

III-VI DEUTSCHLAND

A Global Leader in Engineered
Materials and Optoelectronic Components

Optics for CO₂ Lasers



II-VI DEUTSCHLAND – A SUCCESS STORY

For 40 years II-VI Deutschland GmbH in Weiterstadt, Germany, has been serving its customers in Germany and adjoining countries. The collective experience of many man-years in the field of industrial laser optics means we do not compromise on quality, delivery reliability or thorough technical advice.

Only top-quality optics with the finest production tolerances can satisfy the requirements of modern high per-

formance lasers. Furthermore, our collaboration with reputable research institutes and development departments guarantees you product and application expertise at the very highest technical level.

With production capacity in Europe, the USA and Asia, II-VI is a true global player; diversification of production sites minimises market-related risks.

QUALITY

The reason why we are so successful now in the marketplace is assuredly due to the high quality standards we have set ourselves. Quality is our achievement. Customer service is the measure of all things because we want to create a successful and satisfying commercial relationship with you and maintain it over many years. That is why we are always there for you and are available to help you find a solution to your problems so you can order from us with confidence and will recommend us to your colleagues. Call me! I will deal

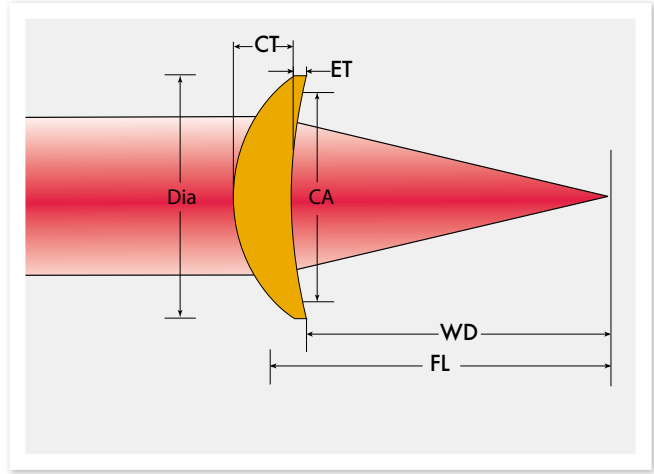
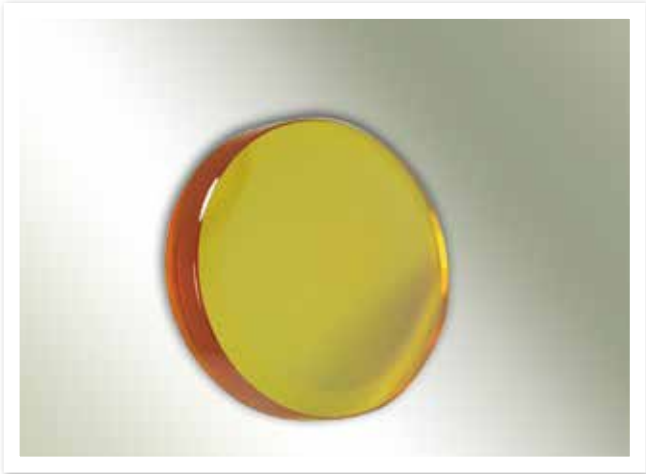
with your request personally because our objective is to show you that you can rely on II-VI Deutschland!



Sincerely
Martin Benzing
Managing Director



ZNSE MENISCUS LENSES



In order to achieve the highest possible power density when cutting with CO₂ lasers, we use meniscus lenses to focus the laser beam. The lens is fitted into the cutter head and also acts as a stopper for the positive pressure region of the cutting gas. The table gives the maximum operating pressure for each lens.

Our lenses are tempered on both sides with an anti-reflective coating (AR) of 10.6 μm as standard. Standard absorption is approx. 0.2% of laser power. **We have the second-generation especially low absorbent coating MP-5 for higher laser output (from 3-4 kW). Absorption typically lies at around ≤0.1%. All optics are delivered in special packaging.**

Technical abbreviations:

- CA: clear aperture, test range
- Dia: diameter
- ET: edge thickness
- FL: focal length
- HP: high pressure
- WD: working distance
- CT: thickness

Technical specifications

	Standard	
Effective focal length		±2% for any focal lengths
Mechanical dimensions	Diameter	+0/-0,13 mm
	Thickness	±0,25 mm
Free aperture (polished)		90% of the diameter
Surface contour accuracy (at 633 nm)	Plano	0,5 – 1 Stripe
	Curvilinear	depending on radius, technical data available on request
Surface quality		Free of scratches and flaws in acc. with S/D

Lenses with other technical data available on request.

