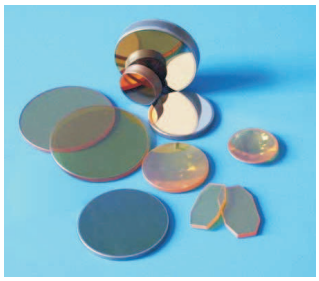
Optics for CO_2-Laser

Tydex offers various optics for CO_2-lasers. Suitable materials for such application are Silicon, Zinc Selenide, Germanium, Gallium Arsenide and Potassium Chloride. Depending on a customer needs we propose the following parts:



- **MIRRORS**
- **WINDOWS**
- **LENSES**
  - **Plano-convex lenses**
  - **Meniscus lenses**
  - **Cylindrical lenses**
  - **Custom-made lenses**
- **PARTIAL REFLECTORS**
  - **Beamsplitters**

Various coatings such as AR, BBAR, PR, HR are available.

MIRRORS

Optical components - mirrors are intended for the following applications:
- laser resonators;
- systems of transforming and focusing of laser's beam.

Silicon is effectively used as the substrates for production of CO_2 mirrors. Laser resonators can be formed in different designs but the cavity mirrors basically consist of a total reflector and an output coupler. The total reflectors are used as rear reflectors and fold mirrors and externally as beam benders in beam delivery systems.

We mainly offer plane, concave, and convex elements. Circular, rectangle, and ellipsoid configuration of the mirrors are realizable.

The reflectivity of such mirrors should be as high as possible for a laser wavelength. To meet above requirement Tydex provides some types of total reflecting coatings on the base of Au which allow to achieve more than 99.0% reflectance at 10.6 µm. Upon special inquiry above coatings can be optimized not only to provide high reflectance at 10.6 µm but to emphasize a definite wavelength at visible spectral range as well. Such coatings for the application discussed withstand power density to 1 kW/cm^2 in CW mode and energy density to 1 J/cm^2 for pulsed lasers.

SILICON MIRRORS

Silicon is the most commonly used mirror substrate. Its advantages are low cost, good durability, and thermal stability. Low value of the coefficient of linear thermal expansion and its weak increasing with the temperature make Silicon key material for low power CO_2-lasers.

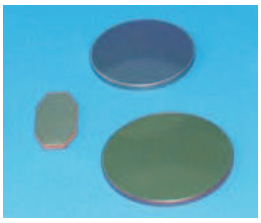
Specification:

Material		**monocrystalline Cz-Si**
Shape of the working surface		plane, spherical
Dimensional range (diagonal of optical part), mm		to 200
Clear aperture		> 90% of a size
Diameter (width & length) tolerances, mm		+0.0 / -0.1
Thickness tolerance, mm		+/- 0.1
Parallelism (concentricity) plano&radiused, arc. min.		<= 5
Surface quality, scr/dig:	for parts to 3 inches	40/20
	for larger parts	60/40
Surface figure (power-irregularity) @ 633 nm:	plano, fringes	1 - 1/2
	radiused	depends on radius
Coating type & Reflectivity* @ 10.6 µm, AOI = 0 deg:	HR, protected Au, %	99.0
	HR, enhanced Au, %	99.2
Damage threshold:	CW mode, kW/cm^2	1
	pulse mode, J/cm^2	1

* upon special inquiry we can provide the reflectivity for VIS wavelengths as high as 85% while saving the above values for 10.6 µm wavelength.

WINDOWS

Windows are used in optical systems to separate the environment of one part of the system from another. For CO_2-lasers Tydex offers windows produced from



- Germanium,
- Zinc Selenide:
  - AR coated windows,
  - Uncoated windows,
  - Combined coated windows,
  - Brewster windows,
- Gallium Arsenide.

GERMANIUM WINDOWS

Specification:

Material		**optical grade monocrystalline Ge**
Clear aperture		> 90% of a size
Diameter (width & length) tolerances, mm		+0.0 / -0.1
Thickness tolerance, mm		+/- 0.1
Parallelism, arc. min.		<= 5
Surface quality, scr/dig:	for parts to 3 in.	40/20
	for parts to 8 in.	60/40
	for larger parts	80/50
Surface figure (power-irregularity) @ 633 nm, fringes		1 - 1/2
Coating (residual reflectivity is specified per surface), %:	AR/AR @ 10.6 µm	< 0.5
	BBAR/BBAR @ 9-11 µm	2.0
Damage threshold (CW mode, kW/cm^2)		1

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ZnSe AR COATED WINDOWS

Specification:

Material	CVD-ZnSe
Diameter tolerance, mm	+0.0 / -0.1
Thickness tolerance, mm	+/- 0.25
Parallelism, arc min	<= 3
Clear aperture	90% of diameter
Surface quality, scr/dig	40/20
Surface figure (power-irregularity)@ 633 nm, fringes	1 - 1/2
AR coating reflectivity per surface @ 10.6 µm, %	< 0.5

BBAR coatings are also available for NIR-MIR.

