegar. Using light pressure, wipe the optic's surface with the damp cotton. Wipe excess distilled vinegar with a clean dry cotton swab. Immediately dampen a cotton swab or cotton ball with acetone. Gently wipe the optic's surface to remove any acetic acid. If this step does not remove the contamination, continue to Step 4.

Note:
Use only paper-bodied 100% cotton swabs.

Use only high-quality surgical cotton balls that have been sorted to remove any with embedded abrasives.

White distilled vinegar with a 6% acetic acid content should be used.

[*No additional steps necessary for mounted optics.*]

NOTES

IR OPTICS HANDLING & CLEANING

Step 4 - Aggressive Cleaning for Severely Contaminated Optics (splatter)

Caution: Step 4 should NEVER be performed on new or unused laser optics. These steps are to be done only on optics that have become severely contaminated from use and have no acceptable results yielded from Steps 2 or 3 as previously noted.

If the thin-film coating is removed, the optic's performance will be destroyed. A change in apparent color indicates the removal of the thin-film coating.

For severely contaminated and dirty optics, an optical polishing compound may need to be used to remove the absorbing contamination film from the optic.

A.
Shake the container of polish thoroughly before opening. Pour four or five drops of polish onto a cotton ball. Gently move the cotton ball in circular patterns across the surface to be cleaned. **Do not press down on the cotton ball!** Let the cotton ball drag lightly across the surface under its own weight. If too much pressure is applied, the polish will quickly scratch the optic's surface. Rotate the optic frequently to avoid excessive polishing in any one direction. Clean the optic in this manner for no more than 30 seconds. If, at any time during this step, you notice the optic's surface change color, stop polishing immediately. This color change indicates that the outer portion of the thin-film coating is being eroded.

[*For a mounted optic, a fluffed cotton swab may have to be substituted for the cotton ball if the entire optic's surface is to be uniformly cleaned. This is especially true with small diameter optics. Be careful not to apply pressure when using a cotton swab!*

For a fluffed cotton swab, take the unused cotton swab and rub it back and forth on a soft piece of foam that is free of foreign particles.]

B.
After using the polish, wet an unused cotton ball with distilled water and gently swab the optic's surface. Thoroughly wet the surface to remove as much of the polish residue as possible. **Do not let the optic's surface dry!** This will make the remaining polish removal much more difficult.

[*For a mounted optic, a fluffed cotton swab may be substituted. Try to remove as much polish residue as possible, especially near the mount's edges.*]

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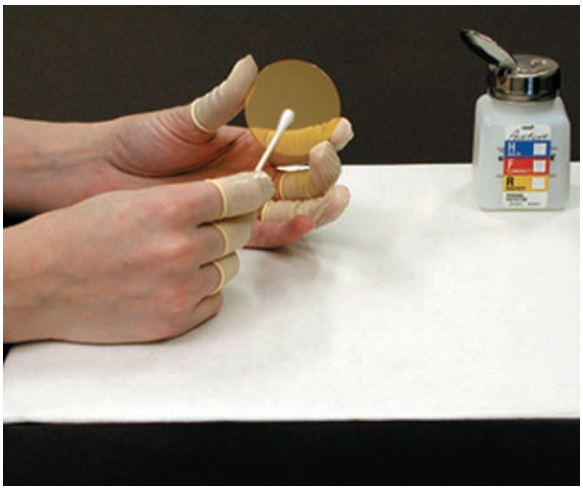
Step 4 (continued) - Aggressive Cleaning for Severely Contaminated Optics (splatter)

C.
Quickly wet a fluffed cotton swab with isopropyl alcohol and gently clean the optic surface thoroughly. Cover the entire surface with the swab to dislodge as much polish residue as possible.

NOTE:
If the optic is 2.00" or larger, a cotton ball may be substituted for the cotton swab in this step.

[*For a mounted optic, place the cotton swab in the optic's center and clean outwards in a spiral motion toward the optic's edges.*]



D.
Wet a fluffed cotton swab with acetone and clean the optic's surface, removing any remaining isopropyl alcohol and polish residue in the process. When performing the final cleaning with acetone, lightly drag the cotton swab across the optic, overlapping strokes until the entire surface has been wiped. Move the swab very slowly for the final strokes to assure that the acetone on the optic's surface dries immediately behind the swab. This will eliminate streaks on the surface.