All measurements are rounded to 1 or 2 decimal places (1 inch = 25.4 mm).

ZNSE MENISCUS LENSES

ZnSe meniscus lenses with standard AR coating

Diameter mm/inch	Focal length mm/inch	Edge thickness mm	Max. operating pressure bar	Part number
27,9 / 1,1	38,1 / 1,5	2,2	4	51610-5
27,9 / 1,1	63,5 / 2,5	2,2	4	51610-6
27,9 / 1,1	63,5 / 2,5	5,3	24	51610-6HP
27,9 / 1,1	95,3 / 3,75	2,2	4	51610-61
27,9 / 1,1	127,0 / 5,0	2,2	4	51610-7
27,9 / 1,1	127,0 / 5,0	3,0	6	51610-7HP3
27,9 / 1,1	127,0 / 5,0	4,1	11	51610-7HP4
27,9 / 1,1	127,0 / 5,0	5,3	24	51610-7HP
38,1 / 1,5	95,3 / 3,75	6,0	16	51610-80HP6
38,1 / 1,5	95,3 / 3,75	7,4	24	51610-80HP
38,1 / 1,5	127,0 / 5,0	3,0	4	51610-9HP3
38,1 / 1,5	127,0 / 5,0	6,0	16	51610-9HP6
38,1 / 1,5	127,0 / 5,0	7,4	24	51610-9HP
38,1 / 1,5	127,0 / 5,0	9,0	35	51610-90VHP
38,1 / 1,5	190,5 / 7,5	3,0	4	51610-91HP3
38,1 / 1,5	190,5 / 7,5	6,0	16	51610-91HP6
38,1 / 1,5	190,5 / 7,5	7,4	24	51610-91HP
38,1 / 1,5	190,5 / 7,5	9,0	35	51610-92VHP
38,1 / 1,5	225,0 / 9,0	7,4	24	51610-95HP
38,1 / 1,5	254,0 / 10,0	7,4	24	51610-10HP
50,8 / 2,0	127,0 / 5,0	9,7	24	52450-025
50,8 / 2,0	190,5 / 7,5	9,7	24	52450-026
50,8 / 2,0	254,0 / 10,0	9,7	24	52450-027

Lenses with other technical data available on request.

All measurements are rounded to 1 or 2 decimal places (1 inch = 25.4 mm).

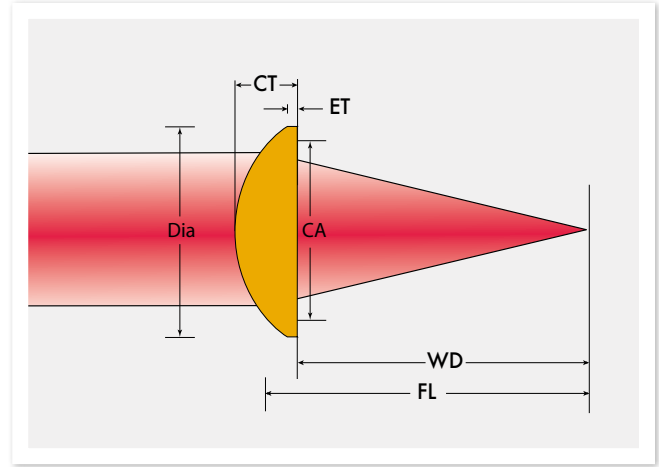
ZnSe meniscus lenses with MP-5 coating

Diameter mm/inch	Focal length mm/inch	Edge thickness mm	Max. operating pressure bar	Part number
38,1 / 1,5	127,0 / 5,0	7,4	24	51610-9HP-MP5
38,1 / 1,5	127,0 / 5,0	9,0	35	51610-90VHP-MP5
38,1 / 1,5	190,5 / 7,5	3,0	4	51610-91HP3-MP5
38,1 / 1,5	190,5 / 7,5	7,4	24	51610-91HP-MP5
38,1 / 1,5	190,5 / 7,5	9,0	35	51610-92VHP-MP5
38,1 / 1,5	225,0 / 9,0	7,4	24	51610-95HP-MP5

Lenses with other technical data available on request.