ZnSe UNCOATED WINDOWS

Specification:

Material	CVD-ZnSe
Diameter tolerance, mm	+0.0 / -0.1
Thickness tolerance, mm	+/- 0.25
Parallelism, arc min	<= 3
Clear aperture	90% of diameter
Surface quality, scr/dig	40/20
Surface figure (power-irregularity)@ 633 nm, fringes	1 - 1/2

The following windows (coated and uncoated) are available from stock:

Diameter		Thickness	
inches	mm	inches	mm
0.250	6.35	0.080	2.0
0.375	9.52	0.080	2.0
0.50	12.7	0.080	2.0
0.75	19.1	0.080	2.0
1.00	25.4	0.080	2.0
1.00	25.4	0.120	3.0
1.10	27.9	0.120	3.0
1.50	38.1	0.120	3.0
2.00	50.8	0.200	5.1
2.50	63.5	0.250	6.4
3.00	76.2	0.250	6.4

Custom sizes are manufactured upon request.

ZnSe COMBINED COATED WINDOWS

For different applications and in particular for dental industry we produce ZnSe combiners allowing to achieve high transmission at working ("drilling") wavelength and reflect "pilot" beam to have enough illumination of an object under prosthetics procedure.

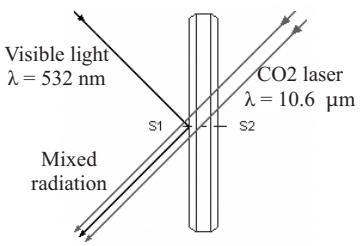

Fig. 1 Combined coated window.

Alternative sizes and custom designs are manufactured upon request.

Specification:

Material	CVD-ZnSe, grade G1
Clear aperture	> 90% of diameter
Diameter tolerances, mm	+0.0 / -0.1
Thickness tolerance, mm	+/- 0.1
Parallelism, arc. min.	<= 5
Surface quality, scr/dig	40/20
Surface figure (power-irregularity) @ 633 nm, fringes	1 - 1/2
Coating combined, to meet the following parameters:	
transmission @ 10.6 µm, AOI = 45 deg, %	>= 95.0
reflectance from one surface @ 532 nm, AOI = 45 deg, %	>= 80.0

BREWSTER WINDOWS

Specification:

Material	CVD-ZnSe
Width tolerance, mm	+0.0 / -0.1
Length tolerance, mm	+0.0 / -0.1
Thickness tolerance, mm	+/- 0.25
Parallelism, arc min	<= 3
Clear aperture, % (of length and width)	90%
Surface quality, scr/dig	40/20
Surface figure (power-irregularity) @ 633 nm, fringe	1 - 1/2
Brewster angle @ 10.6 µm, deg	67.4

The following windows are available from stock:

Width		Length		Thickness	
inches	mm	inches	mm	inches	mm
0.40	10.2	1.04	26.4	0.080	2.0
0.50	12.7	1.30	33.0	0.080	2.0
0.60	15.2	1.56	39.6	0.080	2.0
0.70	17.8	1.82	46.2	0.080	2.0
0.80	20.3	2.08	52.8	0.120	3.0
0.90	22.9	2.34	59.4	0.120	3.0
1.00	25.4	2.60	66.0	0.120	3.0
1.50	38.1	3.91	99.3	0.160	4.0

Custom sizes are manufactured upon request.
For price quotation and delivery please fax or e-mail us.

LENSES

The lens is the key optical component for CO_2-laser-based units. Due to its curved shape it allows to transform incident collimated beam into tiny-size area and thus concentrate the entire power of laser source in the shape of a spot.

Plano-convex lenses are the most economical transmissive focusing elements. Its prime advantage is the lower cost, whereas meniscus lenses can provide better performance, since they are specifically designed to minimize spherical aberration.The lenses of both designs can be effectively

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Optics for CO_2-Laser

utilized for CO_2-laser-based heatreating, welding, cutting, drilling, and marking apparatuses.
Besides the plano-convex and meniscus lens shapes already mentioned, Tydex supplies biconvex and cylindrical lenses. Custom-made lenses are manufactured upon request.
Zinc Selenide, Gallium Arsenide, and Potassium Chloride can be used for production of lenses. Standard ZnSe and GaAs lenses are offered with both surfaces AR coating at 10.6 µm. KCl lenses are supplied uncoated.