[*For a mounted optic, start in the optic's center and work outward in a spiral pattern toward the edge with a fluffed swab dampened with acetone. Use a new cotton swab dampened with acetone and run it around the outside of the optic against the mount to remove the polish residue. Repeat this step several times if necessary to assure that no polish residue is left on the optic's edges when the cotton swab is lifted from the surface.*]

[*For a mounted optic, it may be impossible to remove every trace of residue from the surface, especially near the outer edge. Try to be certain any remaining residue is along the optic's outermost edge only, and not in the center.*]

NOTES

IR OPTICS HANDLING & CLEANING

The final step is to carefully examine the optic's surface under good light in front of a black background. Any visible polish residue should be removed by repeating steps 4B-4D as many times as required.

NOTE:
Contamination and damage types, such as metal splatter, pits, etc., cannot be removed. If the optic shows the contamination or damage mentioned, it will probably need to be replaced.

NOTES

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CO_2 LASER OPTICS CLEANING KIT

CO_2 Laser Optics Cleaning Kit (p/n 911466)

To prolong the life of a CO_2 laser optic, proper handling and cleaning is vital. However, as these optics are not as scratch resistant as glass, special procedures must be used in their cleaning and care.

II-VI Infrared's CO_2 Laser Optics Cleaning Kit (p/n 911466) is designed to meet these special care requirements. Contents include:

1) **Plastic carrying case with foam inserts**
1) **Laminated instruction sheet**
1) **250 ml bottle of 0.1 micron polish**
1) **250 ml bottle of deionized water**
1) **MSDS sheet**
1) **Air bulb**
1) **Bag of cotton balls (130 count)**
1) **Box of Q-Tips® cotton swabs (170 count)**
1) **Bag of lens tissue (approx. 25 count)**
1) **Package of finger cots (20 count)**
2) **4 oz. acetone & propanol dispensers**
   NOTE: acetone & propanol not included

Lens Cleaning Refill Kit (p/n 881308)

A Lens Cleaning Refill Kit (p/n 881308) is also available. Contents include:

1) **250 ml bottle of 0.1 micron polish**
1) **250 ml bottle of deionized water**
1) **MSDS sheet**
1) **Bag of cotton balls (100 count)**
1) **Box of Q-Tips® cotton swabs (170 count)**
1) **Bag of lens tissue (approx. 25 count)**
1) **Package of finger cots (20 count)**

The polish (p/n 787388) is also available separately:

1) **250 ml bottle of 0.1 micron polish**

ABSORPTION

Laser Optics and Absorption's Dominant Role

Since its beginning in 1971, II-VI has played a key role in developing optical materials and coatings that enabled the CO_2 laser to emerge into a leading technology for materials processing, and for applications in fields as diverse as laser surgery, laser imaging, target acquisition, and surveillance.

CO_2 laser technology advancements allowed lasers — with power levels exceeding 1 kW — to develop in the early 1970s. The corresponding need in understanding optical materials and optical coatings was evident.

High-power infrared lasers performance, including high-energy density waveguide lasers, depends heavily upon the absorption control levels in optical substrates, their thin-film coatings, and interfaces. II-VI is the leader in infrared laser optics technology.

II-VI Infrared's MP-5® ultra-low absorption lens

Absorption in Laser Optics

Contamination due to foreign materials on the optic's surface includes dust, oil, grease, fingerprints, and hydrocarbons. These contaminants, if deposited on the optic's surface, may lead to absorption and shorten optic lifespans and efficiency.

Localized heating, caused by contamination, can lead to "thermal runaway" in high-power laser optics. High temperatures create an increase in free carriers within the bulk material which increases absorption. This process reaches an avalanche state, and thermal runaway commences at > 50° C for Ge, and > 200° C for ZnSe and GaAs.

Surface imperfections also cause absorption and can include:

- Scratches
- Pits or digs
- Imbedded polishing abrasives
- Pinholes in coatings
- Inclusions in coatings

These surface defects act as damage sites which suffer degradation due to intense perturbations in the electric field surrounding the sites.

Factors Affecting Absorption

- **Substrate bulk absorption**
- **Coating absorption**
- **Surface contamination**
- **Surface deterioration**

Is Your Lens Stressed?
Or does it just need cleaned?

See p. 22 for information on our Lens Stress Analyzer, and learn how to find out!

Absorption Effects in CO_2 Lasers

The CO_2 wavelength absorption level coupled with the optic thermal conduction characteristics and its mount are important in determining the laser system's performance and optic's lifespan.

While the source and control of factors contributing to absorption are complex, the results are clear and include:

- Decreased output power
- Fluctuations in output power
- Mode instability
- Focal point drifting
- Coating failures
- External cavity optics failures (due to output coupler thermal lensing or beam delivery system contamination)

All these failure mechanisms are the result of thermal lensing (the actual change of an optic's physical characteristics due to absorption). The thermal lensing effect on the beam mode is increased further by a change in the material's refractive index due to temperature. This latter and more significant effect induces additional optical distortion in the transmitted beam.