All measurements are rounded to 1 or 2 decimal places (1 inch = 25.4 mm).

ZNSE PLANO-CONVEX LENSES



Plano-convex lenses are used when the diameter of the focal point is not critical. Applications include cutting, welding and heat treatment of a wide range of media. The lens is fitted into the cutter head and also acts as a stopper for the positive pressure region of the cutting gas. The table shows the maximum operating pressure for each lens

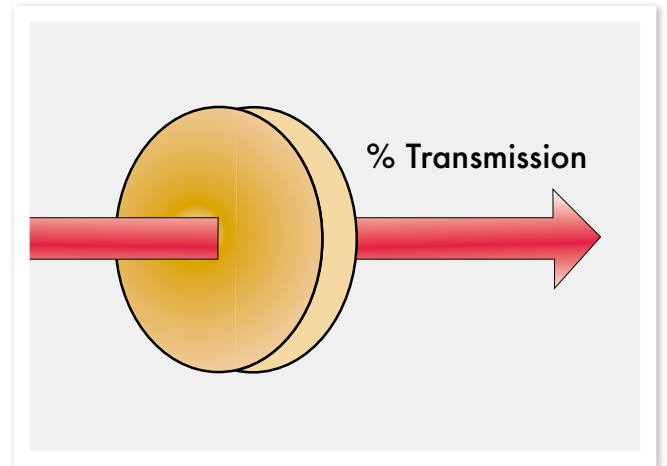
Our lenses are coated on both sides with an anti reflective coating (AR) of 10.6 μm . Standard absorption is approx. 0.2% of the laser power. **For higher laser powers (from 3-4 kW), we recommend the second generation special low absorbing coating MP-5. Absorption typically lies at $\leq 0.1\%$. All optics are delivered in special packaging.**

Standard lenses with AR coating (MP-5 coating)

Diameter mm/inch	Focal length mm/inch	Edge thickness mm	Max. operating pressure bar	Part number
38,1/1,5	127,0/5,0	7,4	25	51600-11HP
38,1/1,5	127,0/5,0	7,6	26	51600-11HP7
38,1/1,5	127,0/5,0	7,9	27	51600-11HP8
38,1/1,5	190,5/7,5	7,4	25	51600-111HP
38,1/1,5	190,5/7,5	7,6	26	51600-111HP7
38,1/1,5	190,5/7,5	7,9	27	51600-111HP8
50,8/2,0	127,0/5,0	7,6	15	51600-12HP7
50,8/2,0	127,0/5,0	7,9	16	51600-12HP8
50,8/2,0	127,0/5,0	9,7	24	51600-12HP
50,8/2,0	190,5/7,5	7,6	15	51600-122HP7
50,8/2,0	190,5/7,5	7,9	16	51600-122HP8
50,8/2,0	190,5/7,5	7,9	16	51600-122HP8-MP5
50,8/2,0	190,5/7,5	9,7	24	51600-122HP

Further lenses with MP-5 coating available on request. We will be happy to advise you.
All measurements are rounded to 1 or 2 decimal places (1 inch = 25.4 mm).

ZNSE WINDOWS



When processing material splashes often occur off the workpiece being processed.

In order to protect the valuable cutting or welding lens, protective windows of ZnSe are used since these can be replaced more easily, because no adjustment is necessary.

Our lenses are coated on both sides with an anti-reflective coating (AR) of 10.6 μm . Standard absorption is approx. 0.2% of the laser power. **For higher laser powers (from 3-4 kW), we recommend the second generation special low absorbing coating MP-5. Absorption typically lies at $\leq 0.1\%$. All optics are delivered in special packaging.**