PLANO-CONVEX LENSES

Specification:

Material		**CVD-ZnSe, GaAs, KCl**
Effective focal length (EFL) tolerance, %		+/- 2
Diameter tolerance, mm		+0.0 / -0.1
Thickness tolerance, mm		+/- 0.25
Edge thickness variation (ETV), mm		<= 0.05
Clear aperture, % of diameter		90%
Surface figure (power-irregularity) @ 633 nm:	plano, fringes	1 - 1/2
	radiused	depends on radius
Surface quality, scr/dig		40/20
AR coating reflectivity per surface @ 10.6 µm, %		< 0.5

BBAR coatings are also available for NIR-MIR.

MENISCUS LENSES

Specification:

Material	**CVD-ZnSe, GaAs**
Effective focal length (EFL) tolerance, %	+/- 2
Diameter tolerance, mm	+0.0 / -0.1
Thickness tolerance, mm	+/- 0.25
Edge thickness variation, mm	<= 0.05
Clear aperture	90% of diameter
Surface quality, scr/dig	40/20
Surface figure (power-irregularity) @ 633 nm	depends on radius
AR coating reflectivity per surface @ 10.6 µm, %	< 0.5

BBAR coatings are also available for NIR-MIR.

The plano-convex lenses and meniscus lenses of the following sizes are available from stock:

Diameter		**EFL**	
inches	mm	inches	mm
0.50	12.7	1.00	25.4
0.75	19.1	1.50	38.1
1.00	25.4	2.50	63.5
1.00	25.4	3.75	95.3
1.00	25.4	5.00	127.0
1.00	25.4	10.00	254.0
1.10	27.9	2.50	63.5
1.10	27.9	3.75	95.3
1.10	27.9	5.00	127.0
1.10	27.9	7.50	190.5
Diameter		**EFL**	
inches	mm	inches	mm
1.50	38.1	2.50	63.5
1.50	38.1	3.50	88.9
1.50	38.1	5.00	127.0
1.50	38.1	7.50	190.5
2.00	50.8	5.00	127.0
2.50	63.5	5.00	127.0
2.50	63.5	10.00	254.0
3.00	76.2	5.0	127.0
3.00	76.2	10.00	254.0

Custom sizes are manufactured upon request.

CYLINDRICAL LENSES

Specification:

Material		CVD-ZnSe
Effective focal length tolerance, %		+/- 2
Diameter (width&length) tolerances, mm		+0.0 / -0.1
Thickness tolerance, mm		+/- 0.25
Edge thickness variation, mm		<= 0.05
Clear aperture		> 85% of a size
Surface figure (power-irregularity) @ 633 nm:	plano, fringes	1 - 1/2
	radiused	depends on radius
Surface quality, scr/dig		60/40
AR Coating reflectivity per surface @ 10.6 µm, %		< 0.5

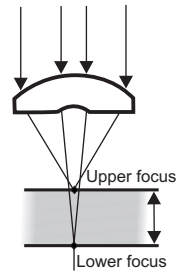
BBAR coatings are also available for NIR-MIR.

CUSTOM-MADE LENSES

DUAL-FOCUS LENS

Dual-focus lenses (DFL) are a revolutionary new type of lens for CO_2 laser cutting.
DFL are intended to be used as a direct replacement for conventional lenses in some industrial laser systems and applications. The basic principal of the lenses coming from their title lies in existence of a couple of focal points. Complex design of these lenses allows to distribute an incident laser energy and deliver its calculated fraction into a secondary (lower) focus.
Especially designed to assist in a range of thick-section cutting jobs such lenses give the following advantages:

- processing of increased thicknesses at a given power,
- increased process speed,
- improved kerf quality,
- elimination of upper and lower surface dross,
- immediate cut-initiation,
- reduced assist-gas usage,
- improved process control.



Δ EFL=material thickness

Tydex proposed and has been using a novel approach in fabrication of DFL, which in particular did allow us to create DFL of cylindrical shape.

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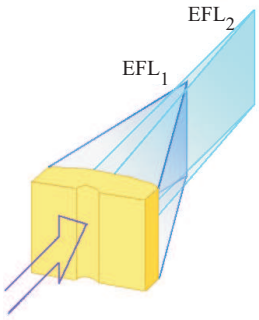


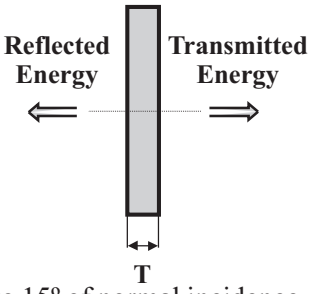
Fig. 2 Cylindrical DFL working principle.