Testing to Ensure Low Absorptivity

II-VI was the first IR optics manufacturer to establish a laser vacuum calorimetry test facility for measuring absorption in commercial CO_2 laser optics.

In laser calorimetry, optic samples are mounted in a vacuum for thermal isolation. The sample is then irradiated with a CO_2 laser beam, while thermocouples monitor the sample temperature rise. The laser beam is then turned off and the sample is cooled. By precisely measuring the sample mass, the laser beam incident power, and the heating and cooling slopes generated during the test, the total sample absorption (as a percentage of incident laser power) is determined.

To maintain the leadership in quality and low-absorption coatings, the laser calorimetry system regularly undergoes calibration testing and refinement by II-VI's technical staff.

Examples of Lens Stress

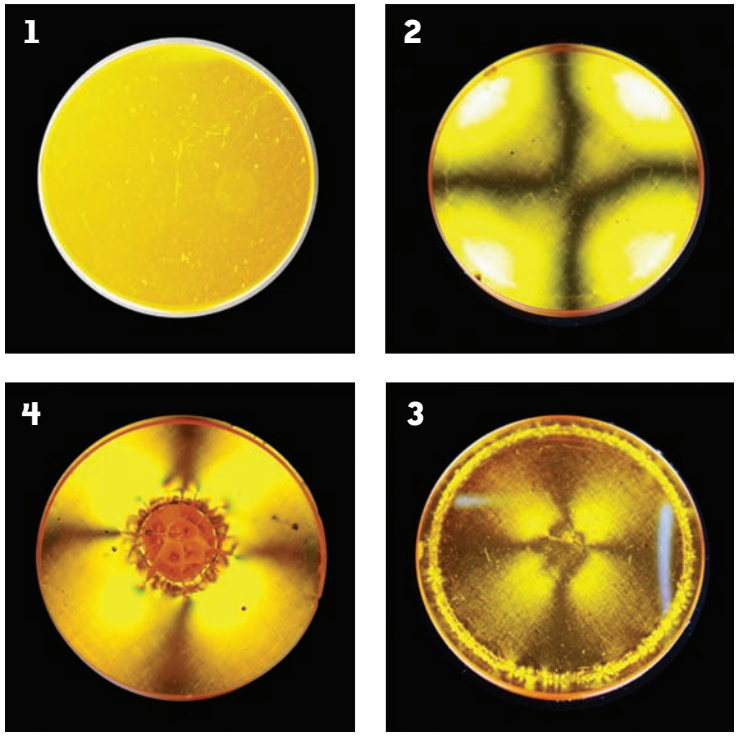
Clockwise from upper left:

1 No apparent stress. May just need cleaned.

2 Moderate stress. Should be replaced.

3 Severe lens stress. Must be replaced to prevent catastrophic lens failure and possible system damage.

4 Catastrophic lens failure and possible system damage.



Note: All images are of optics as seen through II-VI Infrared's Lens Stress Analyzer (LSA).
See p. 22 for details.

LENS STRESS ANALYZER (LSA)

EVEN THE BEST OF LENSES CAN GO BAD. Thermal stress, mechanical stress, and contamination can all cause a lens to fail. When that happens, your business can suffer from costly downtime or, in the event of catastrophic lens failure, even costlier laser system repairs. Conversely, you don't want to discard a perfectly usable lens that may only need to be cleaned to return it to peak performance. The question, then, is how can you determine when a lens is truly in need of replacement?

II-VI Infrared has your answer. Our **NEW, portable Lens Stress Analyzers** enable you to see lens stress before catastrophic lens failure occurs. Or see that an underperforming lens need only be cleaned, rather than discarded. Using a cool-running fluorescent light base and cross-polarizers, our **Lens Stress Analyzers** dramatically show thermal stress, mechanical stress, and contamination that the eye cannot see alone.

For genuine portability, the **Lens Stress Analyzer** can be operated using six AAA batteries. (Batteries not included.) Our **Lens Stress Analyzers** also come standard with 100-240V AC power adapters, and plug adapters for the following:

- North America
- Europe
- Australia
- United Kingdom
- Argentina
- China

Our **Lens Stress Analyzers** will help you keep your laser system running smoothly by showing you when a lens needs only to be cleaned, and when it needs to be replaced.

Contact your II-VI Infrared sales representative and order your **Lens Stress Analyzer** today!

TO LEARN MORE, LOG ONTO: www.iiviinfrared.com/lsa

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NOZZLES & ACCESSORIES

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