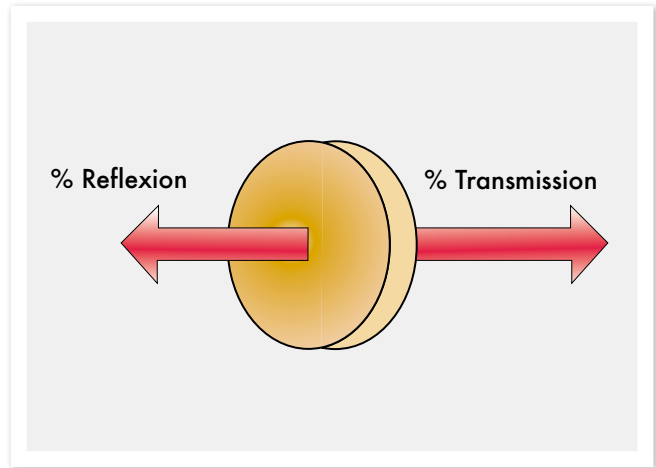
Standard windows

Diameter mm/inch	Edge thickness mm	Part number
12,7/0,5	2,0	51630-2
25,4/1,0	3,1	51630-5
27,9/1,1	3,1	51630-6
38,1/1,5	3,1	51630-7
38,1/1,5	6,0	51630-70
50,0/2,0	10,0	51630-8510
50,8/2,0	5,1	515630-8
63,5/2,5	6,4	51630-9
63,5/2,5	8,9	51630-908
88,9/3,5	6,4	51630-35

Lenses with other technical data available on request. We will be happy to advise you.

All measurements are rounded to 1 or 2 decimal places (1 inch = 25.4 mm).

PARTIAL REFLECTORS AND END REFLECTORS



Partial reflector windows and end reflectors determine the optical quality of the laser resonator and are used to create and/or control laser energy on the workpiece.

There are numerous combinations possible regarding material, dimensions and coating. Only the standard models are listed below.

We will be happy to advise you about other specifications or technical questions.

Substrate material:

- ZnSe : Zinc selenide
- GaAs: Gallium arsenide
- Ge: Germanium

Surfaces (examples):

- S1- po (side 1 - plano)
- S1- 5mcc (side 1 - radius 5 m concave)
- S1-10mcc (side 1 - radius 10 m convex)

The coatings determine the ratio between reflected and transmitted laser output. One side of the lens is coated with a partial reflective (PR) coating and the other side with an anti-reflective (AR) coating.

GaAs end reflector

Diameter mm/inch	side 1 shape-reflectivity	side 2 shape-coating	Edge thickness mm	Part number
25,4/1,0	10mcc-99,5%	plan-AR	3,0	51745-51
25,4/1,0	30mcc-99,5%	plan-AR	6,0	51745-43
25,4/1,0	30mcc-99,7%	plan-AR	6,0	51745-44
25,4/1,0	20mcc-99,7%	plan-AR	6,0	51745-421

PARTIAL REFLECTORS AND END REFLECTORS

ZnSe partial reflector window

Diameter mm/inch	side 1 shape-reflectivity	side 2 shape-coating	Edge thickness mm	Part number
25,4/1,0	15mcc-50%	7mcc-AR	3,0	51641-43
25,4/1,0	30mcc-65%	30mcx-AR	6,0	51641-44M
25,4/1,0	plan-50%	plan-AR	6,0	51641-45
24,4/1,0	plan-60%	plan-AR	6,0	51641-46
25,4/1,0	30mcc-65%	30mcx-AR	6,0	51642-41
30,0/1,2	30mcc-58%	30mcx-AR	6,0	51641-8-58
30,0/1,2	30mcc-MP-5-50%	30mcx-MP-5-AR	6,0	51641-8-50
38,1/1,5	plan-40%	plan-AR	3,1	51641-7
38,1/1,5	plan-70%	plan-AR	3,1	51642-7
38,1/1,5	plan-90%	plan-AR	3,1	51643-7
38,1/1,5	plan-99%	plan-AR	3,1	51644-7
38,1/1,5	20mcc-57%	12mcx-AR	5,1	51641-70
38,1/1,5	30mcc-40%	30mcx-AR	6,0	51641-78
42,0/1,65	30mcc-40%	30mcx-AR	6,0	51641-82
50,8/2,0	plan-40%	plan-AR	5,1	51641-8
50,8/2,0	plan-70%	plan-AR	5,1	51642-8
50,8/2,0	plan-90%	plan-AR	5,1	51643-8
50,8/2,0	plan-99%	plan-AR	5,1	51644-8
50,8/2,0	30mcc-MP-5-48%	30mcx-MP-5-AR	7,6	51641-8-48G
50,8/2,0	30mcc-MP-5-48%	20mcx-MP-5-AR	7,6	51641-8-49G

Ge end reflector

Diameter mm/inch	side 1 shape-reflectivity	side 2 shape-coating	Edge thickness mm	Part number
25,4/1,0	15mcc-99,5%	plan-AR	6,0	51845-31
25,4/1,0	20mcc-99,5%	plan-AR	3,0	51845-36
25,4/1,0	15mcc-99,6%	plan-AR	6,0	51845-311
30,0/1,2	30mcc-99,7%	plan-AR	6,0	51845-381
30,0/1,2	15mcc-99,6%	plan-AR	6,0	51845-382

Reflectors with other technical data available on request.