Specification:

Type of a part	cylindrical dual-focus lens
Material	**CVD-ZnSe**
Overall dimensions, mm	25.4(+0/-0.25)x25.4(+0/-0.25)
Thickness, mm	4.0 (+0.5/-0.0)
Radii of curvature	depend on required combination of EFL
EFL tolerance @10.6 µm, %	+/- 2
Stripe width, mm	4 (+0.5/-0)
Surfaces quality, scr/dig	60/40
Surface figure, fringes	8
AR Coating reflectivity per surface @10.6 µm, %	< 0.5

Tydex supplies cylindrical DFL with the following EFL combinations: 127&254 mm and 169&254 mm. Alternative sizes and custom designs are manufactured upon request.

PARTIAL REFLECTOR



The most common uses of partial reflectors are output couplers or beam attenuators. In these applications they are intended for use at (or close to) normal incidence. The standard coatings described here will perform to specification if used within 10º to 15º of normal incidence, depending upon the reflectivity.

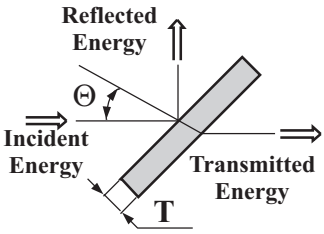
Specification:

Material		**CVD-ZnSe**
Diameter tolerance, mm		+0.0 / -0.1
Thickness tolerance, mm		+0.1 / -0.2
Thickness (radiused) tolerance, mm		+/- 0.25
Parallelism, arc min:	plano	<= 3
	radiused	<= 10 (diameter <1")
	radiused	<= 5 (diameter >=1")
Surface figure (power-irregularity) @ 633 nm:	plano, fringes	1 - 1/2
	rudiused	depends on radius
Surface quality, scr/dig		40/20
Side 1: Reflectivity tolerance @ 10.6 µm:	1-5%	+/- 0.5% x R
	6-85%	+/- 5%
	86-95%	+/- 2%
	96-98%	+/- 1%
	99-99.5%	+/- 0.2%
Side 2: AR Coating reflectivity per surface @ 10.6 µm		<= 0.5%

The following reflectors are available from stock:

Diameter		**Thickness**	
inches	mm	inches	mm
0.250	6.35	0.080	2.0
0.375	9.52	0.080	2.0
0.50	12.7	0.080	2.0
0.75	19.1	0.080	2.0
1.00	25.4	0.120	3.0
1.00	25.4	0.236	6.0
1.10	27.9	0.120	3.0
1.10	27.9	0.236	6.0
1.50	38.1	0.120	3.0
2.00	50.8	0.200	5.1
2.00	50.8	0.300	7.6

BEAMSPLITTERS



Beamsplitters allow a certain percentage of incident energy to be reflected while transmitting the remainder. In most cases beamsplitters are angle, wavelength, and polarization sensitive.

Specification:

Material		**CVD-ZnSe**
Diameter tolerance, mm		+0.0 / -0.1
Thickness tolerance, mm		+/- 0.25
Parallelism, arc min		<= 3
Clear aperture		90% of diameter
Surface quality, scr/dig		40/20
Surface figure (power-irregularity) @633 nm, fringes:		1 - 1/2
Side 1: Reflectivity tolerance @ 10.6 µm, %	1% - 5%	+/- 0.5 x R
	6% - 85%	+/- 7
	86% - 93%	+/- 5
	94% - 99.5%	+/- 0.5
Side 2: ARcoating reflectivity per surface @10.6 µm, %		typically <1, varies with polarisation and incidence angle
Angle of incidence, deg		45

The following beamsplitters are available from stock:

Diameter		**Thickness**	
inches	mm	inches	mm
0.375	9.52	0.080	2.0
0.50	12.7	0.080	2.0
0.75	19.1	0.080	2.0
1.00	25.4	0.080	2.0
1.00	25.4	0.120	3.0
1.10	27.9	0.120	3.0
1.50	38.1	0.120	3.0
2.00	50.8	0.200	5.1

Alternative sizes are manufactured upon request.

The finished parts of different dimensions are available from stock and supplied within a week. Please check the Optics stock at our website.

For price quotation and delivery please fax or e-mail us.

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