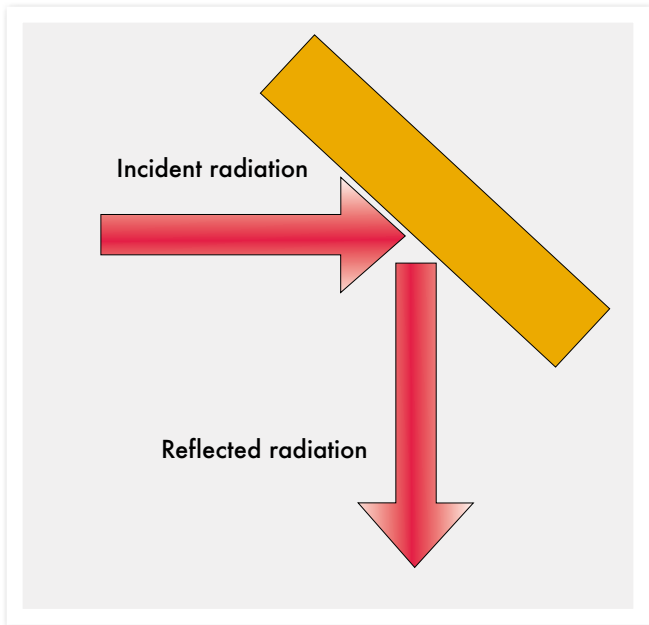
All measurements are rounded to 1 or 2 decimal places. (1 inch = 25.4 mm).

REFLECTORS

PASSIVE REFLECTOR WITH OPTIMISED REFLECTIVITY FOR LASER RESONATORS AND BEAM CONTROL



NB: Copper surfaces without a protective layer will oxidise very quickly when exposed to air



The reflectors inside a CO₂ laser are designated differently depending on their location and application. Inside the resonator they are called folding mirrors, partial reflectors or rear mirrors. In the beam path, outside the resonator, they are also called passive reflectors, deflection reflectors or in general optical beam guidance. However, their characteristics are always the same: optimised reflection with low energy loss.

Silicon, copper and molybdenum (uncoated) are used predominantly as substrate material. With a highly reflective coating, silicon is resistant to high laser power and thermally stable, while copper has high heat conductivity.

The following coatings are used by industry as standard:

HIGHLY REFLECTIVE METAL-BASED COATING ON SI AND CU

(MMR – Maximum Metal Reflector)

This dielectric coating has high reflectivity of >99.7% with 10.6 μm and hence satisfies the highest requirements with regard to the lowest possible loss of energy with high laser power.

UNCOATED SUBSTRATE

Copper or molybdenum without an increased reflectivity coating have a reflection of c. 98 % and are used in laser systems where the very highest reflection values are not required.

Molybdenum coatings available on request.

REFLECTORS

Silicon plano reflector

Diameter mm/inch	Thickness mm	Part number EG coating	Part number MMR coating
12,7/0,5	2,0	51310-2EG	51310-2MMR
25,4/1,0	3,1	51310-4EG	51310-4MMR
27,9/1,1	3,1	51310-5EG	51310-5MMR
27,9/1,1	5,0	51310-6EG	51610-6MMR
38,1/1,5	4,1	51300-75EG	51310-7MMR
38,1/1,5	9,5	-	51310-7MMR-2
44,5/1,75	4,1	51310-8EG	51310-8MMR
50,8/2,0	5,1	51300-9EG	51310-9MMR
76,2/3,0	6,4	51310-10EG	51310-10MMR

Copper plano reflector

Diameter mm/inch	Thickness mm	Part number uncoated	Part number EG coating	Part number MMR coating
25,4/1,0	6,4	51450-0	51410-0EG	51410-0MMR
38,1/1,5	6,4	51450-1	51410-1EG	51410-1MMR
50,0/1,97	10,0	51450-2UC50	51410-2EG50	51410-2MMR50
50,0/1,97	25,0	-	52641-25	52641-26
50,8/2,0	9,5	51450-2	51410-2EG	51410-2MMR
50,8/2,0	54,0	-	52641-54	51410-2MMR505
63,5/2,5	9,5	51450-21	51410-21EG	51410-21MMR
76,2/3,0	12,7	51450-3	51410-3EG	51410-3MMR
101,6/4,0	19,1	51450-4	51410-4EG	51410-4MMR

Molybdenum plano reflector

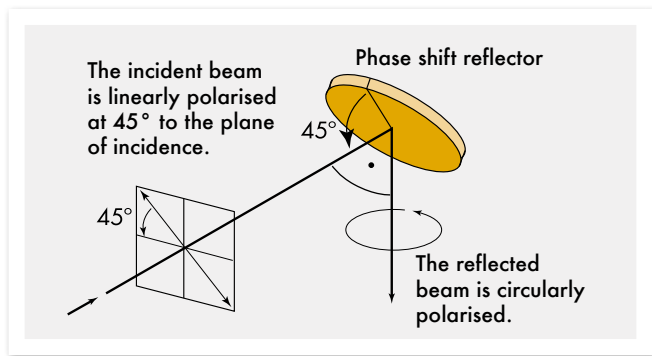
Diameter mm/inch	Thickness mm	Part number uncoated
25,0/0,98	6,0	552001
38,0/1,5	6,0	552011
50,0/1,97	6,0	552002
50,0/1,97	10,0	552002-10

Reflectors with other technical data, e.g. integrated cooling or curvature radii are available on request.

All measurements are rounded to 1 or 2 decimal places (1 inch = 25.4 mm).

REFLECTORS

90° REFLECTIVE PHASE RETARDER (RPR)



When CO₂-Laser cutting with linearly polarised radiation Beams, the results are different depending on the direction of cut. Therefore a circularly polarised beam is used for cutting contours.

Circularly polarised light results when a reflective phase retarder (RPR) is used with 90° ($\lambda/4$) angular phase shift. A linearly polarised laser beam uncoupled from the resonator must be tilted 45° to the plane of incidence (see image).

The standard reflectivity for RPRs is >98% at 10.6 μm . In addition, highly reflective phase shift reflectors (HRPR) are available with a reflectivity of $R > 99\%$ at 10.6 μm . Both types of reflection layers have a standard tolerance of $\pm 6^\circ$ phase shift.

Small tolerances up to $\pm 1^\circ$ are available on request.

Silicon 90° reflective phase retarder

Diameter mm/inch	Thickness mm	Part number RPR ($\geq 98\%$)	Part number HRPR ($\geq 99\%$)
25,4/1,0	3,1	51320-0	51320-0H
27,9/1,1	3,1	51320-1	51320-1H
38,1/1,5	4,1	51320-2	51320-2H
44,5/1,75	4,1	51320-3	51320-3H
50,8/2,0	5,1	51320-4	51320-4H
50,8/2,0	10,2	51320-40	51320-40H
68,0/2,6	20,3	51320-45	51320-45H
76,2/3,0	6,4	51320-5	51320-5H

Copper 90° reflective phase retarder

Diameter mm/inch	Thickness mm	Part number RPR ($\geq 98\%$)	Part number HRPR ($\geq 99\%$)
25,4/1,0	6,4	51420-0	51420-0H
38,1/1,5	6,4	51420-2	51420-2H
50,0/1,97	10,0	51420-4501	51420-4501H
50,0/1,97	25,0	51420-4502	51420-4502H
50,8/2,0	54,0	52641-58	52641-57
75,0/2,9	17,0	51420-4817	51420-4817H
76,2/3,0	12,7	51420-5	51420-5H
76,2/3,0	19,1	51420-50	51420-50H

REFLECTORS

ZERO PHASE SHIFT TOTAL REFLECTOR (TRZ)

The quality of CO₂ laser beam cutters is highly dependent on a defined polarisation of the laser beam along the whole beam control optics.

Silicon zero phase shift total reflectors

Diameter mm/inch	Thickness mm	Part number TRZ (≥99,5%)
25,4/1,0	3,1	51315-4
27,9/1,1	3,1	51315-5
38,1/1,5	4,1	51315-7
44,5/1,75	4,1	51315-8
50,0/1,97	5,1	51315-85
50,8/2,0	5,1	51315-9
63,5/2,5	6,4	51315-91
68,0/2,6	20,3	51315-900
76,2/3,0	6,4	51315-10

Copper zero phase shift total reflector

Diameter mm/inch	Thickness mm	Part number TRZ (≥99,5%)
25,4/1,0	6,4	51415-0
50,8/2,0	9,5	51415-2
50,8/2,0	10,0	51415-20
50,8/2,0	25,0	51415-2TRZ
50,8/2,0	54,0	52641-56
63,5/2,5	9,5	51415-21
75,0/2,9	17,0	51415-75
76,2/3,0	12,7	51415-3
101,6/4,0	19,1	51415-4

ATFR REFLECTOR

In addition to reflectors optimised for reflectivity, zero phase shift reflectors (TRZ) are used with increa-



sing frequency as passive reflectors in beam control systems. The high reflectivity ($R > 99,5\%$) with a minimised phase shift of $< 2^\circ$ guarantees optimum cutting results.

ATFR reflectors (Absorbing Thin Film Reflector) are used to avoid reflection caused by highly reflective metals (e.g. copper, aluminium, brass, etc.).

Reflections can cause instability in the laser. Coatings for ATFR reflectors reflect incident S-polarised laser light. The P-polarised laser light reflected by the workpiece is absorbed. Copper ATFR reflectors are designed for laser output of ≤ 10 kW.

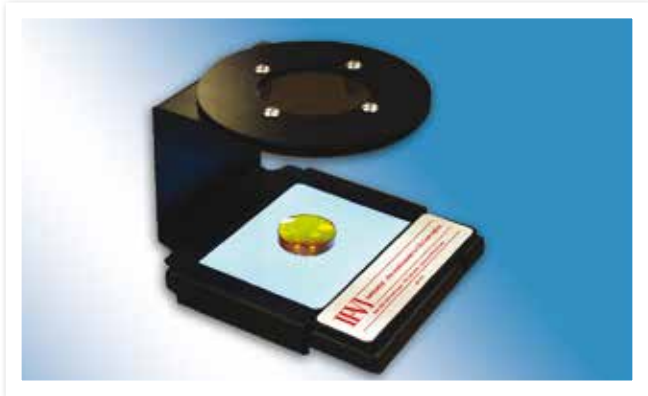
Copper ATFR reflector

Diameter mm/inch	Thickness mm	Part number TRZ (≥99,5%)
50,0/1,97	10,0	51675-91
50,8/2,0	9,5	51675-9
76,2/3,0	12,7	51675-10

Reflectors with other technical data or cooling systems available on request. All dimensions are rounded to 1 or 2 decimal places. (1 inch = 25.4 mm).

TESTING AND CLEANING CO₂ LENSES

LENS TESTER (LSA)



Part number 51000-LSA

Thermal stress, mechanical stress (also caused by incorrect mounting of the lens) and dirt can result in a lens cutting badly and reduced optical quality. This can lead to long downtimes or even costly repairs to the laser itself.

The portable lens tester (LSA) allows you to determine quickly and easily whether a lens simply needs cleaning or whether it has to be disposed of properly.

A cold cathode-fluorescent light source and polarisation are used by the LSA to make the different types of stress in a ZnSe lens visible.

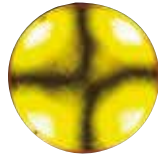
The LSA is easy to use and is powered by 6 AAA batteries (not supplied).

- For fast and reliable testing of your ZnSe lenses, windows and partial reflectors.
- Different types of stress become visible and can be identified easily.
- The lens tester is much easier to use compared with individual polarisation films.
- Results can be documented at any time with a photograph

EXAMPLES



No visible stress.
Only cleaning is required.



Medium stress.
Must be replaced.



High stress.
Lens must be replaced
to prevent damage to
the system.

LENS CLEANING MOUNT



Part number 51000-CT

TESTING AND CLEANING CO₂ LENSES

CLEANING CO₂ CUTTER LENSES



Industrial laser beam cutting technology requires laser optics optimised for the wavelength range of 10.6 μm and which ensure constant process conditions. The slightest rise in temperature through absorption can cause changes in focussing conditions. The slightest oscillation of the raw beam diameter or divergence

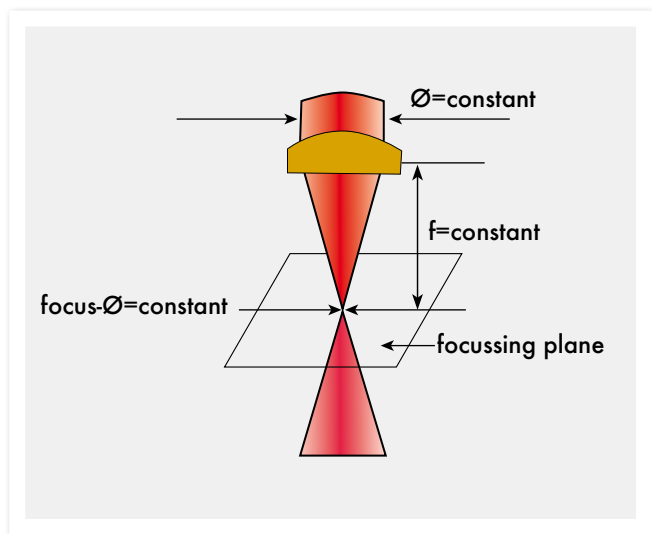
of the laser beam will cause variations in the focus diameter and the power spectral density of the laser beam attainable in the focal point.

Even the objective of maintaining identical focussing conditions for a constant raw beam is often difficult to achieve.

Regular checks and cleaning of all optical elements in the beam control, especially the focus lens, will extend the service life of the optical components dramatically and will aid process stability.

Depending on the laser power and certain operating temperature, dirty lenses can shift the focussing plane. Heavily damaged and very dirty lenses can cause a focus drift of several millimetres.

Maintaining constant cutting quality is difficult. Improve your laser quality with clean lens surfaces.



We will be happy to send you laminated cleaning instructions so you can keep them ready to hand by your laser system.

TERMINOLOGY: ABBREVIATIONS FOR LASER LENSES

High performance laser lenses sold in Germany are often described using bewildering abbreviations, mostly from America. To make life easier, we have compiled a small list:

Abbreviation	Explanation in German	Explanation in English
ZnSe	Zinkselenid	zinc selenide
GaAs	Galliumarsenid	gallium arsenide
Ge	Germanium	germanium
Si	Silizium	silicon
Cu	Kupfer	copper
dia	Durchmesser	diameter
thk	Dicke	thickness
e.t.	Randdicke	edge thickness
f.l.	Brennweite	focal length
c.t.	Mittendicke	center thickness
wedge	Keilwinkel	wedge
ROC	Krümmungsradius	radius of curvature
men	Meniskus(linse)	meniscus (lens)
cc	konkav	concave
xx mcc	xx m konkav	xx m concave
cx	konvex	convex
xx mcx	xx m konvex	xx m convex
po	plan	plano
Abs.	Gesamtabsorption	absorption
PR	Auskoppelspiegel	partial reflector
BS	Strahlteiler	beamsplitter
TR	Spiegel	total reflector
TRZ	0°-Phasenschieber	total reflector zerophaseshift
RPR	Phasenschieber	reflective phase retarder
HRPR	hochreflektierender Phasenschieber	high reflecting phase retarder
HR	hochreflektierender Spiegel	high reflector
%R @ 10,6 µm	% Refl. für 10,6 µm bei Auskoppelspiegeln	% reflectivity at 10.6 µm
AR	Entspiegelung	anti-reflection coating
PS	Silber mit Schutzschicht	protective silver coating
ES	vergütete Silberbeschichtung	enhanced silver coating
SES	spezialvergütete Silberbeschichtung	super enhanced silver coating
EG	vergütete Goldbeschichtung	enhanced gold coating
PPR	spezielle Beschichtung für gepulste Laser	partial reflecting coating for pulsed lasers
PVAR	Entspiegelung für gepulste Laser	anti-reflection coating for pulsed lasers
MMR	metallisch-dielektrische Beschichtung	max. metallic reflector coating
UC	unbeschichtet	uncoated
FG	geschliffen	fine grind
FS	poliert	fine shine
SPT	gedreht	single point turned
C.A.	freie Apertur, Prüfbereich	clear aperture
C.A.	Beschichtungsdurchmesser	coated aperture
AOI	Einfallswinkel	angle of incidence



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